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CITY OF TUCSON, a municipal corporation, Plaintiff/Appellee,

v.

Cheryl A. TANNO and the Estate of Pasquale J. Tanno, Defendants/Appellants.

No. 2 CA-CV 2017-0143

Court of Appeals of Arizona, Division 2.

Filed October 10, 2018

Jennings, Strouss & Salmon P.L.C., Tucson, By John J. Egbert and Danielle J.K. Constant, Counsel for Plaintiff/Appellee

Stubbs & Schubart P.C., Tucson, By Thomas M. Parsons, Counsel for Defendants/Appellants

Judge Eppich authored the opinion of the Court, in which Presiding Judge Vásquez and Judge Espinosa concurred.

OPINION

EPPICH, Judge:

¶1 In this eminent domain case, Cheryl Tanno and the estate of Pasquale Tanno appeal from a final judgment awarding them \$365,910 in compensation for real property condemned by the City of Tucson. They argue the trial court committed error in making evidentiary determinations, refusing to tender certain jury instructions, and declining to award sanctions for a purported discovery violation. For the reasons that follow, we affirm.

Factual and Procedural Background

¶2 In 2015, the City of Tucson filed an eminent domain complaint in superior court seeking to condemn a parcel of real property owned by the Tannos. The city sought to acquire the property for the development of the "Downtown Links," a proposed roadway project it asserted was for public use. In response, the Tannos requested a

determination of the value of the condemned property and a jury trial.

¶3 After the conclusion of discovery, the city filed several motions in limine seeking to exclude portions of expert testimony disclosed by the Tannos, portions of Cheryl's testimony regarding the value of her property, and evidence relating to certain legal theories advanced by the Tannos. After conducting three hearings, the trial court granted the majority of the city's motions.

¶4 The case proceeded to a jury trial, where the sole issue was the value of the Tanno property. At trial, the court reaffirmed its prior evidentiary rulings, in some instances considering more evidence than was available at the time of its pretrial rulings. The jury returned a verdict in favor of the Tannos, awarding them \$365,910 for the fair market value of the property. The trial court issued a final, appealable judgment based on the jury's verdict. We have jurisdiction pursuant to A.R.S. § 12-2101(A)(1).

Eminent Domain

¶5 In Arizona, the state, a county, city, town, village, political subdivision, or person, may exercise the right of eminent domain to acquire property for public use. *See* A.R.S. § 12-1111. Pursuant to our constitution, however, a property owner is entitled to just compensation for land taken by eminent domain. Ariz. Const. art. II, § 17. "Just compensation is the amount of money necessary to put the property owner in as good a

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financial position as if the property had not been taken." *City of Phoenix v. Wilson*, 200 Ariz. 2, 5, ¶ 8, 21 P.3d 388, 391 (2001). Further, "[t]he value of land taken by eminent domain in Arizona is to be determined by the market value of the property: by what a willing buyer would pay for the property and what a willing seller would take." *State ex rel. Ordway v. Buchanan*, 154 Ariz. 159, 162, 741 P.2d 292, 295 (1987). The market value of the property is set as of the day of the summons. A.R.S. § 12-1123(A).

¶6 The Tannos argue the trial court committed several errors that prevented them from receiving just compensation for their property. Their arguments largely stem from the court's decision not to admit certain evidence, which the Tannos contend would have shown the property's value. "A trial court has broad discretion in the admission of evidence, and we will not disturb its decision absent an abuse of that discretion and resulting prejudice." *Crackel v. Allstate Ins. Co.*, 208 Ariz. 252, 268, ¶ 59, 92 P.3d 882, 898 (App. 2004). "To test whether a trial court has abused its discretion, we must determine not whether we might have so acted under the circumstances, but whether the lower court exceeded the bounds of reason by performing the challenged act." *Toy v. Katz*, 192 Ariz. 73, 83, 961 P.2d 1021, 1031 (App. 1997). "It is well established law in Arizona that appellate courts will not disturb the exercise of discretion of the trial court if it is supported by any reasonable evidence." *Peters v. M & O Constr., Inc.*, 119 Ariz. 34, 36, 579 P.2d 72, 74 (App. 1978).

Evidence of Project Influence

¶7 The Tannos first argue the trial court erred in precluding evidence of the city project's influence on the value of their property. They argue they should have been permitted to present evidence of a roadway project initiated by the Arizona Department of Transportation (ADOT) in the 1980s, asserting the Downtown Links is a continuation of that same project. They argue the decades-long development of the roadway resulted in a substantial decrease to the value of their property, or "condemnation blight."

¶8 Under the project influence doctrine, "property may not be charged with a lesser or greater value at the time of taking, when the change in value is caused by the taking itself or by anticipation of appreciation or depreciation arising from the planned project." *City of Phoenix v. Clauss*, 177 Ariz. 566, 569, 869 P.2d 1219, 1222 (App. 1994); see also A.R.S. § 28-7097 ("[W]hen determining the market value of the property to be taken ... a decrease or increase in the market value ... before the date of valuation caused by the public project

for which the property is to be acquired ... shall be disregarded."). Thus, pursuant to this doctrine, a property owner in an eminent domain action is entitled to recover damages from a decrease in value caused by the government project for which the property is taken. See *Clauss*, 177 Ariz. at 569, 869 P.2d at 1222. But, "[t]he doctrine applies only to properties that were 'probably within the scope of the project from the time the government was committed to it.'" *Id.* (quoting *City of Tucson v. Ruelas*, 19 Ariz. App. 530, 532, 508 P.2d 1174, 1176 (1973)).

¶9 The trial court determined the ADOT project and the Downtown Links were separate and distinct projects. The court thus concluded that any decrease in value caused by the ADOT project would not have been recoverable as damages caused by development of the Downtown Links project. In doing so, the court concluded the ADOT project had been abandoned "in or about the year 2000," and further concluded "the City began planning the Downtown Links Project in approximately 2005 or 2006." As a result, the court precluded the Tannos "from seeking damages for 'Condemnation Blight' allegedly caused by the State of Arizona's plans and activities related to the [ADOT project]."

¶10 The Tannos have not established the trial court abused its discretion, as there was reasonable evidence to support the court's conclusion that the Downtown Links was distinguishable from the ADOT project. See *Peters*, 119 Ariz. at 36, 579 P.2d at 74. While the projects are similar, perhaps even similar enough to support a determination that the Downtown Links is a continuation of the prior ADOT project, our role on review is limited to determining whether there was

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reasonable evidence to support the court's conclusion that the two projects were distinct. See *Toy*, 192 Ariz. at 83, 961 P.2d at 1031.

¶11 The ADOT project initially sought to construct a state route with a speed limit of fifty miles per

hour, similar to a freeway. Plans for the Downtown Links also include a parkway-style roadway, but with plans to include landscaping, major infrastructure for rainwater drainage, and a speed limit of thirty miles per hour. There was evidence the city had planned to complete the last mile of the project which had been abandoned by ADOT in 1989.¹ However, the Downtown Links was not approved by a city resolution until 2009. If the Downtown Links were a mere continuation of the ADOT project, we fail to see how a separate resolution approving it would have been necessary.

¶12 Based on the trial court's reasonable conclusion that the two projects were distinct, any decrease in value caused by the ADOT project would not have been attributable to the Downtown Links. Thus, any evidence of such would not be admissible as evidence of project influence from the Downtown Links. *See Clauss*, 177 Ariz. at 569, 869 P.2d at 1222. Accordingly, the court did not abuse its discretion in precluding the Tannos from seeking damages for project influence prior to 2005 or 2006, the timeframe in which the city had apparently committed to the Downtown Links project.

Evidence of Best Use

¶13 The Tannos next argue the trial court erred in disallowing evidence of the best use of their property. Specifically, they contend they should have been permitted to present expert testimony of the property's potential "assemblage" with other properties in the area, thereby increasing its potential value.²

¶14 In order to determine the value of property in a condemnation case, the highest and best use of the property must be considered. *Wilson*, 200 Ariz. 2, 5-6, ¶ 8, 21 P.3d 388, 391-92. There is no rigid formula to determine the value of a parcel of property, and each case must be viewed in light of its own facts. *Id.* ¶¶ 15-16. While the best use of a smaller tract of property may be in combination with others as part of a larger tract of property (as in an assemblage theory), such evidence of best use should be grounded in common sense and

market data. *Cf. id.* ¶¶ 12, 16. "Remote and speculative damages may not be considered in eminent domain cases." *City of Tucson v. Estate of DeConcini*, 155 Ariz. 582, 583, 748 P.2d 1206, 1207 (App. 1987).

¶15 The trial court precluded evidence of assemblage, stating it was the Tannos' "burden to show that as of the time of taking, development based on assemblage of surrounding parcels was reasonably probable at any time in the foreseeable future," and concluding the Tannos had failed to meet that burden. It also noted that even if there was some evidence to show that assemblage was probable, the expert's opinion on the value of the property apparently did not depend on an assemblage theory. The expert assigned the same value to the Tannos' property both as a single parcel and under an assemblage theory. The court thus concluded "the theory of assemblage is of very minimal relevance and its relevance is substantially outweighed by Rule 403 considerations of wasting time and confusing the issues and misleading the jury." *See Ariz. R. Evid.* 403.

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¶16 The Tannos have not established the trial court abused its discretion in concluding the possibility of assemblage was remote or speculative. *See id.* In support of their argument, the Tannos point to a city document showing their property could be joined with surrounding properties into a larger tract for development. But the document does not establish that assemblage of the properties would be supported by the market or that it was likely to occur. *See Wilson*, 200 Ariz. 2, 8, ¶ 16, 21 P.3d 388, 394. Indeed, interests in the surrounding properties were owned by the state or the city, presenting a significant obstacle to joining them with the Tanno parcel.

¶17 Furthermore, the Tannos apparently do not contest the trial court's conclusion that the expert's testimony on value was not based on assemblage. Thus, the court could have reasonably concluded that theory had minimal

probative value to the expert's testimony. Accordingly, it was within the court's discretion to preclude evidence of assemblage if its probative value was substantially outweighed by the dangers of wasting time, confusing the issues, or misleading the jury, as it did here. *See* Ariz. R. Evid. 403. We see no abuse of discretion.

Owner Testimony

¶18 The Tannos also argue the trial court "improperly excluded, or improperly limited, [Cheryl] Tanno's opinion of value, as the [property] owner," asserting the court's rulings effectively precluded her from "explaining the methods she used to support her opinion of value." In Arizona, a property owner may always testify about the value of his or her property because "[a]n owner of property has, by definition, knowledge of the components of value that are useful in ascertaining value." *Town of Paradise Valley v. Laughlin*, 174 Ariz. 484, 486, 851 P.2d 109, 111 (App. 1992) (alteration in *Laughlin*) (quoting *United Cal. Bank v. Prudential Ins. Co. of Am.*, 140 Ariz. 238, 304, 681 P.2d 390, 456 (App. 1983)). In other words, a property owner may testify to the value of his or her property because he or she has knowledge of what makes it valuable, even if he or she is not qualified as an expert. *Id.*

¶19 The Tannos argue Cheryl should have been able to testify that \$250,000 from 1993 would have been worth \$1,065,655 in 2015 had it been invested in companies listed in the stock market's S & P 500.³ They point to a 1993 negotiation with the city, in which both sides purportedly agreed the property was worth \$250,000. The trial court precluded evidence of the value of the hypothetical investment, concluding Cheryl "did not tie that figure to what she thinks the fair market value of her property was in 2015." It found that line of testimony would be irrelevant, and concluded even if it were relevant, it would be "substantially outweighed by Rule 403 concerns."

¶20 The Tannos have not established the trial court abused its discretion in precluding evidence of a hypothetical investment. When deposed,

Cheryl could not tie the value of her hypothetical investment to the actual value of her property, or any components of value thereof. As such, her opinion of value based on an investment theory was not rooted in her experience as a land owner—the very experience which would have qualified her to give valuation testimony notwithstanding her lack of expert qualifications. *See Laughlin*, 174 Ariz. at 486, 851 P.2d at 111. We therefore cannot conclude the trial court abused its discretion in limiting this aspect of Cheryl's testimony, even in light of the general latitude given to land owners testifying to the value of their property. *See id.*; *see also* Ariz. R. Evid. 403.

Motions in Limine

¶21 The Tannos also argue the trial court's evidentiary rulings, described above, constituted "improper[] ... dispositive relief," contrary to Rule 56, Ariz. R. Civ. P. In order for us to reach this issue, we first consider whether the Tannos have waived any right of review for failure to present the issue below. *See*

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Cont'l Lighting & Contracting, Inc., v. Premier Grading & Utils., LLC, 227 Ariz. 382, 386, ¶ 12, 258 P.3d 200, 204 (App. 2011) (argument waived by failing to raise it below). The Tannos did not raise any argument premised upon Rule 56 in any of their written responses opposing the city's motions in limine. In response to the trial court's questioning at a pretrial hearing, however, the Tannos argued "[i]f [the admissibility of evidence of assemblage] were a question of law, it should have been brought up as a motion for partial summary judgment." While not particularly well-developed below, we conclude the issue as it relates to evidence of best use (or assemblage) was sufficiently preserved for our review.

¶22 Based on the briefs submitted on appeal, the arguments of counsel at oral argument before this court, and our own review of the record, it appears the Tannos failed to raise a Rule 56 challenge to the project influence and owner

testimony regarding value rulings below. As a general rule, appellate courts "will not consider issues not raised in the trial court." *Hawkins v. Allstate Ins. Co.*, 152 Ariz. 490, 503, 733 P.2d 1073, 1086 (1987). Our supreme court has explained: "The concept of waiver is based on two factors: fair notice and judicial efficiency." *Geronimo Hotel & Lodge v. Putzi*, 151 Ariz. 477, 479, 728 P.2d 1227, 1229 (1986). But, waiver "is merely a rule of procedure, and not a matter of jurisdiction," *Town of S. Tucson v. Bd. of Supervisors*, 52 Ariz. 575, 582, 84 P.2d 581, 584 (1938), and our supreme court has, in its discretion, declined to find waiver when considering "issues of statewide importance, those of constitutional dimension or situations in which the public interest is better served by having the issue considered rather than deferred," *Schoenfelder v. Ariz. Bank*, 165 Ariz. 79, 90 n.8, 796 P.2d 881, 892 (1990) (quoting *Dombey v. Phx. Newspapers, Inc.*, 150 Ariz. 476, 482, 724 P.2d 562, 568 (1986)); accord *Harris v. Cochise Health Sys.*, 215 Ariz. 344, 349, ¶ 17, 160 P.3d 223, 228 (App. 2007) ("[A]lthough Arizona appellate courts have the discretion to hear arguments first raised on appeal, we rarely exercise that discretion.").

¶23 This case involves the right of a property owner to receive just compensation for property condemned pursuant to eminent domain—a right of constitutional dimension. See Ariz. Const. art. II, § 17. The arguments presented for our review are purely legal and involve the same analysis as the Tannos' non-waived claim, making it judicially efficient for us to consider them. See *Geronimo Hotel & Lodge*, 151 Ariz. at 479, 728 P.2d at 1229. Moreover, the Tannos presented these arguments in their opening brief, and the city has been afforded the opportunity to, and did in fact, respond to them in its answering brief. See *id.* We thus conclude it is appropriate for us to address the Tannos' Rule 56 argument in its entirety. We review whether the court applied the proper legal standard in evaluating the city's motions de novo. See *Mobilisa, Inc. v. Doe*, 217 Ariz. 103, 107, ¶ 9, 170 P.3d 712, 716 (App. 2007).

¶24 The Tannos contend the city's motions in limine were essentially motions for summary judgment, and suggest the trial court's rulings did not comply with the requirements of Rule 56, effectively precluding their claim for just compensation. In support of their argument, the Tannos rely on two extra-jurisdictional cases holding a claim or defense may not be dismissed in a motion in limine. See *Meyer Intellectual Props. Ltd. v. Bodum, Inc.*, 690 F.3d 1354, 1378 (Fed. Cir.2012) ("Because we conclude that it was procedurally improper for the court to dispose of [defendant's] inequitable conduct defense on a motion *in limine*, we reverse the court's decision and remand for further proceedings."); *Gold Cross Ems, Inc. v. Children's Hosp. of Ala.*, 309 F.R.D. 699, 700-02 (S.D. Georgia 2015) ("The Court ... therefore finds that Plaintiff's motion in limine is an improper and untimely motion for summary judgment.").

¶25 But the Tannos have not provided any authority to establish that their theories of calculating just compensation through evidence of project influence, best use, and owner testimony, were, in and of themselves, claims or defenses. The trial court's rulings did not preclude the Tannos from pursuing their claim, which ultimately resulted in a monetary judgment in their favor. Rather, the court's rulings limited the evidence that could be introduced in support of the claim. As such, the court's rulings involved "disputed

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evidentiary issue[s]" of relevance and Rule 403 considerations, which may be properly considered in a motion in limine. See Ariz. R. Civ. P. 7.2. We see no error.

Remaining Issues

¶26 The Tannos additionally argue the trial court erred in refusing to tender jury instructions or special interrogatories consistent with their theory of the case. But, they fail to meaningfully develop this argument. They do not cite any legal authority requiring the court to tender the

instructions proposed, do not argue which instructions should have been given, and do not meaningfully establish how the instructions would have been supported by the facts in evidence. *See* Ariz. R. Civ. App. P. 13(a)(7) (argument must contain citations to legal authority and references to the record); *Clauss*, 177 Ariz. at 569, 869 P.2d at 1222 (jury instructions must be supported by facts in evidence). We therefore consider this argument waived, and decline to consider it further. *See Ritchie v. Krasner*, 221 Ariz. 288, 305, ¶ 62, 211 P.3d 1272, 1289 (App. 2009).

¶27 Similarly, the Tannos argue the trial court erred in declining to award sanctions for a purported discovery violation. Again, they fail to meaningfully develop this argument. Aside from providing a citation to Rule 37, Ariz. R. Civ. P., which generally affords the trial court discretion to award sanctions, their argument lacks citations to the record and argument supported by legal authority. *See* Ariz. R. Civ. App. P. 13(a)(7). This argument is waived. *See Ritchie*, 221 Ariz. 288, 305, ¶ 62, 211 P.3d 1272, 1289.

Disposition

¶28 The trial court's judgment is affirmed. Because the Tannos are not the prevailing party on appeal, we deny their request for attorney fees.

Notes:

¹ In particular, the Tannos rely on a city report outlining the background of the Downtown Links, which associates the Downtown Links with the ADOT project. According to the report, the ADOT project was largely completed in the 1980s with the exception of the final mile, which was not built due to "lack of funding and lack of community support." Responsibility for the final mile of the project was thus relinquished to the City of Tucson in 1989. Although the report supports the Tannos' argument, we are not persuaded it is sufficient to establish an abuse of the trial court's discretion.

² "Assemblage," also referred to as "joinder," is "a theory involving the prospect of joining separate parcels." *M & R Inv. Co. v. State ex rel. Dep't of Transp.*, 103 Nev. 445, 451, 744 P.2d 531, 535 (1987). "If the highest and best use of separate parcels would involve a prospective, integrated, unitary use, then such prospective use may be considered in fixing the value of the property condemned providing joinder of the parcels is *reasonably practicable*." *Id.*

³ The S & P 500 is an index of 500 widely held common stocks that measures the general performance of the financial market.

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STATE of Arizona, ex rel., Charles L.
MILLER, Director, Department of
Transportation, Petitioner,
v.
SUPERIOR COURT of the State of Arizona,
in and for the County of Maricopa, the
Honorable Ruth H. Hilliard, a judge
thereof, Respondent Judge,
A. Paul STEPHENS, Sr. and Jane Doe
Stephens, husband and wife; A. Paul
Stephens, Sr. a married man, as his sole
and separate property; A. Paul Stephens,
Jr., a married man, as his sole and
separate property; A. Paul Stephens, Jr.
and Jane Doe Stephens, husband and wife;
Elizabeth Jane Stephens, as her sole and
separate property; First Interstate Bank;
Arrowhead Section 30 Corporation, an
Arizona corporation; Skunk Creek
Properties, Inc., an Arizona corporation,
Real Parties in Interest.
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[189 Ariz. 229] Grant Woods, The Attorney General by James R. Redpath, Joe Acosta, Jr., and George E. Mariscal, Assistant Attorneys General, Transportation Section, Phoenix, for Petitioner Phoenix.

Meyer & Vucichevich by Rad L. Vucichevich and Stanley Z. Goodfarb, Phoenix, for Real Parties in Interest Stephens Phoenix.

Bell Law Office by Leonard M. Bell, Scottsdale, and Streich Lang by Dan M.

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[189 Ariz. 230] Durrant, Phoenix, for Real Parties in Interest First Interstate Bank Phoenix.

OPINION

THOMPSON, Presiding Judge.

Can a property owner introduce an Arizona Department of Transportation (ADOT) appraisal and portions of a stipulated agreement as an admission against interest on value after a partial taking? We find such evidence is barred as evidence of compromise under Arizona Rule of Evidence 408 if not already statutorily precluded by Ariz.Rev.Stat. Ann. (A.R.S.) § 12-1116(J).¹ Relief granted.

I. JURISDICTION

Petitioner ADOT urges us to accept special action jurisdiction to address the trial court's denial of two of its motions in limine. The motions sought to preclude an appraisal review and valuation approval (the Appraisal) prepared by an ADOT employee and the stipulation agreement (the Agreement)² between the property owners and ADOT.³ Admission of the Appraisal and Agreement at trial, ADOT claims, would result in reversible error.

ADOT partially condemned real party in interest Stephens's⁴ property in Arrowhead Ranch for highway construction in February 1987. Recognizing the magnitude of this condemnation, our supreme court stated: "[A]DOT's exercise of eminent domain against the condemnees in these proceedings is the largest in Arizona history and will result in at least 9 separate condemnation trials...." State ex rel. Miller v. Filler, 168 Ariz. 147, 148, 812 P.2d 620, 621 (1991) (addressing another evidentiary issue on special action). Six years after Filler and ten years after the condemnation, six of those cases still await resolution--including Stephens's case.

Special action relief is reserved for those instances where there is no other equally plain, speedy or adequate remedy and is appropriately granted on pure questions of law where the issue is a matter of first impression and of statewide importance; this is one of those cases. See Orme School v. Reeves, 166 Ariz. 301, 303, 802 P.2d

1000, 1002 (1990); Arizona Rules of Procedure for Special Actions 1.

II. ISSUES

We grant review of the following evidentiary issues:

1. Whether the Appraisal and Agreement are precluded from use at trial by Ariz.R.Evid. 408 (Rule 408) as evidence of compromise or an offer to compromise.

2. Whether the Appraisal and Agreement are precluded from use at trial under A.R.S. § 12-1116(J) as evidence of a stipulation for immediate possession or to prejudice ADOT.

We review legal questions de novo. *Libra Group, Inc. v. State*, 167 Ariz. 176, 179, 805 P.2d 409, 412 (App.1991).

III. FACTUAL AND PROCEDURAL HISTORY

The facts before us are undisputed. ADOT is the plaintiff in multiple lawsuits arising from condemnations in the Arrowhead Ranch area. On January 12, 1987, a stipulated agreement for immediate possession was reached between ADOT and some of the property owners, including Stephens. Pursuant to the Agreement, the signatory property owners agreed to make no objection to "ADOT's initiation, maintenance and prosecution of condemnation actions...." ADOT agreed to seek immediate possession and to deposit \$30,795,000 as the "value estimated by ADOT to be the fair value of the fee interest in the Property." The Agreement

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[189 Ariz. 231] provided that the property owners could withdraw the funds deposited.

The value estimated by ADOT was supported by Exhibit C to the Agreement; the bases for Exhibit C were the 1986 appraisal and the resulting January 9, 1987 appraisal review by ADOT employee Mike Chierighino (Chierighino).

On February 13, 1987, ADOT initiated condemnation proceedings in superior court. ADOT took immediate possession of a portion of Stephens's property around Beardsley Road and 59th Avenue.

The only viable issue for trial is the value of the property and the property owners' damages. Each party plans to offer expert testimony at trial on the value of the land. ADOT's recent valuations are lower than the amounts indicated in the Appraisal and Agreement.⁵ Therefore the property owners seek to introduce the Appraisal and Agreement as evidence relevant to value; they claim that these documents are "admissions against interest"⁶ by ADOT.

ADOT made motions in limine to preclude the Appraisal and Agreement. In support of its motions, ADOT introduced Chierighino's sworn affidavit that appraisal reviews are generally done for two purposes: (1) as a basis for the acquisition offer, and (2) to set the deposit amount for immediate possession. Chierighino's sworn statement says that his January 9, 1987 appraisal review was specifically prepared for the purposes of making an offer and setting the deposit amount.

The trial court found the Appraisal and Agreement admissible in its October 30, 1996 minute entry, which reads in pertinent part:

As to Plaintiff's Motion in Limine re. State's Deposit and Chierighino Appraisal, the Court notes that all parties agree that the amount of the deposit is not admissible. As to the issue of whether the review appraisal prepared by Chierighino dated 1/9/87 and the Summary and Distribution of ADOT Values dated 1/12/87 are admissible, the State seeks to preclude these documents based on ARS 12-1116(J) and seeks to preclude any witness from testifying about any figures included in those documents. The Defendants argue that the values included in these reports are admissible as the State's determination of value per ARS 28-1865 now (J), then (I) and, therefore, as an admission against interest under Rule 801(d)(2), Rules of Evidence.

The Court finds that the statutory determination of value is admissible as an admission against interest. Only the valuation figures are admissible, however.

IT IS ORDERED allowing into evidence the schedule of values from the 1/12/87 agreement.

Following this ruling, ADOT filed the special action petition now before us.

IV. DISCUSSION

The Arizona Constitution requires "just compensation" be paid to property owners prior to a taking. Ariz. Const. art. 2, § 17. "Just compensation" puts the property owner in the position he would have been in if no taking had occurred. Filler, 168 Ariz. at 149, 812 P.2d 620. "Just compensation" in partial takings is measured by (1) the fair market value of the property actually taken and (2) the diminution of the value of the remaining property. Id.; A.R.S. § 12-1122(A). "Fair market value" is the price a willing buyer would pay and a willing seller would accept. Defnet Land & Inv. Co. v. State ex rel. Herman, 103 Ariz. 388, 389, 442 P.2d 835, 836 (1968).

ADOT asserts two distinct bases supporting preclusion of the Appraisal and Agreement: (1) A.R.S. § 12-1116(J), and (2) Rule

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[189 Ariz. 232] of evidence 408, which pertains to evidence of settlement negotiations.

Property owners argued to the lower court that: (1) the appraisal report was statutorily required under A.R.S. § 28-1865(J) ⁷ to support the price for acquisition and therefore is a party admission under Rule 801(d)(2); (2) California law formed the basis for Arizona eminent domain law and, property owners argue, would have allowed for admission of the appraisal under a similar statute; (3) the evidence was not introduced under A.R.S. § 12-1116(J) and

therefore, the prohibition is irrelevant; and (4) Rule 408 is inapplicable.

1. Statutory Preclusion under A.R.S. § 12-1116(J)

ADOT maintains that both A.R.S. § 12-1116(J) and Rule 408 preclude the Appraisal and Agreement. Property owners claim that because no evidence was ever "introduced" pursuant to A.R.S. § 12-1116(J), the prohibition is irrelevant.

A.R.S. § 12-1116 is entitled "Actions for condemnation; immediate possession; money deposit" and details the procedure whereby immediate possession may be taken of condemned property. A.R.S. § 12-1116(J) reads:

No stipulation which is made nor any evidence which is introduced pursuant to this section shall be introduced in evidence or used to the prejudice of any party in interest on the trial of the action.

The statute explicitly precludes the use of either the stipulation or evidence introduced pursuant to the stipulation. Property owners assert that (1) A.R.S. § 12-1116(J) is inapplicable because it is the exhibits and not the Agreement itself which property owners wish to introduce; and (2) because the stipulation agreement happened privately and without a judicial hearing the protections of the statute no longer apply.

To apply the property owners' interpretation would be to read the statute too narrowly. We find that the stipulated agreement for immediate possession is a "stipulation" covered under the statute and Chierighino's appraisal review is "evidence" produced to show probable damages in court or used to effectuate that stipulation. Furthermore, we agree that any use of the Appraisal and Agreement at the trial on valuation would be highly prejudicial to ADOT.

2. Compromise Evidence under Rule 408

Rule 408 of Evidence reads, in part:

Evidence of (1) furnishing or offering or promising to furnish, or (2) accepting or offering or promising to accept, a valuable consideration in compromising or attempting to compromise a claim which was disputed as to either validity or amount, is not admissible to prove liability for or invalidity of the claim or its amount. Evidence of conduct or statements made in compromise negotiations is likewise not admissible. This rule does not require the exclusion of any evidence otherwise discoverable merely because it is presented in the course of compromise negotiations.

We find that the Appraisal was prepared either: (1) for the purposes of negotiating a stipulation between ADOT and the property owners to receive immediate possession without court intervention; or (2) to provide a court with evidence to determine probable damages after application for immediate possession under A.R.S. § 12-1116(J). Rule 408 precludes the evidence in, at least, the former situation; A.R.S. § 12-1116(J) surely precludes the evidence in the latter situation.

Rule 408 precludes more than the "offer" to compromise; conduct and statements made in the pursuit of a settlement are also precluded. The Appraisal by Chierighino falls squarely within the scope of "conduct and statements" because it was done to effectuate either the stipulation or a court determination for immediate possession.

In *Ramada Dev. Co. v. Rauch*, the Fifth Circuit Court of Appeals upheld the trial court's exclusion of an architect's report

discussed in monetary terms in the negotiations." *Id.* at 1107.

The Court of Appeals found the architect's report was not within the "otherwise discoverable" exception of Rule 408 because "such an exception does not cover the present case where the document, or statement, would not have existed but for the negotiations" *Id.* (emphasis added). That court further stated "[t]he rule does not indicate that there must be a pretrial understanding or agreement between the parties regarding the nature of the report." *Id.* We find that the architect's report in *Ramada Dev. Co.* is substantially similar to the Appraisal by Chierighino.

In *Berthot v. Courtyard Properties, Inc.*, a letter from plaintiff was excluded under Rule 408 where there was testimony that the letter allowed defendants a financial "credit" on their debt solely to get matters settled quickly. 138 Ariz. 566, 568, 675 P.2d 1385, 1387 (App.1983). Here, Chierighino's affidavit states the purpose of the Appraisal was for offer and deposit purposes, both of which fall under the purview of Rule 408.

3. California Law

Property owners indicate that, because Arizona's current eminent domain statutes were based on earlier California statutes, we should follow old California case law interpreting these outdated California statutes which allowed appraisals in evidence at trial.⁸ We disagree for the following reasons.

First, it must be noted that California has long since changed its statute to explicitly exclude appraisal reports or other statements made in connection to a deposit or withdrawal of funds. See California Code of Civil Procedure (C.C.P.) § 1255.060. The current California statute explicitly says "nor shall such a report or statement and summary be considered to be an admission of any party." C.C.P. § 1255.060(b).

Far from being nearly identical statutes, as the property owners claim, a comparison of the

[189 Ariz. 233] which detailed the investigation into alleged defects in a hotel built by Ramada for Rauch, on the basis that Rule 408 precluded its admission. 644 F.2d 1097, 1106-07 (5th Cir.1981). After reviewing Rule 408, the court concluded that the architect "was commissioned by Ramada to prepare a report that would function as a basis of settlement negotiations regarding the alleged defects in the motel ... that could then be

relevant sections from Arizona and California shows clear differences. A.R.S. § 12-1116(J) states:

No stipulation which is made nor any evidence which is introduced pursuant to this section shall be introduced in evidence or used to the prejudice of any party in interest on the trial of the action.

The old California statute read:

(a) The amount deposited or withdrawn pursuant to this chapter shall not be given in evidence or referred to in the trial of the issue of compensation.

We read the old California statute as more limited than A.R.S. § 12-1116(J) and note that it completely fails to address anything outside the actual amount of the deposit or withdrawal. The Arizona statute precludes not only the stipulation itself from being introduced but also "evidence which is introduced pursuant to this section." The Arizona statute even refers to the "prejudice" that may beset a party against whom such interim value estimates are introduced at trial on the issue of final valuation.

We decline to adopt an outdated rule from another jurisdiction when its statute is not even similar to our own. Further, we agree with the California Commission's policy-based comment that the new rule precluding appraisals ensures that the state will not make inadequate deposits to protect itself

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[189 Ariz. 234] and find it equally persuasive here in Arizona. ⁹

4. A.R.S. § 28-1865

Property owners next argue the Appraisal was conducted as statutorily required by A.R.S. § 28-1865(J) to justify ADOT's acquisition of the properties, and is therefore a party admission not excluded by Rule 408. The only evidence supporting the assertion that the Appraisal is, in fact, the A.R.S. § 28-1865(J) memorandum is an

ADOT employee's answer to a convoluted deposition question. ¹⁰

We find that even if the A.R.S. § 28-1865 appraisal constitutes an "admission" under Rule 801(d)(2), its status as an admission merely obviates a hearsay objection. Even if the Appraisal contained "admissions" under Rule 801(d)(2), they remain inadmissible as settlement matters under Rule 408. "Admissions" made in settlement offers are not admissible for policy reasons under Rule 408. Rule 801(d)(2) does not trump Rule 408. We are unpersuaded that the Appraisal by Chierighino is the A.R.S. § 28-1865(J) review, but we do not find that it would make a significant difference in the result here if it were. ¹¹

Finally, we determine that as a matter of policy when an agency is required to take steps to protect public funds, as here in requiring analysis of the financial worth of property, the agency should not be punished by being subject to the admission of that document at trial. See *United States v. Two Tracts of Land*, 412 F.2d 347, 350 (2nd Cir.1969), cert. denied, sub nom. *Sailors Haven Fire Island, Inc. v. United States*, 396 U.S. 906, 90 S.Ct. 222, 24 L.Ed.2d 183 (1969) (appraisal required for federal funding not admissible in determining damages at trial).

V. CONCLUSION

For the above stated reasons we reverse the trial court's ruling that the Appraisal and Agreement are admissible.

GRANT and VOSS, JJ., concur.

1 A.R.S. § 12-1116(J) controls the introduction of stipulation agreements and related evidence at any subsequent trial on value.

2 ADOT's motion did not focus on the "Agreement" itself, but rather on information contained in Exhibit C to the Agreement which states the number of square feet in each parcel

and makes an appraisal based on price per square foot.

3 We refer to these documents collectively as "the Appraisal and Agreement."

4 We refer to real parties in interest Stephens as Stephens and refer to the other real parties in interest as "property owners."

5 For example, ADOT's recent appraisals value Stephens's land, parcel 7-4064, at \$4.50 a square foot. The Appraisal and Agreement valued it at \$6.00 a square foot. Compensation and damages accrue as of the date of the summons and the land's actual value on that date is the measure of compensation and damages. A.R.S. § 12-1123(A).

6 The property owners have termed this an "admission against interest"; we refer to it, as does Rule 801(d)(2), as an admission by party opponent. Rule 801(d)(2) defines statements which are not hearsay; Rule 804(b)(3) concerns the hearsay exception for statements against interest when the declarant is unavailable.

7 A.R.S. § 28-1865(J) (Supp.1996) requires the ADOT Director to have an appraisal report justifying the economic basis for the condemnation of any property for transportation purposes valued at over \$2500. In 1987 this section was A.R.S. § 12-1865(I).

8 California has case law, prior to the 1975 Code amendments, allowing the admission of appraisal reports. See *People v. Cowan*, 1 Cal.App.3d 1001, 81 Cal.Rptr. 713 (1969) (holding that it was reversible error to deny property owner opportunity to call state appraiser who appraised the property when state had relied on appraisal in determining the deposit for the condemned property); *People v. Douglas*, 15 Cal.App.3d 814, 93 Cal.Rptr. 644 (1971). Both of these cases have been explicitly overruled by the new statute.

9 The Law Revision Commission Comment to the 1975 Addition to C.C.P. § 1255.060 states in part:

[T]he purpose of [the new changes are] to encourage the plaintiff to make an adequate

deposit by protecting the plaintiff from the defendant's use of the evidence upon which the deposit is based in the trial on the issue of compensation. If such evidence could be so used, it is likely that the plaintiff would make an inadequate deposit in order to protect itself against the use at the trial of evidence submitted in connection with the deposit....

10 To this end property owners also claim that an A.R.S. § 28-1865(J) report is admissible under the theory that "what a public officer does pursuant to a statutory obligation is admissible, except cases of statutory exclusion or confidentiality." In support of this theory property owners cite *Killingsworth v. Nottingham*, 18 Ariz.App. 356, 501 P.2d 1197 (1972). Ariz.R.Civ.P. 44(a) provides that records of public officials "shall be received in evidence as prima facie evidence of the facts therein stated." Arizona cases addressing Rule 44(a) and its predecessors hold that "[t]he statute making certain public records admissible in evidence was prompted by the rule ... of expediency of accepting hearsay testimony of public officers" and that the government documents are still subject to the general rules of admissibility. *State v. Stracuzzi*, 79 Ariz. 314, 318, 289 P.2d 187, 190 (1955) (superseded by statute as stated in *State v. Bradley*, 102 Ariz. 482, 433 P.2d 273 (1967)) (state mental hospital records in defendant's murder trial); *Douglass v. State*, 44 Ariz. 84, 95, 33 P.2d 985, 989 (1934) (military discharge forms were hearsay and not admissible to show mental defect); *Mutual Benefit Health & Accident Ass'n v. Neale*, 43 Ariz. 532, 547-49, 33 P.2d 604, 610-11 (1934) (industrial commission records not admissible to show how injury occurred). Furthermore, as property owners concede this rule does not apply where there is a statutory exclusion, as in A.R.S. § 12-1116(J).

11 Mr. Helmandollar was ADOT's former Assistant Chief Right-of-Way Agent from 1983 to 1988, and its Chief Right-of-Way Agent from 1989 to 1994. When asked at deposition "[W]hether or not a determination of value was made pursuant to the statute, the determination that was made is based upon Mike Chierighino's review appraisal as concurred in by the chief right-of-way agent,

the assistant chief right-of-way agent, and the manager of appraisals?" Helmandollar replied "I believe you are right."

113 S.Ct. 2786

Supreme Court of the United States

William DAUBERT, et ux., etc., et al., Petitioners,

v.

MERRELL DOW PHARMACEUTICALS, INC.

No. 92–102.



|

Argued March 30, 1993

|

Decided June 28, 1993.

Synopsis

Infants and their guardians ad litem sued pharmaceutical company to recover for limb reduction birth defects allegedly sustained as result of mothers' ingestion of antinausea drug  [Bendectin](#). The United States District Court for the Southern District of California, [727 F.Supp. 570](#), granted company's motion for summary judgment, and plaintiffs appealed. The Court of Appeals,  [951 F.2d 1128](#), affirmed. Plaintiffs filed petition for writ of certiorari, which was granted. The Supreme Court, Justice [Blackmun](#), held that: (1) “general acceptance” is not necessary precondition to admissibility of scientific evidence under Federal Rules of Evidence, and (2) Rules assign to trial judge the task of ensuring that expert's testimony both rests on reliable foundation and is relevant to task at hand.

Vacated and remanded.

Chief Justice [Rehnquist](#) filed opinion concurring in part and dissenting in part in which Justice [Stevens](#) joined.

Procedural Posture(s): On Appeal; Motion for Summary Judgment.

West Headnotes (36)

[1] Evidence  **General acceptance**

Federal Rules of Evidence superseded *Frye* “general acceptance” test for admissibility of scientific evidence. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#)

[169 Cases that cite this headnote](#)

[2] Federal Civil Procedure  **Rules of Court in General**

Supreme Court interprets legislatively enacted Federal Rules of Evidence as it would any statute.

[44 Cases that cite this headnote](#)

[3] Evidence  **Tendency to Prove or Disprove Fact at Issue; Relevance**

Basic standard of relevance under Federal Rules of Evidence is liberal one. [Fed.Rules Evid.Rules 401, 402, 28 U.S.C.A.](#)

[167 Cases that cite this headnote](#)

[4] Evidence  **General acceptance**

Rigid “general acceptance” requirement for admission of scientific evidence would be at odds with “liberal thrust” of Federal Rules of Evidence and their general approach of relaxing traditional barriers to “opinion” testimony. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#)

[209 Cases that cite this headnote](#)

[5] Evidence  **Gatekeeping in general**


Trial judge is not disabled under Federal Rules of Evidence from screening purportedly scientific evidence. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#)

[27 Cases that cite this headnote](#)

[6] Evidence  **Necessity of both reliability and relevance**

Under Federal Rules of Evidence, trial judge must ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#)

[2328 Cases that cite this headnote](#)

[7] Evidence  **Daubert and Frye tests in general**

“Scientific,” within meaning of Federal Rule of Evidence stating that if “scientific,” technical, or other specialized knowledge will assist trier of

fact to understand evidence or to determine fact in issue an expert may testify thereto, implies grounding in methods and procedures of science. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

[2533 Cases that cite this headnote](#)

- [8] **Evidence** 🔑 Matters involving scientific, technical, or specialized knowledge
 “Knowledge,” within meaning of Federal Rule of Evidence stating that if scientific, technical, or other specialized “knowledge” will assist trier of fact to understand evidence or to determine fact in issue an expert may testify thereto, connotes more than subjective belief or unsupported speculation. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

[2702 Cases that cite this headnote](#)

- [9] **Evidence** 🔑 Certainty in general
 Subject of scientific knowledge need not be “known” to certainty to permit expert testimony, since, arguably, there are not certainties in science. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

[146 Cases that cite this headnote](#)

- [10] **Evidence** 🔑 Matters involving scientific, technical, or specialized knowledge
 Inference or assertion must be derived by scientific method to qualify as “scientific knowledge,” within meaning of Federal Rule of Evidence stating that if scientific, technical, or other specialized knowledge will assist trier of fact to understand evidence or to determine fact in issue an expert may testify thereto. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

[1320 Cases that cite this headnote](#)

- [11] **Evidence** 🔑 Foundation in general
 For scientific testimony to be admitted, proposed testimony must be supported by appropriate validation, in other words, “good grounds” based on what is known. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

[659 Cases that cite this headnote](#)

- [12] **Evidence** 🔑 Daubert and Frye tests as to reliability in general

Requirement under Federal Rule of Evidence that expert's testimony pertain to “scientific knowledge” establishes standard of evidentiary reliability. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

[875 Cases that cite this headnote](#)

- [13] **Evidence** 🔑 Methodology and reasoning; scientific validity

In case involving scientific evidence, evidentiary reliability will be based upon scientific reliability. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

[209 Cases that cite this headnote](#)

- [14] **Evidence** 🔑 Helpfulness; assisting trier of fact

Condition for admission of scientific evidence or testimony under Federal Rule of Evidence, that evidence or testimony assist trier of fact to understand evidence or to determine fact in issue, goes primarily to relevance. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

[1230 Cases that cite this headnote](#)

- [15] **Evidence** 🔑 Methodology and reasoning; scientific validity

In determining admissibility of scientific evidence or testimony, scientific validity for one purpose is not necessarily scientific validity for other, unrelated purposes. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

[252 Cases that cite this headnote](#)

- [16] **Evidence** 🔑 Helpfulness; assisting trier of fact

“Helpfulness” standard under Federal Rule of Evidence for admissibility of scientific

evidence or testimony requires valid scientific connection to pertinent inquiry as precondition to admissibility. [Fed.Rules Evid.Rule 702](#), 28 U.S.C.A.

[455 Cases that cite this headnote](#)

[17] Evidence 🔑 [Personal knowledge of expert](#)

Unlike ordinary witness, expert is permitted wide latitude to offer opinions, including those that are not based on first-hand knowledge or observation. [Fed.Rules Evid.Rules 701–703](#), 28 U.S.C.A.

[440 Cases that cite this headnote](#)

[18] Evidence 🔑 [Personal knowledge of expert](#)

Presumably, relaxation under Federal Rules of Evidence of usual requirement of first-hand knowledge when there is testimony by expert is premised on assumption that expert's opinion will have reliable basis in knowledge and experience of his discipline. [Fed.Rules Evid.Rules 701–703](#), 28 U.S.C.A.

[2096 Cases that cite this headnote](#)

[19] Evidence 🔑 [Factors, Tests, and Standards in General](#)

Faced with proffer of expert scientific testimony, trial judge must determine at outset whether expert is proposing to testify to (1) scientific knowledge that (2) will assist trier of fact to understand or determine fact in issue; preliminary assessment must be made of whether reasoning or methodology underlying testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to facts in issue. [Fed.Rules Evid.Rules 104\(a\), 702](#), 28 U.S.C.A.

[8086 Cases that cite this headnote](#)

[20] Evidence 🔑 [Qualifications and competency](#)
[Privileged Communications and Confidentiality](#) 🔑 [Weight and sufficiency](#)

Preliminary questions concerning qualification of person to be witness, existence of privilege, or admissibility of evidence should be established by preponderance of proof. [Fed.Rules Evid.Rules 104\(a\), 702](#), 28 U.S.C.A.

[57 Cases that cite this headnote](#)

[21] Evidence 🔑 [Matters involving scientific, technical, or specialized knowledge](#)

Requirements for admissibility of scientific testimony or opinion under Federal Rule of Evidence do not apply specially or exclusively to unconventional evidence. [Fed.Rules Evid.Rule 702](#), 28 U.S.C.A.

[36 Cases that cite this headnote](#)

[22] Evidence 🔑 [Scientific facts and principles](#)

Scientific theories that are so firmly established as to have obtained status of scientific law, such as laws of thermodynamics, properly are subject to judicial notice. [Fed.Rules Evid.Rule 201](#), 28 U.S.C.A.

[37 Cases that cite this headnote](#)

[23] Evidence 🔑 [Correctness or soundness](#)

Definitive checklist or test does not exist in making preliminary assessment of whether reasoning or methodology underlying expert testimony is scientifically valid and whether that reasoning or methodology properly can be applied to facts in issue. [Fed.Rules Evid.Rule 104\(a\)](#), 28 U.S.C.A.

[5451 Cases that cite this headnote](#)

[24] Evidence 🔑 [Reliability of Experiments, Tests, and Studies](#)

Ordinarily, key question to be answered in determining whether theory or technique is scientific knowledge that will assist trier of fact, and, thus, whether expert testimony is admissible, will be whether theory or technique can be, and has been, tested. [Fed.Rules Evid.Rules 104\(a\), 702](#), 28 U.S.C.A.

2493 Cases that cite this headnote

[25] Evidence 🔑 Reliability of Experiments, Tests, and Studies

In determining whether theory or technique is scientific knowledge that will assist trier of fact, and, thus, whether expert testimony is admissible, is whether theory or technique has been subjected to peer review and publication. [Fed.Rules Evid.Rules 104\(a\), 702](#), 28 U.S.C.A.

4444 Cases that cite this headnote

[26] Evidence 🔑 Reliability of Experiments, Tests, and Studies

Publication of theory or technique, which is but one element of peer review, is not sine qua non of admissibility of expert testimony; publication does not necessarily correlate with reliability, and, in some instances, well-grounded but innovative theories will not have been published. [Fed.Rules Evid.Rules 104\(a\), 702](#), 28 U.S.C.A.

1228 Cases that cite this headnote

[27] Evidence 🔑 Reliability of Experiments, Tests, and Studies

Fact of publication of theory or technique, or lack thereof, in peer-review journal will be relevant, though not dispositive, consideration in assessing scientific validity of particular technique or methodology on which expert opinion is premised; submission to scrutiny of scientific community is component of “good science,” in part because it increases likelihood that substantive flaws in methodology will be detected. [Fed.Rules Evid.Rules 104\(a\), 702](#), 28 U.S.C.A.

2830 Cases that cite this headnote

[28] Evidence 🔑 Reliability of Experiments, Tests, and Studies

In determining admissibility of expert opinion regarding particular scientific technique, court ordinarily should consider known or potential

rate of error, and existence and maintenance of standards controlling technique's operation. [Fed.Rules Evid.Rules 104\(a\), 702](#), 28 U.S.C.A.

3845 Cases that cite this headnote

[29] Evidence 🔑 Reliability of Experiments, Tests, and Studies

“General acceptance” of scientific theory or technique can have bearing in determining admissibility of expert testimony. [Fed.Rules Evid.Rules 104\(a\), 702](#), 28 U.S.C.A.

871 Cases that cite this headnote

[30] Evidence 🔑 General acceptance

Widespread acceptance of scientific theory or technique can be important factor in ruling particular evidence admissible, and known technique that has been able to draw only minimal support within community may properly be viewed with skepticism. [Fed.Rules Evid.Rules 104\(a\), 702](#), 28 U.S.C.A.

162 Cases that cite this headnote

[31] Evidence 🔑 Flexibility

Inquiry envisioned by Federal Rule of Evidence pertaining to admission of scientific testimony and evidence is flexible one. [Fed.Rules Evid.Rule 702](#), 28 U.S.C.A.

53 Cases that cite this headnote

[32] Evidence 🔑 Necessity of both reliability and relevance

Overarching subject of Federal Rule of Evidence on admission of scientific testimony and evidence is scientific validity, and, thus, evidentiary relevance and reliability, of principles that underlie proposed submission. [Fed.Rules Evid.Rule 702](#), 28 U.S.C.A.

465 Cases that cite this headnote

[33] Evidence 🔑 Methodology and reasoning; scientific validity

Focus of Federal Rule of Evidence on admission of scientific testimony and evidence must be solely on principles and methodology, not on conclusions that they generate. [Fed.Rules Evid.Rule 702](#), 28 U.S.C.A.

48 Cases that cite this headnote

848 Cases that cite this headnote

****2789 Syllabus***

[34] Evidence  **Determination of Question of Admissibility**

Judge assessing proffer of expert's scientific testimony under Federal Rule of Evidence on testimony by experts should also be mindful of other applicable rules, including rule on expert opinions based on otherwise inadmissible hearsay, rule allowing court to procure assistance of expert of its own choosing, and rule permitting exclusion of relevant evidence if its probative value is substantially outweighed by danger of unfair prejudice, confusion of issues, or misleading jury. [Fed.Rules Evid.Rules 403, 702, 703, 706](#), 28 U.S.C.A.

751 Cases that cite this headnote

[35] Federal Civil Procedure  **Scintilla of evidence**


Federal Civil Procedure  **Weight and sufficiency**

In event that trial court concludes that scintilla of scientific evidence presented supporting a position is insufficient to allow reasonable juror to conclude that position more likely than not is true, court remains free to direct verdict, and likewise to grant summary judgment. [Fed.Rules Civ.Proc.Rules 50\(a\), 56, 28 U.S.C.A.](#); [Fed.Rules Evid.Rule 702](#), 28 U.S.C.A.



298 Cases that cite this headnote

[36] Federal Civil Procedure  **Rules of Court in General**

Federal Rules of Evidence are designed not for exhaustive search for cosmic understanding but for particularized resolution of legal disputes.

Petitioners, two minor children and their parents, alleged in their suit against respondent that the children's serious birth defects had been caused by the mothers' prenatal ingestion of Bendectin, a prescription drug marketed by respondent. The District Court granted respondent summary judgment based on a well-credentialed expert's affidavit concluding, upon reviewing the extensive published scientific literature on the subject, that maternal use of Bendectin has not been shown to be a risk factor for human birth defects. Although petitioners had responded with the testimony of eight other well-credentialed experts, who based their conclusion ****2790** that Bendectin can cause birth defects on animal studies, chemical structure analyses, and the unpublished "reanalysis" of previously published human statistical studies, the court determined that this evidence did not meet the applicable "general acceptance" standard for the admission of expert testimony. The Court of Appeals agreed and affirmed, citing  [Frye v. United States](#), 54 App.D.C. 46, 47, 293 F. 1013, 1014, for the rule that expert opinion based on a scientific technique is inadmissible unless the technique is "generally accepted" as reliable in the relevant scientific community.

Held: The Federal Rules of Evidence, not *Frye*, provide the standard for admitting expert scientific testimony in a federal trial. Pp. 2792–99.

(a) *Frye's* "general acceptance" test was superseded by the Rules' adoption. The Rules occupy the field,  [United States v. Abel](#), 469 U.S. 45, 49, 105 S.Ct. 465, 467, 83 L.Ed.2d 450, and, although the common law of evidence may serve as an aid to their application,  *id.*, at 51–52, 105 S.Ct., at 468–469, respondent's assertion that they somehow assimilated *Frye* is unconvincing. Nothing in the Rules as a whole or in the text and drafting history of [Rule 702](#), which specifically governs expert testimony, gives any indication that "general acceptance" is a necessary precondition to the admissibility of scientific evidence. Moreover, such a rigid standard would be at odds with the Rules' liberal thrust and their general approach of relaxing the traditional barriers to "opinion" testimony. Pp. 2792–94.

(b) The Rules—especially [Rule 702](#)—place appropriate limits on the admissibility of purportedly scientific evidence by assigning to the trial ***580** judge the task of ensuring that an expert's testimony both rests on a reliable foundation and is relevant to the task at hand. The reliability standard is established by [Rule 702](#)'s requirement that an expert's testimony pertain to “scientific ... knowledge,” since the adjective “scientific” implies a grounding in science's methods and procedures, while the word “knowledge” connotes a body of known facts or of ideas inferred from such facts or accepted as true on good grounds. The Rule's requirement that the testimony “assist the trier of fact to understand the evidence or to determine a fact in issue” goes primarily to relevance by demanding a valid scientific connection to the pertinent inquiry as a precondition to admissibility. Pp. 2794–96.

(c) Faced with a proffer of expert scientific testimony under [Rule 702](#), the trial judge, pursuant to [Rule 104\(a\)](#), must make a preliminary assessment of whether the testimony's underlying reasoning or methodology is scientifically valid and properly can be applied to the facts at issue. Many considerations will bear on the inquiry, including whether the theory or technique in question can be (and has been) tested, whether it has been subjected to peer review and publication, its known or potential error rate and the existence and maintenance of standards controlling its operation, and whether it has attracted widespread acceptance within a relevant scientific community. The inquiry is a flexible one, and its focus must be solely on principles and methodology, not on the conclusions that they generate. Throughout, the judge should also be mindful of other applicable Rules. Pp. 2796–98.

(d) Cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof, rather than wholesale exclusion under an uncompromising “general acceptance” standard, is the appropriate means by which evidence based on valid principles may be challenged. That even limited screening by the trial judge, on occasion, will prevent the jury from hearing of authentic scientific breakthroughs is simply a consequence of the fact that the Rules are not designed to seek cosmic understanding but, rather, to resolve legal disputes. Pp. 2798–99.

 [951 F.2d 1128 \(CA9 1991\)](#), vacated and remanded.

****2791** [BLACKMUN, J.](#), delivered the opinion for a unanimous Court with respect to Parts I and II–A, and the

opinion of the Court with respect to Parts II–B, II–C, III, and IV, in which [WHITE](#), [O'CONNOR](#), [SCALIA](#), [KENNEDY](#), [SOUTER](#), and [THOMAS, JJ.](#), joined. [REHNQUIST, C.J.](#), filed an opinion concurring in part and dissenting in part, in which [STEVENS, J.](#), joined, *post*, p. —.

Attorneys and Law Firms

***581** [Michael H. Gottesman](#), Washington, DC, for petitioners.

[Charles Fried](#), Cambridge, MA, for respondent.

Opinion

***582** Justice [BLACKMUN](#) delivered the opinion of the Court.

In this case we are called upon to determine the standard for admitting expert scientific testimony in a federal trial.

I

Petitioners Jason Daubert and Eric Schuller are minor children born with serious birth defects. They and their parents sued respondent in California state court, alleging that the birth defects had been caused by the mothers' ingestion of Bendectin, a prescription antinausea drug marketed by respondent. Respondent removed the suits to federal court on diversity grounds.

After extensive discovery, respondent moved for summary judgment, contending that Bendectin does not cause birth defects in humans and that petitioners would be unable to come forward with any admissible evidence that it does. In support of its motion, respondent submitted an affidavit of Steven H. Lamm, physician and epidemiologist, who is a well-credentialed expert on the risks from exposure to various chemical substances.¹ Doctor Lamm stated that he had reviewed all the literature on Bendectin and human [birth defects](#)—more than 30 published studies involving over 130,000 patients. No study had found Bendectin to be a human teratogen (*i.e.*, a substance capable of causing malformations in fetuses). On the basis of this review, Doctor Lamm concluded that maternal use of Bendectin during the first trimester of pregnancy has not been shown to be a risk factor for human [birth defects](#).

*583 Petitioners did not (and do not) contest this characterization of the published record regarding Bendectin. Instead, they responded to respondent's motion with the testimony of eight experts of their own, each of whom also possessed impressive credentials.² These experts had concluded that Bendectin can cause birth defects. Their conclusions were based upon “in vitro” (test tube) and “in vivo” (live) animal studies that found a link between Bendectin and malformations; pharmacological studies of the chemical structure of Bendectin that purported to show similarities between the structure of the drug and that of other substances known to cause birth defects; and the “reanalysis” of previously **2792 published epidemiological (human statistical) studies.

The District Court granted respondent's motion for summary judgment. The court stated that scientific evidence is admissible only if the principle upon which it is based is “ ‘sufficiently established to have general acceptance in the field to which it belongs.’ ” [727 F.Supp. 570, 572 \(S.D.Cal.1989\)](#), quoting [United States v. Kilgus, 571 F.2d 508, 510 \(CA9 1978\)](#). The court concluded that petitioners' evidence did not meet this standard. Given the vast body of epidemiological data concerning Bendectin, the court held, expert opinion which is not based on epidemiological evidence *584 is not admissible to establish causation. [727 F.Supp., at 575](#). Thus, the animal-cell studies, live-animal studies, and chemical-structure analyses on which petitioners had relied could not raise by themselves a reasonably disputable jury issue regarding causation. *Ibid*. Petitioners' epidemiological analyses, based as they were on recalculations of data in previously published studies that had found no causal link between the drug and birth defects, were ruled to be inadmissible because they had not been published or subjected to peer review. *Ibid*.

The United States Court of Appeals for the Ninth Circuit affirmed. [951 F.2d 1128 \(1991\)](#). Citing [Frye v. United States, 54 App.D.C. 46, 47, 293 F. 1013, 1014 \(1923\)](#), the court stated that expert opinion based on a scientific technique is inadmissible unless the technique is “generally accepted” as reliable in the relevant scientific community. [951 F.2d, at 1129–1130](#). The court declared that expert opinion based on a methodology that diverges “significantly from the procedures accepted by recognized authorities in the field ... cannot be shown to be ‘generally accepted as a reliable technique.’ ”

[Id.](#), at 1130, quoting [United States v. Solomon, 753 F.2d 1522, 1526 \(CA9 1985\)](#).

The court emphasized that other Courts of Appeals considering the risks of Bendectin had refused to admit reanalyses of epidemiological studies that had been neither published nor subjected to peer review. [951 F.2d, at 1130–1131](#). Those courts had found unpublished reanalyses “particularly problematic in light of the massive weight of the original published studies supporting [respondent's] position, all of which had undergone full scrutiny from the scientific community.” [Id.](#), at 1130. Contending that reanalysis is generally accepted by the scientific community only when it is subjected to verification and scrutiny by others in the field, the Court of Appeals rejected petitioners' reanalyses as “unpublished, not subjected to the normal peer review process and generated solely for use in litigation.” [Id.](#), at 1131. The *585 court concluded that petitioners' evidence provided an insufficient foundation to allow admission of expert testimony that Bendectin caused their injuries and, accordingly, that petitioners could not satisfy their burden of proving causation at trial.


We granted certiorari, [506 U.S. 914, 113 S.Ct. 320, 121 L.Ed.2d 240 \(1992\)](#), in light of sharp divisions among the courts regarding the proper standard for the admission of expert testimony. Compare, e.g., [United States v. Shorter, 257 U.S.App.D.C. 358, 363–364, 809 F.2d 54, 59–60 \(applying the “general acceptance” standard\)](#), cert. denied, [484 U.S. 817, 108 S.Ct. 71, 98 L.Ed.2d 35 \(1987\)](#), with [DeLuca v. Merrell Dow Pharmaceuticals, Inc., 911 F.2d 941, 955 \(CA3 1990\)](#) (rejecting the “general acceptance” standard).

II

A


In the 70 years since its formulation in the *Frye* case, the “general acceptance” test has been the dominant standard for determining the admissibility of novel scientific evidence at trial. See E. Green & C. Nesson, *Problems, Cases, and Materials on Evidence* 649 (1983). Although under increasing attack of late, the rule continues to be followed by a **2793 majority of courts, including the Ninth Circuit.³

The *Frye* test has its origin in a short and citation-free 1923 decision concerning the admissibility of evidence derived from a systolic blood pressure deception test, a crude precursor to the polygraph machine. In what has become a famous (perhaps infamous) passage, the then Court of Appeals for the District of Columbia described the device and its operation and declared:

“Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages *586 is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, *the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.*”  54 App.D.C., at 47, 293 F., at 1014 (emphasis added).



Because the deception test had “not yet gained such standing and scientific recognition among physiological and psychological authorities as would justify the courts in admitting expert testimony deduced from the discovery, development, and experiments thus far made,” evidence of its results was ruled inadmissible. *Ibid.*


[1] The merits of the *Frye* test have been much debated, and scholarship on its proper scope and application is legion.⁴ *587 Petitioners' primary attack, however, is not on the content but on the continuing authority of the rule. They contend that the *Frye* test was superseded by the adoption of the Federal Rules of Evidence.⁵ We agree.



[2] [3] We interpret the legislatively enacted Federal Rules of Evidence as we would any statute.  *Beech Aircraft Corp. v. Rainey*, 488 U.S. 153, 163, 109 S.Ct. 439, 446, 102 L.Ed.2d 445 (1988). Rule 402 provides the baseline:

“All relevant evidence is admissible, except as otherwise provided by the Constitution of the United States, by Act of Congress, **2794 by these rules, or by other rules prescribed by the Supreme Court pursuant to statutory authority. Evidence which is not relevant is not admissible.”

“Relevant evidence” is defined as that which has “any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence.” Rule 401. The Rule's basic standard of relevance thus is a liberal one.


Frye, of course, predated the Rules by half a century. In  *United States v. Abel*, 469 U.S. 45, 105 S.Ct. 465, 83 L.Ed.2d 450 (1984), we considered the pertinence of background common law in interpreting the Rules of Evidence. We noted that the Rules occupy the field,  *id.*, at 49, 105 S.Ct., at 467, but, quoting Professor Cleary, the Reporter, *588 explained that the common law nevertheless could serve as an aid to their application:

“ ‘In principle, under the Federal Rules no common law of evidence remains. “All relevant evidence is admissible, except as otherwise provided...” In reality, of course, the body of common law knowledge continues to exist, though in the somewhat altered form of a source of guidance in the exercise of delegated powers.’ ”  *Id.*, at 51–52, 105 S.Ct., at 469.

We found the common-law precept at issue in the *Abel* case entirely consistent with Rule 402's general requirement of admissibility, and considered it unlikely that the drafters had intended to change the rule.  *Id.*, at 50–51, 105 S.Ct., at 468–469. In  *Bourjaily v. United States*, 483 U.S. 171, 107 S.Ct. 2775, 97 L.Ed.2d 144 (1987), on the other hand, the Court was unable to find a particular common-law doctrine in the Rules, and so held it superseded.

[4] Here there is a specific Rule that speaks to the contested issue. Rule 702, governing expert testimony, provides:

“If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.”


Nothing in the text of this Rule establishes “general acceptance” as an absolute prerequisite to admissibility. Nor does respondent present any clear indication that [Rule 702](#) or the Rules as a whole were intended to incorporate a “general acceptance” standard. The drafting history makes no mention of *Frye*, and a rigid “general acceptance” requirement would be at odds with the “liberal thrust” of the Federal Rules and their “general approach of relaxing the traditional barriers to ‘opinion’ testimony.”  [Beech Aircraft Corp. v. Rainey](#), 488 U.S., at 169, 109 S.Ct., at 450 (citing Rules 701 to 705). See also Weinstein, *589 [Rule 702 of the Federal Rules of Evidence is Sound; It Should Not Be Amended](#), 138 F.R.D. 631 (1991) (“The Rules were designed to depend primarily upon lawyer-adversaries and sensible triers of fact to evaluate conflicts”). Given the Rules’ permissive backdrop and their inclusion of a specific rule on expert testimony that does not mention “‘general acceptance,’ ” the assertion that the Rules somehow assimilated *Frye* is unconvincing. *Frye* made “general acceptance” the exclusive test for admitting expert scientific testimony. That austere standard, absent from, and incompatible with, the Federal Rules of Evidence, should not be applied in federal trials.⁶

B

[5] [6] That the *Frye* test was displaced by the Rules of Evidence does not mean, **2795 however, that the Rules themselves place no limits on the admissibility of purportedly scientific evidence.⁷ Nor is the trial judge disabled from screening such evidence. To the contrary, under the Rules the trial judge must ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable.

[7] [8] [9] [10] [11] [12] [13] The primary locus of this obligation is [Rule 702](#), which clearly contemplates

some degree of regulation of the subjects and theories about which an expert may testify. “If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue” an expert “may testify thereto.” (Emphasis added.) The subject of an expert’s testimony must *590 be “scientific ... knowledge.”⁸ The adjective “scientific” implies a grounding in the methods and procedures of science. Similarly, the word “knowledge” connotes more than subjective belief or unsupported speculation. The term “applies to any body of known facts or to any body of ideas inferred from such facts or accepted as truths on good grounds.” Webster’s Third New International Dictionary 1252 (1986). Of course, it would be unreasonable to conclude that the subject of scientific testimony must be “known” to a certainty; arguably, there are no certainties in science. See, e.g., Brief for Nicolaas Bloembergen et al. as *Amici Curiae* 9 (“Indeed, scientists do not assert that they know what is immutably ‘true’—they are committed to searching for new, temporary, theories to explain, as best they can, phenomena”); Brief for American Association for the Advancement of Science et al. as *Amici Curiae* 7–8 (“Science is not an encyclopedic body of knowledge about the universe. Instead, it represents a process for proposing and refining theoretical explanations about the world that are subject to further testing and refinement” (emphasis in original)). But, in order to qualify as “scientific knowledge,” an inference or assertion must be derived by the scientific method. Proposed testimony must be supported by appropriate validation—i.e., “good grounds,” based on what is known. In short, the requirement that an expert’s testimony pertain to “scientific knowledge” establishes a standard of evidentiary reliability.⁹

[14] [15] [16] *591 [Rule 702](#) further requires that the evidence or testimony “assist the trier of fact to understand the evidence or to determine a fact in issue.” This condition goes primarily to relevance. “Expert testimony which does not relate to any issue in the case is not relevant and, ergo, non-helpful.” 3 Weinstein & Berger ¶ 702[02], p. 702–18. See also  [United States v. Downing](#), 753 F.2d 1224, 1242 (CA3 1985) (“An additional consideration **2796 under [Rule 702](#)—and another aspect of relevancy—is whether expert testimony proffered in the case is sufficiently tied to the facts of the case that it will aid the jury in resolving a factual dispute”). The consideration has been aptly described by Judge Becker as one of “fit.” *Ibid.* “Fit” is not always obvious, and scientific validity for one purpose is not necessarily scientific validity for

other, unrelated purposes. See Starrs, *Frye v. United States Restructured and Revitalized: A Proposal to Amend Federal Evidence Rule 702*, 26 *Jurimetrics J.* 249, 258 (1986). The study of the phases of the moon, for example, may provide valid scientific “knowledge” about whether a certain night was dark, and if darkness is a fact in issue, the knowledge will assist the trier of fact. However (absent creditable grounds supporting such a link), evidence that the moon was full on a certain night will not assist the trier of fact in determining whether an individual was unusually likely to have behaved irrationally on that night. Rule 702’s “helpfulness” *592 standard requires a valid scientific connection to the pertinent inquiry as a precondition to admissibility.



[17] [18] That these requirements are embodied in Rule 702 is not surprising. Unlike an ordinary witness, see Rule 701, an expert is permitted wide latitude to offer opinions, including those that are not based on firsthand knowledge or observation. See Rules 702 and 703. Presumably, this relaxation of the usual requirement of firsthand knowledge—a rule which represents “a ‘most pervasive manifestation’ of the common law insistence upon ‘the most reliable sources of information,’ ” Advisory Committee’s Notes on Fed. Rule Evid. 602, 28 U.S.C.App., p. 755 (citation omitted)—is premised on an assumption that the expert’s opinion will have a reliable basis in the knowledge and experience of his discipline.

[19] [20] [21] [22] [23] Faced with a proffer of expert scientific testimony, then, the trial judge must determine at the outset, pursuant to Rule 104(a),¹⁰ whether the expert is proposing to testify to (1) scientific knowledge that (2) will assist the trier of fact to understand or determine a fact in issue.¹¹ This entails a preliminary assessment of whether the reasoning or methodology *593 underlying the testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to the facts in issue. We are confident that federal judges possess the capacity to undertake this review. Many factors will bear on the inquiry, and we do not presume to set out a definitive checklist or test. But some general observations are appropriate.

[24] Ordinarily, a key question to be answered in determining whether a theory or technique is scientific knowledge that will assist the trier of fact will be whether it can be (and has been) tested. “Scientific methodology today is based on generating hypotheses and testing them to see

if they can be falsified; indeed, this methodology is what distinguishes science from other fields of human inquiry.” Green 645. See also C. Hempel, *Philosophy of Natural Science* 49 (1966) **2797 (“[T]he statements constituting a scientific explanation must be capable of empirical test”); K. Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge* 37 (5th ed. 1989) (“[T]he criterion of the scientific status of a theory is its falsifiability, or refutability, or testability”) (emphasis deleted).

[25] [26] [27] Another pertinent consideration is whether the theory or technique has been subjected to peer review and publication. Publication (which is but one element of peer review) is not a *sine qua non* of admissibility; it does not necessarily correlate with reliability, see S. Jasanoff, *The Fifth Branch: Science Advisors as Policymakers* 61–76 (1990), and in some instances well-grounded but innovative theories will not have been published, see Horrobin, *The Philosophical Basis of Peer Review and the Suppression of Innovation*, 263 *JAMA* 1438 (1990). Some propositions, moreover, are too particular, too new, or of too limited interest to be published. But submission to the scrutiny of the scientific community is a component of “good science,” in part because it increases the likelihood that substantive flaws in methodology will be detected. See J. Ziman, *Reliable Knowledge: An Exploration* *594 of the Grounds for Belief in Science 130–133 (1978); Relman & Angell, *How Good Is Peer Review?*, 321 *New Eng. J. Med.* 827 (1989). The fact of publication (or lack thereof) in a peer reviewed journal thus will be a relevant, though not dispositive, consideration in assessing the scientific validity of a particular technique or methodology on which an opinion is premised.

[28] Additionally, in the case of a particular scientific technique, the court ordinarily should consider the known or potential rate of error, see, e.g.,  *United States v. Smith*, 869 F.2d 348, 353–354 (CA7 1989) (surveying studies of the error rate of spectrographic voice identification technique), and the existence and maintenance of standards controlling the technique’s operation, see  *United States v. Williams*, 583 F.2d 1194, 1198 (CA2 1978) (noting professional organization’s standard governing spectrographic analysis), cert. denied, 439 U.S. 1117, 99 S.Ct. 1025, 59 L.Ed.2d 77 (1979).

[29] [30] Finally, “general acceptance” can yet have a bearing on the inquiry. A “reliability assessment does not require, although it does permit, explicit identification of a

relevant scientific community and an express determination of a particular degree of acceptance within that community.”

United States v. Downing, 753 F.2d, at 1238. See also 3 Weinstein & Berger ¶ 702[03], pp. 702–41 to 702–42. Widespread acceptance can be an important factor in ruling particular evidence admissible, and “a known technique which has been able to attract only minimal support within the community,” Downing, 753 F.2d, at 1238, may properly be viewed with skepticism.

[31] [32] [33] The inquiry envisioned by Rule 702 is, we emphasize, a flexible one.¹² Its overarching subject is the scientific validity *595 and thus the evidentiary relevance and reliability—of the principles that underlie a proposed submission. The focus, of course, must be solely on principles and methodology, not on the conclusions that they generate.

[34] Throughout, a judge assessing a proffer of expert scientific testimony under Rule 702 should also be mindful of other applicable rules. Rule 703 provides that expert opinions based on otherwise inadmissible **2798 hearsay are to be admitted only if the facts or data are “of a type reasonably relied upon by experts in the particular field in forming opinions or inferences upon the subject.” Rule 706 allows the court at its discretion to procure the assistance of an expert of its own choosing. Finally, Rule 403 permits the exclusion of relevant evidence “if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury...” Judge Weinstein has explained: “Expert evidence can be both powerful and quite misleading because of the difficulty in evaluating it. Because of this risk, the judge in weighing possible prejudice against probative force under Rule 403 of the present rules exercises more control over experts than over lay witnesses.” Weinstein, 138 F.R.D., at 632.

III

[35] We conclude by briefly addressing what appear to be two underlying concerns of the parties and amici in this case. Respondent expresses apprehension that abandonment of “general acceptance” as the exclusive requirement for admission will result in a “free-for-all” in which befuddled juries are confounded by absurd and irrational pseudoscientific assertions. *596 In this regard respondent seems to us to be overly pessimistic about the capabilities of the jury and of the adversary system generally. Vigorous

cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence. See Rock v. Arkansas, 483 U.S. 44, 61, 107 S.Ct. 2704, 2714, 97 L.Ed.2d 37 (1987). Additionally, in the event the trial court concludes that the scintilla of evidence presented supporting a position is insufficient to allow a reasonable juror to conclude that the position more likely than not is true, the court remains free to direct a judgment, Fed.Rule Civ.Proc. 50(a), and likewise to grant summary judgment, Fed.Rule Civ.Proc. 56. Cf., e.g., Turpin v. Merrell Dow Pharmaceuticals, Inc., 959 F.2d 1349 (CA6) (holding that scientific evidence that provided foundation for expert testimony, viewed in the light most favorable to plaintiffs, was not sufficient to allow a jury to find it more probable than not that defendant caused plaintiff’s injury), cert. denied, 506 U.S. 826, 113 S.Ct. 84, 121 L.Ed.2d 47 (1992); Brock v. Merrell Dow Pharmaceuticals, Inc., 874 F.2d 307 (CA5 1989) (reversing judgment entered on jury verdict for plaintiffs because evidence regarding causation was insufficient), modified, 884 F.2d 166 (CA5 1989), cert. denied, 494 U.S. 1046, 110 S.Ct. 1511, 108 L.Ed.2d 646 (1990); Green 680–681. These conventional devices, rather than wholesale exclusion under an uncompromising “general acceptance” test, are the appropriate safeguards where the basis of scientific testimony meets the standards of Rule 702.

[36] Petitioners and, to a greater extent, their amici exhibit a different concern. They suggest that recognition of a screening role for the judge that allows for the exclusion of “invalid” evidence will sanction a stifling and repressive scientific orthodoxy and will be inimical to the search for truth. See, e.g., Brief for Ronald Bayer et al. as Amici Curiae. It is true that open debate is an essential part of both legal and scientific analyses. Yet there are important differences between the quest for truth in the courtroom and the quest *597 for truth in the laboratory. Scientific conclusions are subject to perpetual revision. Law, on the other hand, must resolve disputes finally and quickly. The scientific project is advanced by broad and wide-ranging consideration of a multitude of hypotheses, for those that are incorrect will eventually be shown to be so, and that in itself is an advance. Conjectures that are probably wrong are of little use, however, in the project of reaching a quick, final, and binding legal judgment—often of great consequence—about a particular set of events in the past. We recognize that, in practice, a gatekeeping role for the judge, no matter how flexible, inevitably on occasion will prevent the jury

from learning of authentic ****2799** insights and innovations. That, nevertheless, is the balance that is struck by Rules of Evidence designed not for the exhaustive search for cosmic understanding but for the particularized resolution of legal disputes.¹³


IV

To summarize: “General acceptance” is not a necessary precondition to the admissibility of scientific evidence under the Federal Rules of Evidence, but the Rules of Evidence—especially [Rule 702](#)—do assign to the trial judge the task of ensuring that an expert’s testimony both rests on a reliable foundation and is relevant to the task at hand. Pertinent evidence based on scientifically valid principles will satisfy those demands.

The inquiries of the District Court and the Court of Appeals focused almost exclusively on “general acceptance,” as gauged by publication and the decisions of other courts. Accordingly, ***598** the judgment of the Court of Appeals is vacated, and the case is remanded for further proceedings consistent with this opinion.

It is so ordered.

Chief Justice [REHNQUIST](#), with whom Justice [STEVENS](#) joins, concurring in part and dissenting in part.

The petition for certiorari in this case presents two questions: first, whether the rule of  [Frye v. United States](#), 54 App.D.C. 46, 293 F. 1013 (1923), remains good law after the enactment of the Federal Rules of Evidence; and second, if *Frye* remains valid, whether it requires expert scientific testimony to have been subjected to a peer review process in order to be admissible. The Court concludes, correctly in my view, that the *Frye* rule did not survive the enactment of the Federal Rules of Evidence, and I therefore join Parts I and II–A of its opinion. The second question presented in the petition for certiorari necessarily is mooted by this holding, but the Court nonetheless proceeds to construe [Rules 702](#) and [703](#) very much in the abstract, and then offers some “general observations.” *Ante*, at 2796.

“General observations” by this Court customarily carry great weight with lower federal courts, but the ones offered here suffer from the flaw common to most such observations—

they are not applied to deciding whether particular testimony was or was not admissible, and therefore they tend to be not only general, but vague and abstract. This is particularly unfortunate in a case such as this, where the ultimate legal question depends on an appreciation of one or more bodies of knowledge not judicially noticeable, and subject to different interpretations in the briefs of the parties and their *amici*. Twenty-two *amicus* briefs have been filed in the case, and indeed the Court’s opinion contains no fewer than 37 citations to *amicus* briefs and other secondary sources.

***599** The various briefs filed in this case are markedly different from typical briefs, in that large parts of them do not deal with decided cases or statutory language—the sort of material we customarily interpret. Instead, they deal with definitions of scientific knowledge, scientific method, scientific validity, and peer review—in short, matters far afield from the expertise of judges. This is not to say that such materials are not useful or even necessary in deciding how [Rule 703](#) should be applied; but it is to say that the unusual subject matter should cause us to proceed with great caution in deciding more than we have to, because our reach can so easily exceed our grasp.

But even if it were desirable to make “general observations” not necessary to decide ****2800** the questions presented, I cannot subscribe to some of the observations made by the Court. In Part II–B, the Court concludes that reliability and relevancy are the touchstones of the admissibility of expert testimony. *Ante*, at 2794–95. [Federal Rule of Evidence 402](#) provides, as the Court points out, that “[e]vidence which is not relevant is not admissible.” But there is no similar reference in the Rule to “reliability.” The Court constructs its argument by parsing the language “[i]f scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, ... an expert ... may testify thereto....” [Fed.Rule Evid. 702](#). It stresses that the subject of the expert’s testimony must be “scientific ... knowledge,” and points out that “scientific” “implies a grounding in the methods and procedures of science” and that the word “knowledge” “connotes more than subjective belief or unsupported speculation.” *Ante*, at 2794–95. From this it concludes that “scientific knowledge” must be “derived by the scientific method.” *Ante*, at 2795. Proposed testimony, we are told, must be supported by “appropriate validation.” *Ante*, at 2795. Indeed, in footnote 9, the Court decides that “[i]n a case involving scientific evidence, evidentiaryreliability ***600** will be based upon *scientific validity*.” *Ante*, at 2795, n. 9 (emphasis in original).

Questions arise simply from reading this part of the Court's opinion, and countless more questions will surely arise when hundreds of district judges try to apply its teaching to particular offers of expert testimony. Does all of this *dicta* apply to an expert seeking to testify on the basis of “technical or other specialized knowledge”—the other types of expert knowledge to which [Rule 702](#) applies—or are the “general observations” limited only to “scientific knowledge”? What is the difference between scientific knowledge and technical knowledge; does [Rule 702](#) actually contemplate that the phrase “scientific, technical, or other specialized knowledge” be broken down into numerous subspecies of expertise, or did its authors simply pick general descriptive language covering the sort of expert testimony which courts have customarily received? The Court speaks of its confidence that federal judges can make a “preliminary assessment of whether the reasoning or methodology underlying the testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to the facts in issue.” *Ante*, at 2796. The Court then states that a “key question” to be answered in deciding whether something is “scientific knowledge” “will be whether it can be (and has been) tested.” *Ante*, at 2796. Following this sentence are three quotations

from treatises, which not only speak of empirical testing, but one of which states that the “ ‘criterion of the scientific status of a theory is its falsifiability, or refutability, or testability.’ ” *Ante*, at 2796–97.


I defer to no one in my confidence in federal judges; but I am at a loss to know what is meant when it is said that the scientific status of a theory depends on its “falsifiability,” and I suspect some of them will be, too.

I do not doubt that [Rule 702](#) confides to the judge some gatekeeping responsibility in deciding questions of the admissibility of proffered expert testimony. But I do not think [*601](#) it imposes on them either the obligation or the authority to become amateur scientists in order to perform that role. I think the Court would be far better advised in this case to decide only the questions presented, and to leave the further development of this important area of the law to future cases.

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Footnotes

- * The syllabus constitutes no part of the opinion of the Court but has been prepared by the Reporter of Decisions for the convenience of the reader. See  [United States v. Detroit Lumber Co.](#), 200 U.S. 321, 337, 26 S.Ct. 282, 287, 50 L.Ed. 499.
- 1 Doctor Lamm received his master's and doctor of medicine degrees from the University of Southern California. He has served as a consultant in birth-defect epidemiology for the National Center for Health Statistics and has published numerous articles on the magnitude of risk from exposure to various chemical and biological substances. App. 34–44.
- 2 For example, Shanna Helen Swan, who received a master's degree in biostatistics from Columbia University and a doctorate in statistics from the University of California at Berkeley, is chief of the section of the California Department of Health and Services that determines causes of birth defects and has served as a consultant to the World Health Organization, the Food and Drug Administration, and the National Institutes of Health. *Id.*, at 113–114, 131–132. Stuart A. Newman, who received his bachelor's degree in chemistry from Columbia University and his master's and doctorate in chemistry from the University of Chicago, is a professor at New York Medical College and has spent over a decade studying the effect of chemicals on limb development. *Id.*, at 54–56. The credentials of the others are similarly impressive. See *Id.*, at 61–66, 73–80, 148–153, 187–192, and Attachments 12, 20, 21, 26, 31, and 32 to Petitioners' Opposition to Summary Judgment in No. 84–2013–G(I) (SD Cal.).

- 3 For a catalog of the many cases on either side of this controversy, see P. Giannelli & E. Imwinkelried, *Scientific Evidence* § 1–5, pp. 10–14 (1986 and Supp.1991).
- 4 See, e.g., Green, *Expert Witnesses and Sufficiency of Evidence in Toxic Substances Litigation: The Legacy of Agent Orange and Bendectin Litigation*, 86 Nw.U.L.Rev. 643 (1992) (hereinafter Green); Becker & Orenstein, *The Federal Rules of Evidence After Sixteen Years—the Effect of “Plain Meaning” Jurisprudence, the Need for an Advisory Committee on the Rules of Evidence, and Suggestions for Selective Revision of the Rules*, 60 Geo.Wash.L.Rev. 857, 876–885 (1992); Hanson, *James Alphonzo Frye is Sixty-Five Years Old; Should He Retire?*, 16 West.St.U.L.Rev. 357 (1989); Black, *A Unified Theory of Scientific Evidence*, 56 Ford.L.Rev. 595 (1988); Imwinkelried, *The “Bases” of Expert Testimony: The Syllogistic Structure of Scientific Testimony*, 67 N.C.L.Rev. 1 (1988); *Proposals for a Model Rule on the Admissibility of Scientific Evidence*, 26 Jurimetrics J. 235 (1986); Giannelli, *The Admissibility of Novel Scientific Evidence: Frye v. United States, a Half-Century Later*, 80 Colum.L.Rev. 1197 (1980); *The Supreme Court, 1986 Term*, 101 Harv.L.Rev. 7, 119, 125–127 (1987).

Indeed, the debates over *Frye* are such a well-established part of the academic landscape that a distinct term—“*Frye*-ologist”—has been advanced to describe those who take part. See Behringer, *Introduction, Proposals for a Model Rule on the Admissibility of Scientific Evidence*, 26 Jurimetrics J. 237, 239 (1986), quoting Lacey, *Scientific Evidence*, 24 Jurimetrics J. 254, 264 (1984).

- 5 Like the question of *Frye*'s merit, the dispute over its survival has divided courts and commentators. Compare, e.g.,  *United States v. Williams*, 583 F.2d 1194 (CA2 1978) (*Frye* is superseded by the Rules of Evidence), cert. denied, 439 U.S. 1117, 99 S.Ct. 1025, 59 L.Ed.2d 77 (1979) with  *Christophersen v. Allied-Signal Corp.*, 939 F.2d 1106, 1111, 1115–1116 (CA5 1991) (en banc) (*Frye* and the Rules coexist), cert. denied, 503 U.S. 912, 112 S.Ct. 1280, 117 L.Ed.2d 506 (1992), 3 J. Weinstein & M. Berger, *Weinstein's Evidence* ¶ 702[03], pp. 702–36 to 702–37 (1988) (hereinafter Weinstein & Berger) (*Frye* is dead), and M. Graham, *Handbook of Federal Evidence* § 703.2 (3d ed. 1991) (*Frye* lives). See generally P. Giannelli & E. Imwinkelried, *Scientific Evidence* § 1–5, at 28–29 (citing authorities).
- 6 Because we hold that *Frye* has been superseded and base the discussion that follows on the content of the congressionally enacted Federal Rules of Evidence, we do not address petitioners' argument that application of the *Frye* rule in this diversity case, as the application of a judge-made rule affecting substantive rights, would violate the doctrine of  *Erie R. Co. v. Tompkins*, 304 U.S. 64, 58 S.Ct. 817, 82 L.Ed. 1188 (1938).
- 7 THE CHIEF JUSTICE “do[es] not doubt that Rule 702 confides to the judge some gatekeeping responsibility,” *post*, at 2800, but would neither say how it does so nor explain what that role entails. We believe the better course is to note the nature and source of the duty.
- 8 Rule 702 also applies to “technical, or other specialized knowledge.” Our discussion is limited to the scientific context because that is the nature of the expertise offered here.
- 9 We note that scientists typically distinguish between “validity” (does the principle support what it purports to show?) and “reliability” (does application of the principle produce consistent results?). See Black, 56 Ford.L.Rev., at 599. Although “the difference between accuracy, validity, and reliability may be such that each is distinct from the other by no more than a hen's kick,” Starrs, *Frye v. United States Restructured and Revitalized: A Proposal to Amend Federal Evidence Rule 702*, 26 Jurimetrics J. 249, 256 (1986), our reference here is to *evidentiary* reliability—that is, trustworthiness. Cf., e.g., Advisory Committee's Notes on Fed.Rule Evid. 602, 28 U.S.C.App., p. 755 (“ [T]he rule requiring that a witness who testifies to a fact which can be perceived by the senses must have had an opportunity to observe, and must have actually observed the fact’ is a ‘most pervasive manifestation’ of the common law insistence upon ‘the most reliable


sources of information' ” (citation omitted)); Advisory Committee's Notes on Art. VIII of Rules of Evidence, 28 U.S.C.App., p. 770 (hearsay exceptions will be recognized only “under circumstances supposed to furnish guarantees of trustworthiness”). In a case involving scientific evidence, *evidentiary reliability* will be based upon *scientific validity*.

10 Rule 104(a) provides:

“Preliminary questions concerning the qualification of a person to be a witness, the existence of a privilege, or the admissibility of evidence shall be determined by the court, subject to the provisions of subdivision (b) [pertaining to conditional admissions]. In making its determination it is not bound by the rules of evidence except those with respect to privileges.” These matters should be established by a preponderance of proof.

See  *Bourjaily v. United States*, 483 U.S. 171, 175–176, 107 S.Ct. 2775, 2778–2779, 97 L.Ed.2d 144 (1987).

11 Although the *Frye* decision itself focused exclusively on “novel” scientific techniques, we do not read the requirements of Rule 702 to apply specially or exclusively to unconventional evidence. Of course, well-established propositions are less likely to be challenged than those that are novel, and they are more handily defended. Indeed, theories that are so firmly established as to have attained the status of scientific law, such as the laws of thermodynamics, properly are subject to judicial notice under Federal Rule of Evidence 201.

12 A number of authorities have presented variations on the reliability approach, each with its own slightly different set of factors. See, e.g.,  *Downing*, 753 F.2d, at 1238–1239 (on which our discussion draws in part); 3 Weinstein & Berger ¶ 702[03], pp. 702–41 to 702–42 (on which the *Downing* court in turn partially relied); McCormick, Scientific Evidence: Defining a New Approach to Admissibility, 67 Iowa L.Rev. 879, 911–912 (1982); and Symposium on Science and the Rules of Evidence, 99 F.R.D. 187, 231 (1983) (statement by Margaret Berger). To the extent that they focus on the reliability of evidence as ensured by the scientific validity of its underlying principles, all these versions may well have merit, although we express no opinion regarding any of their particular details.

13 This is not to say that judicial interpretation, as opposed to adjudicative factfinding, does not share basic characteristics of the scientific endeavor: “The work of a judge is in one sense enduring and in another ephemeral.... In the endless process of testing and retesting, there is a constant rejection of the dross and a constant retention of whatever is pure and sound and fine.” B. Cardozo, *The Nature of the Judicial Process* 178, 179 (1921).

119 S.Ct. 1167

Supreme Court of the United States

KUMHO TIRE COMPANY, LTD., et al., Petitioners,

v.

Patrick CARMICHAEL, etc., et al.

No. 97-1709


|


Argued Dec. 7, 1998.

|

Decided March 23, 1999.

Synopsis

Plaintiffs brought products liability action against tire manufacturer and tire distributor for injuries sustained when right rear tire on vehicle failed. The United States District Court for the Southern District of  Alabama, No. 93-0860-CB-S, 923 F.Supp. 1514, Charles R. Butler, J., granted summary judgment for defendants, and plaintiffs appealed.

The Court of Appeals for the Eleventh Circuit,  131 F.3d 1433, reversed and remanded. Defendants filed application for writ of certiorari. The Supreme Court, Justice Breyer, held that: (1) *Daubert's* “gatekeeping” obligation, requiring an inquiry into both relevance and reliability, applies not only to “scientific” testimony, but to all expert testimony; (2) when assessing reliability of engineering expert's testimony, trial court may consider the *Daubert* factors to the extent relevant; and (3) trial court did not abuse its discretion in its application of *Daubert to exclude* tire failure analyst's expert testimony that particular tire failed due to manufacturing or design defect.

Reversed.

Justice Scalia filed concurring opinion in which Justice O'Connor and Justice Thomas joined.

Justice Stevens filed opinion concurring in part and dissenting in part.


Procedural Posture(s): On Appeal; Motion for Summary Judgment.

West Headnotes (7)

[1] **Evidence**  Necessity of both reliability and relevance

Daubert's “gatekeeping” obligation, requiring an inquiry into both relevance and reliability, applies not only to “scientific” testimony, but to all expert testimony. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

6283 Cases that cite this headnote

[2] **Evidence**  Daubert and Frye tests as to reliability in general


When assessing the reliability of an engineering expert's testimony, the trial court may consider the *Daubert* factors to the extent relevant, which will depend upon the nature of the issue, the expert's particular expertise, and the subject of his testimony. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

5588 Cases that cite this headnote

[3] **Evidence**  Necessity of both reliability and relevance

Objective of *Daubert's* “gatekeeping” requirement is to ensure the reliability and relevancy of expert testimony; it is to make certain that an expert, whether basing testimony upon professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

6110 Cases that cite this headnote

[4] **Evidence**  Daubert and Frye tests as to reliability in general

Trial court should consider the specific factors identified in *Daubert* where they are reasonable measures of the reliability of expert testimony. Fed.Rules Evid.Rule 702, 28 U.S.C.A.

2016 Cases that cite this headnote


****1169 Syllabus***

[5] **Federal Courts** 🔑 Expert evidence and witnesses

Court of Appeals is to apply an abuse-of-discretion standard when it reviews a trial court's decision to admit or exclude expert testimony, and when it reviews the trial court's decisions about how to determine reliability as to its ultimate conclusion. [Fed.Rules Evid.Rule 702](#), 28 U.S.C.A.

1286 Cases that cite this headnote

[6] **Evidence** 🔑 Discretion of court in general



Whether  *Daubert's* specific factors are, or are not, reasonable measures of expert's reliability in a particular case is a matter that the law grants the trial judge broad latitude to determine. [Fed.Rules Evid.Rules 102, 702](#), 28 U.S.C.A.

1482 Cases that cite this headnote

[7] **Evidence** 🔑 Products liability

Trial court did not abuse its discretion in its application of *Daubert* to exclude tire failure analyst's expert testimony that particular tire failed due to manufacturing or design defect, on grounds that methodology employed by analyst in analyzing the data obtained in his visual and tactile examination of tire in question was unreliable, even though court did not doubt analyst's qualification as expert, where there was no evidence that other experts in the industry used analyst's particular approach with regard visual and tactile examinations of tires, analyst's own testimony cast doubt upon reliability of both his theory and his proposition about significance of visual inspection of tire in question, and tire bore some of marks that analyst said indicated abuse, rather than defect. [Fed.Rules Evid.Rule 702](#), 28 U.S.C.A.

470 Cases that cite this headnote

***137** When a tire on the vehicle driven by Patrick Carmichael blew out and the vehicle overturned, one passenger died and the others were injured. The survivors and the decedent's representative, respondents here, brought this diversity suit against the tire's maker and its distributor (collectively Kumho Tire), claiming that the tire that failed was defective. They rested their case in significant part upon the depositions of a tire failure analyst, Dennis Carlson, Jr., who intended to testify that, in his expert opinion, a defect in the tire's manufacture or design caused the blowout. That opinion was based upon a visual and tactile inspection of the tire and upon the theory that in the absence of at least two of four specific, physical symptoms indicating tire abuse, the tire failure of the sort that occurred here was caused by a defect. Kumho Tire moved to exclude Carlson's testimony on the ground that his methodology failed to satisfy [Federal Rule of Evidence 702](#), which says: "If scientific, technical, or other specialized knowledge will assist the trier of fact ..., a witness qualified as an expert ... may testify thereto in the form of an opinion." Granting the motion (and entering summary judgment for the defendants), the District Court acknowledged that it should act as a reliability "gatekeeper" under  *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 589, 113 S.Ct. 2786, 125 L.Ed.2d 469, in which this Court held that [Rule 702](#) imposes a special obligation upon a trial judge to ensure that scientific testimony is not only relevant, but reliable. The court noted that *Daubert* discussed four factors—testing, peer review, error rates, and "acceptability" in the relevant scientific community—which might prove helpful in determining the reliability of a particular scientific theory or technique,  *id.*, at 593–594, 113 S.Ct. 2786, and found that those factors argued against the reliability of Carlson's methodology. On the plaintiffs' motion for reconsideration, the court agreed that *Daubert* should be applied flexibly, that its four factors were simply illustrative, and that other factors could argue in favor of admissibility. However, the court affirmed its earlier order because it found insufficient indications of the reliability of Carlson's methodology. In reversing, the Eleventh Circuit held that the District Court had erred as a matter of law in applying *Daubert*. Believing that *Daubert* was limited to the scientific context, ***138** the court held that the *Daubert* factors did not apply to Carlson's testimony, which it characterized as skill or experience based.

Held:

1. The *Daubert* factors may apply to the testimony of engineers and other experts who are not scientists. Pp. 1174–1176.

(a) The *Daubert* “gatekeeping” obligation applies not only to “scientific” testimony, but to all expert testimony. Rule 702 does not distinguish between “scientific” knowledge and “technical” or “other specialized” knowledge, but makes clear that any such knowledge might become the subject of expert testimony. It is the Rule’s word “knowledge,” not the words (like “scientific”) that modify that word, that establishes a standard of evidentiary reliability. [509 U.S., at 589–590, 113 S.Ct. 2786](#). *Daubert* referred only to “scientific” knowledge because that was the nature of the expertise there at issue. [Id., at 590, n. 8, 113 S.Ct. 2786](#). Neither is the evidentiary rationale underlying *Daubert*’s “gatekeeping” determination limited to “scientific” knowledge. Rules 702 and 703 grant all expert witnesses, not just “scientific” ones, testimonial latitude unavailable to other witnesses on the assumption that the expert’s opinion will have a reliable basis in the knowledge and experience of his discipline. [Id., at 592, 113 S.Ct. 2786](#). Finally, it would prove difficult, if not impossible, for judges to administer evidentiary rules under which a “gatekeeping” obligation depended upon a distinction between “scientific” knowledge and “technical” or “other specialized” knowledge, since there is no clear line dividing the one from the others and no convincing need to make such distinctions. Pp. 1174–1175.

****1170** (b) A trial judge determining the admissibility of an engineering expert’s testimony *may* consider one or more of the specific [Daubert](#) factors. The emphasis on the word “*may*” reflects *Daubert*’s description of the Rule 702 inquiry as “a flexible one.” [509 U.S., at 594, 113 S.Ct. 2786](#). The *Daubert* factors do *not* constitute a definitive checklist or test, [id., at 593, 113 S.Ct. 2786](#), and the gatekeeping inquiry must be tied to the particular facts, [id., at 591, 113 S.Ct. 2786](#). Those factors may or may not be pertinent in assessing reliability, depending on the nature of the issue, the expert’s particular expertise, and the subject of his testimony. Some of those factors may be helpful in evaluating the reliability even of experience-based expert testimony, and the Court of Appeals erred insofar as it ruled those factors out in such cases. In determining whether particular expert testimony is reliable, the trial court should consider the specific *Daubert*

factors where they are reasonable measures of reliability. Pp. 1175–1176.

(c) A court of appeals must apply an abuse-of-discretion standard when it reviews a trial court’s decision to admit or exclude expert ***139** testimony. [General Electric Co. v. Joiner, 522 U.S. 136, 138–139, 118 S.Ct. 512, 139 L.Ed.2d 508](#). That standard applies as much to the trial court’s decisions about how to determine reliability as to its ultimate conclusion. Thus, whether *Daubert*’s specific factors are, or are not, reasonable measures of reliability in a particular case is a matter that the law grants the trial judge broad latitude to determine. See [id., at 143, 118 S.Ct. 512](#). The Eleventh Circuit erred insofar as it held to the contrary. P. 1176.

2. Application of the foregoing standards demonstrates that the District Court’s decision not to admit Carlson’s expert testimony was lawful. The District Court did not question Carlson’s qualifications, but excluded his testimony because it initially doubted his methodology and then found it unreliable after examining the transcript in some detail and considering respondents’ defense of it. The doubts that triggered the court’s initial inquiry were reasonable, as was the court’s ultimate conclusion that Carlson could not reliably determine the cause of the failure of the tire in question. The question was not the reliability of Carlson’s methodology in general, but rather whether he could reliably determine the cause of failure of *the particular tire at issue*. That tire, Carlson conceded, had traveled far enough so that some of the tread had been worn bald, it should have been taken out of service, it had been repaired (inadequately) for punctures, and it bore some of the very marks that he said indicated, not a defect, but abuse. Moreover, Carlson’s own testimony cast considerable doubt upon the reliability of both his theory about the need for at least two signs of abuse and his proposition about the significance of visual inspection in this case. Respondents stress that other tire failure experts, like Carlson, rely on visual and tactile examinations of tires. But there is no indication in the record that other experts in the industry use Carlson’s *particular* approach or that tire experts normally make the very fine distinctions necessary to support his conclusions, nor are there references to articles or papers that validate his approach. Respondents’ argument that the District Court too rigidly applied *Daubert* might have had some validity with respect to the court’s initial opinion, but fails because the court, on reconsideration, recognized that the relevant reliability inquiry should be “flexible,” and ultimately based its decision upon Carlson’s failure to

satisfy either *Daubert's* factors or any other set of reasonable reliability criteria. Pp. 1176–1179.

 131 F.3d 1433, reversed.

BREYER, J., delivered the opinion of the Court, Parts I and II of which were unanimous, and Part III of which was joined by REHNQUIST, C.J., and O'CONNOR, SCALIA, KENNEDY, SOUTER, THOMAS, **1171 and GINSBURG, *140 JJ. SCALIA, J., filed a concurring opinion, in which O'CONNOR and THOMAS, JJ., joined, *post*, p. 1179. STEVENS, J., filed an opinion concurring in part and dissenting in part, *post*, p. 1179.

Attorneys and Law Firms




Joseph H. Babington, Mobile, AL, for petitioners.

Jeffrey P. Minear, Washington, DC, for the United States as amicus curiae, by special leave of the court.

Sidney W. Jackson, for respondents.


Opinion

*141 Justice BREYER delivered the opinion of the Court.

In  *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469 (1993), this Court focused upon the admissibility of scientific expert testimony. It pointed out that such testimony is admissible only if it is both relevant and reliable. And it held that the Federal Rules of Evidence “assign to the trial judge the task of ensuring that an expert's testimony both rests on a reliable foundation and is relevant to the task at hand.”  *Id.*, at 597, 113 S.Ct. 2786. The Court also discussed certain more specific factors, such as testing, peer review, error rates, and “acceptability” in the relevant scientific community, some or all of which might prove helpful in determining the reliability of a particular scientific “theory or technique.”  *Id.*, at 593–594, 113 S.Ct. 2786.

This case requires us to decide how *Daubert* applies to the testimony of engineers and other experts who are not scientists. We conclude that *Daubert's* general holding—setting forth the trial judge's general “gatekeeping” obligation—applies not only to testimony based on “scientific” knowledge, but also to testimony based on “technical” and

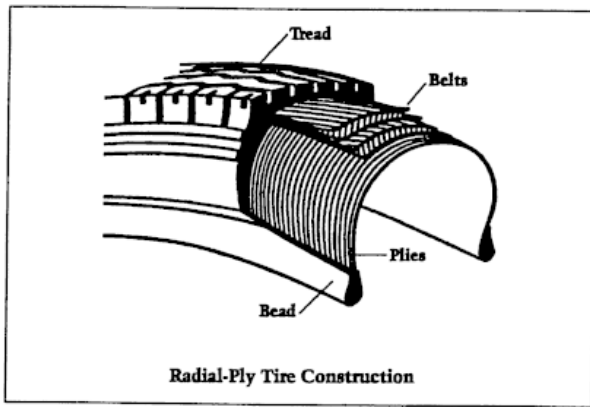
“other specialized” knowledge. See Fed. Rule Evid. 702. We also conclude that a trial court *may* consider one or more of the more specific factors that *Daubert* mentioned when doing so will help determine that testimony's reliability. But, as the Court stated in *Daubert*, the test of reliability is “flexible,” and *Daubert's* list of specific factors neither necessarily nor exclusively applies to all experts or in every case. *142 Rather, the law grants a district court the same broad latitude when it decides *how* to determine reliability as it enjoys in respect to its ultimate reliability determination.

See  *General Electric Co. v. Joiner*, 522 U.S. 136, 143, 118 S.Ct. 512, 139 L.Ed.2d 508 (1997) (courts of appeals are to apply “abuse of discretion” standard when reviewing district court's reliability determination). Applying these standards, we determine that the District Court's decision in this case—not to admit certain expert testimony—was within its discretion and therefore lawful.

I

On July 6, 1993, the right rear tire of a minivan driven by Patrick Carmichael blew out. In the accident that followed, one of the passengers died, and others were severely injured. In October 1993, the Carmichaels brought this diversity suit against the tire's maker and its distributor, whom we refer to collectively as Kumho Tire, claiming that the tire was defective. The plaintiffs rested their case in significant part upon deposition testimony provided by an expert in tire failure analysis, Dennis Carlson, Jr., who intended to testify in support of their conclusion.

Carlson's depositions relied upon certain features of tire technology that are not in dispute. A steel-belted radial tire like the Carmichaels' is made up of a “carcass” containing many layers of flexible cords, called “plies,” along which (between the cords and the outer tread) are laid steel strips called “belts.” Steel wire loops, called “beads,” hold the cords together at the plies' bottom edges. An outer layer, called the “tread,” encases the carcass, and the entire tire is bound together in rubber, through the application of heat and various chemicals. See generally, *e.g.*, J. Dixon, *Tires, Suspension and Handling* 68–72 (2d ed.1996). The bead of the tire sits upon a “bead seat,” which is part of the wheel assembly. That assembly contains a “rim flange,” which extends over the bead and rests against the side of the *143 tire. See M. Mavrigian, *Performance Wheels & Tires* 81, 83 (1998) (illustrations).



****1172** Carlson's testimony also accepted certain background facts about the tire in question. He assumed that before the blowout the tire had traveled far. (The tire was made in 1988 and had been installed some time before the Carmichaels bought the used minivan in March 1993; the Carmichaels had driven the van approximately 7,000 additional miles in the two months they had owned it.) Carlson noted that the tire's tread depth, which was $\frac{11}{32}$ of an inch when new, App. 242, had been worn down to depths that ranged from $\frac{3}{32}$ of an inch along some parts of the tire, to nothing at all along others. *Id.*, at 287. He conceded that the tire tread had at least two punctures which had been inadequately repaired. *Id.*, at 258–261, 322.

Despite the tire's age and history, Carlson concluded that a defect in its manufacture or design caused the blowout. He rested this conclusion in part upon three premises which, ***144** for present purposes, we must assume are not in dispute: First, a tire's carcass should stay bound to the inner side of the tread for a significant period of time after its tread depth has worn away. *Id.*, at 208–209. Second, the tread of the tire at issue had separated from its inner steel-belted carcass prior to the accident. *Id.*, at 336. Third, this “separation” caused the blowout. *Ibid.*

Carlson's conclusion that a defect caused the separation, however, rested upon certain other propositions, several of which the defendants strongly dispute. First, Carlson said that if a separation is *not* caused by a certain kind of tire misuse called “overdeflection” (which consists of underinflating the tire or causing it to carry too much weight, thereby generating heat that can undo the chemical tread/carcass bond), then, ordinarily, its cause is a tire defect. *Id.*, at 193–195, 277–278. Second, he said that if a tire has been subject to sufficient overdeflection to cause a separation, it should reveal certain physical symptoms. These symptoms include (a) tread wear

on the tire's shoulder that is greater than the tread wear along the tire's center, *id.*, at 211; (b) signs of a “bead groove,” where the beads have been pushed too hard against the bead seat on the inside of the tire's rim, *id.*, at 196–197; (c) sidewalls of the tire with physical signs of deterioration, such as discoloration, *id.*, at 212; and/or (d) marks on the tire's rim flange, *id.*, at 219–220. Third, Carlson said that where he does not find *at least two* of the four physical signs just mentioned (and presumably where there is no reason to suspect a less common cause of separation), he concludes that a manufacturing or design defect caused the separation. *Id.*, at 223–224.

Carlson added that he had inspected the tire in question. He conceded that the tire to a limited degree showed greater wear on ****1173** the shoulder than in the center, some signs of “bead groove,” some discoloration, a few marks on the rim flange, and inadequately filled puncture holes (which can also cause heat that might lead to separation). ***145** *Id.*, at 256–257, 258–261, 277, 303–304, 308. But, in each instance, he testified that the symptoms were not significant, and he explained why he believed that they did not reveal overdeflection. For example, the extra shoulder wear, he said, appeared primarily on one shoulder, whereas an overdeflected tire would reveal equally abnormal wear on both shoulders. *Id.*, at 277. Carlson concluded that the tire did not bear at least two of the four overdeflection symptoms, nor was there any less obvious cause of separation; and since neither overdeflection nor the punctures caused the blowout, a defect must have done so.

Kumho Tire moved the District Court to exclude Carlson's testimony on the ground that his methodology failed [Rule 702's](#) reliability requirement. The court agreed with Kumho that it should act as a *Daubert*-type reliability “gatekeeper,” even though one might consider Carlson's testimony as “technical,” rather than “scientific.” See [Carmichael v. Samyang Tires, Inc.](#), 923 F.Supp. 1514, 1521–1522 (S.D.Ala.1996). The court then examined Carlson's methodology in light of the reliability-related factors that *Daubert* mentioned, such as a theory's testability, whether it “has been a subject of peer review or publication,” the “known or potential rate of error,” and the “degree of acceptance ... within the relevant scientific community.” [923 F.Supp.](#), at 1520 (citing [Daubert](#), 509 U.S., at 589–595, 113 S.Ct. 2786). The District Court found that all those factors argued against the reliability of Carlson's methods, and it granted the motion to exclude the testimony (as well as the defendants' accompanying motion for summary judgment).

The plaintiffs, arguing that the court's application of the *Daubert* factors was too “inflexible,” asked for reconsideration. And the court granted that motion.

█ *Carmichael v. Samyang Tires, Inc.*, Civ. Action No. 93–0860–CB–S (S.D.Ala., June 5, 1996), App. to Pet. for Cert. 1c. After reconsidering the matter, the court agreed with the plaintiffs that *Daubert* should be applied flexibly, that its four factors were *146 simply illustrative, and that other factors could argue in favor of admissibility. It conceded that there may be widespread acceptance of a “visual-inspection method” for some relevant purposes. But the court found insufficient indications of the reliability of

“the component of Carlson's tire failure analysis which most concerned the Court, namely, the methodology employed by the expert in analyzing the data obtained in the visual inspection, and the scientific basis, if any, for such an analysis.” *Id.*, at 6c.

It consequently affirmed its earlier order declaring Carlson's testimony inadmissible and granting the defendants' motion for summary judgment.

The Eleventh Circuit reversed. See █ *Carmichael v. Samyang Tire, Inc.*, 131 F.3d 1433 (1997). It “review[ed] ... *de novo*” the “district court's legal decision to apply *Daubert*.” █ *Id.*, at 1435. It noted that “the Supreme Court in *Daubert* explicitly limited its holding to cover only the ‘scientific context,’ ” adding that “a *Daubert* analysis” applies only where an expert relies “on the application of scientific principles,” rather than “on skill- or experience-based observation.” █ *Id.*, at 1435–1436. It concluded that Carlson's testimony, which it viewed as relying on experience, “falls outside the scope of *Daubert*,” that “the district court erred as a matter of law by applying *Daubert* in this case,” and that the case must be remanded for further (non-*Daubert*-type) consideration under Rule 702. █ 131 F.3d, at 1436.

Kumho Tire petitioned for certiorari, asking us to determine whether a trial court “may” consider *Daubert's* specific “factors” when determining the “admissibility of an engineering expert's testimony.” Pet. for Cert. i. We granted certiorari in light of uncertainty among the lower courts about whether, or how, *Daubert* applies to expert testimony that might be characterized as based not upon “scientific” knowledge, but rather upon “technical” or “other specialized” *147 knowledge. Fed. Rule Evid. 702; compare, *e.g.*,

█ *Watkins v. Telsmith, Inc.*, 121 F.3d 984, 990–991 (C.A.5 1997), with, *e.g.*, █ **1174 *Compton v. Subaru of America, Inc.*, 82 F.3d 1513, 1518–1519 (C.A.10), cert. denied, 519 U.S. 1042, 117 S.Ct. 611, 136 L.Ed.2d 536 (1996).

II

A

[1] In *Daubert*, this Court held that Federal Rule of Evidence 702 imposes a special obligation upon a trial judge to “ensure that any and all scientific testimony ... is not only relevant, but reliable.” █ 509 U.S., at 589, 113 S.Ct. 2786. The initial question before us is whether this basic gatekeeping obligation applies only to “scientific” testimony or to all expert testimony. We, like the parties, believe that it applies to all expert testimony. See Brief for Petitioners 19; Brief for Respondents 17.

For one thing, Rule 702 itself says:

“If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.”

This language makes no relevant distinction between “scientific” knowledge and “technical” or “other specialized” knowledge. It makes clear that any such knowledge might become the subject of expert testimony. In *Daubert*, the Court specified that it is the Rule's word “knowledge,” not the words (like “scientific”) that modify that word, that “establishes a standard of evidentiary reliability.” █ 509 U.S., at 589–590, 113 S.Ct. 2786. Hence, as a matter of language, the Rule applies its reliability standard to all “scientific,” “technical,” or “other specialized” matters within its scope. We concede that the Court in *Daubert* referred only to “scientific” knowledge. But as the Court there said, it referred to “scientific” *148 testimony “because that [wa]s the nature of the expertise” at issue. █ *Id.*, at 590, n. 8, 113 S.Ct. 2786.

Neither is the evidentiary rationale that underlay the Court's basic *Daubert* “gatekeeping” determination limited to “scientific” knowledge. *Daubert* pointed out that Federal

Rules 702 and 703 grant expert witnesses testimonial latitude unavailable to other witnesses on the “assumption that the expert's opinion will have a reliable basis in the knowledge and experience of his discipline.” *Id.*, at 592, 113 S.Ct. 2786 (pointing out that experts may testify to opinions, including those that are not based on firsthand knowledge or observation). The Rules grant that latitude to all experts, not just to “scientific” ones.

Finally, it would prove difficult, if not impossible, for judges to administer evidentiary rules under which a gatekeeping obligation depended upon a distinction between “scientific” knowledge and “technical” or “other specialized” knowledge. There is no clear line that divides the one from the others. Disciplines such as engineering rest upon scientific knowledge. Pure scientific theory itself may depend for its development upon observation and properly engineered machinery. And conceptual efforts to distinguish the two are unlikely to produce clear legal lines capable of application in particular cases. Cf. Brief for National Academy of Engineering as *Amicus Curiae* 9 (scientist seeks to understand nature while the engineer seeks nature's modification); Brief for Rubber Manufacturers Association as *Amicus Curiae* 14–16 (engineering, as an “‘applied science,’ ” relies on “scientific reasoning and methodology”); Brief for John Allen et al. as *Amici Curiae* 6 (engineering relies upon “scientific knowledge and methods”).

Neither is there a convincing need to make such distinctions. Experts of all kinds tie observations to conclusions through the use of what Judge Learned Hand called “general truths derived from ... specialized experience.” Hand, *149 *Historical and Practical Considerations Regarding Expert Testimony*, 15 *Harv. L.Rev.* 40, 54 (1901). And whether the specific expert testimony focuses upon specialized observations, the specialized translation of those observations into theory, a specialized theory itself, or the application of such a theory in a particular case, the expert's testimony often will rest “upon an experience confessedly foreign in kind to [the jury's] own.” *Ibid.* The trial judge's effort to assure that the specialized testimony is reliable and relevant can help the jury evaluate **1175 that foreign experience, whether the testimony reflects scientific, technical, or other specialized knowledge.

We conclude that *Daubert's* general principles apply to the expert matters described in [Rule 702](#). The Rule, in respect to all such matters, “establishes a standard of evidentiary

reliability.” *Id.*, at 590, 113 S.Ct. 2786. It “requires a valid ... connection to the pertinent inquiry as a precondition to admissibility.” *Id.*, at 592, 113 S.Ct. 2786. And where such testimony's factual basis, data, principles, methods, or their application are called sufficiently into question, see Part III, *infra*, the trial judge must determine whether the testimony has “a reliable basis in the knowledge and experience of [the relevant] discipline.” *Id.*, at 592, 113 S.Ct. 2786.

B

Petitioners ask more specifically whether a trial judge determining the “admissibility of an engineering expert's testimony” *may* consider several more specific factors that *Daubert* said might “bear on” a judge's gatekeeping determination. Brief for Petitioners i. These factors include:

- Whether a “theory or technique ... can be (and has been) tested”;
- Whether it “has been subjected to peer review and publication”;
- Whether, in respect to a particular technique, there is a high “known or potential rate of error” and whether there are “standards controlling the technique's operation”; and
- *150 Whether the theory or technique enjoys “‘general acceptance’ ” within a “‘relevant scientific community.’ ” *Id.*, at 592–594, 113 S.Ct. 2786.

Emphasizing the word “may” in the question, we answer that question yes.

[2] Engineering testimony rests upon scientific foundations, the reliability of which will be at issue in some cases. See, e.g., Brief for Stephen N. Bobo et al. as *Amici Curiae* 23 (stressing the scientific bases of engineering disciplines). In other cases, the relevant reliability concerns may focus upon personal knowledge or experience. As the Solicitor General points out, there are many different kinds of experts, and many different kinds of expertise. See Brief for United States as *Amicus Curiae* 18–19, and n. 5 (citing cases involving experts in drug terms, handwriting analysis, criminal *modus operandi*, land valuation, agricultural practices, railroad procedures, attorney's fee valuation, and others). *Id.* Our emphasis on

the word “may” thus reflects *Daubert's* description of the Rule 702 inquiry as “a flexible one.” 509 U.S., at 594, 113 S.Ct. 2786. *Daubert* makes clear that the factors it mentions do *not* constitute a “definitive checklist or test.” *Id.*, at 593, 113 S.Ct. 2786. And *Daubert* adds that the gatekeeping inquiry must be “‘tied to the facts’” of a particular “case.” *Id.*, at 591, 113 S.Ct. 2786 (quoting *United States v. Downing*, 753 F.2d 1224, 1242 (C.A.3 1985)). We agree with the Solicitor General that “[t]he factors identified in *Daubert* may or may not be pertinent in assessing reliability, depending on the nature of the issue, the expert's particular expertise, and the subject of his testimony.” Brief for United States as *Amicus Curiae* 19. The conclusion, in our view, is that we can neither rule out, nor rule in, for all cases and for all time the applicability of the factors mentioned in *Daubert*, nor can we now do so for subsets of cases categorized by category of expert or by kind of evidence. Too much depends upon the particular circumstances of the particular case at issue.

*151 *Daubert* itself is not to the contrary. It made clear that its list of factors was meant to be helpful, not definitive. Indeed, those factors do not all necessarily apply even in every instance in which the reliability of scientific testimony is challenged. It might not be surprising in a particular case, for example, that a claim made by a scientific witness has never been the subject of peer review, for the particular application at issue may never previously have interested any scientist. Nor, on the other hand, does the presence of *Daubert's* general acceptance factor help show that an expert's testimony is reliable where the discipline itself lacks reliability, as, for example, do theories grounded in any so-called generally accepted principles of astrology or necromancy.

**1176 At the same time, and contrary to the Court of Appeals' view, some of *Daubert's* questions can help to evaluate the reliability even of experience-based testimony. In certain cases, it will be appropriate for the trial judge to ask, for example, how often an engineering expert's experience-based methodology has produced erroneous results, or whether such a method is generally accepted in the relevant engineering community. Likewise, it will at times be useful to ask even of a witness whose expertise is based purely on experience, say, a perfume tester able to distinguish among 140 odors at a sniff, whether his preparation is of a kind that others in the field would recognize as acceptable.

We must therefore disagree with the Eleventh Circuit's holding that a trial judge may ask questions of the sort

Daubert mentioned only where an expert “relies on the application of scientific principles,” but not where an expert relies “on skill- or experience-based observation.” 131 F.3d, at 1435. We do not believe that Rule 702 creates a schematism that segregates expertise by type while mapping certain kinds of questions to certain kinds of experts. Life and the legal cases that it generates are too complex to warrant so definitive a match.

[3] [4] *152 To say this is not to deny the importance of *Daubert's* gatekeeping requirement. The objective of that requirement is to ensure the reliability and relevancy of expert testimony. It is to make certain that an expert, whether basing testimony upon professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field. Nor do we deny that, as stated in *Daubert*, the particular questions that it mentioned will often be appropriate for use in determining the reliability of challenged expert testimony. Rather, we conclude that the trial judge must have considerable leeway in deciding in a particular case how to go about determining whether particular expert testimony is reliable. That is to say, a trial court should consider the specific factors identified in *Daubert* where they are reasonable measures of the reliability of expert testimony.

[5] [6] The trial court must have the same kind of latitude in deciding *how* to test an expert's reliability, and to decide whether or when special briefing or other proceedings are needed to investigate reliability, as it enjoys when it decides *whether or not* that expert's relevant testimony is reliable. Our opinion in *Joiner* makes clear that a court of appeals is to apply an abuse-of-discretion standard when it “review[s] a trial court's decision to admit or exclude expert testimony.”

522 U.S., at 138–139, 118 S.Ct. 512. That standard applies as much to the trial court's decisions about how to determine reliability as to its ultimate conclusion. Otherwise, the trial judge would lack the discretionary authority needed both to avoid unnecessary “reliability” proceedings in ordinary cases where the reliability of an expert's methods is properly taken for granted, and to require appropriate proceedings in the less usual or more complex cases where cause for questioning the expert's reliability arises. Indeed, the Rules seek to avoid “unjustifiable expense and delay” as part of their search for *153 “truth” and the “jus[t] determin[ation]” of proceedings. *Fed. Rule Evid.* 102. Thus, whether *Daubert's*

specific factors are, or are not, reasonable measures of reliability in a particular case is a matter that the law grants the trial judge broad latitude to determine. See [Joiner, supra](#), at 143, 118 S.Ct. 512. And the Eleventh Circuit erred insofar as it held to the contrary.

III

[7] We further explain the way in which a trial judge “may” consider *Daubert's* factors by applying these considerations to the case at hand, a matter that has been briefed exhaustively by the parties and their 19 *amici*. The District Court did not doubt Carlson's qualifications, which included a masters degree in mechanical engineering, 10 years' work at Michelin America, Inc., and testimony as a tire failure consultant in other tort cases. Rather, it excluded the testimony because, despite those qualifications, it initially ***1177** doubted, and then found unreliable, “the methodology employed by the expert in analyzing the data obtained in the visual inspection, and the scientific basis, if any, for such an analysis.” Civ. Action No. 93–0860–CB–S (S.D.Ala., June 5, 1996), App. to Pet. for Cert. 6c. [After examining the transcript in “some detail,” 923 F.Supp., at 1518–1519, n. 4](#), and after considering respondents' defense of Carlson's methodology, the District Court determined that Carlson's testimony was not reliable. It fell outside the range where experts might reasonably differ, and where the jury must decide among the conflicting views of different experts, even though the evidence is “shaky.” [Daubert, 509 U.S., at 596, 113 S.Ct. 2786](#). In our view, the doubts that triggered the District Court's initial inquiry here were reasonable, as was the court's ultimate conclusion.

For one thing, and contrary to respondents' suggestion, the specific issue before the court was not the reasonableness *in general* of a tire expert's use of a visual and tactile inspection to determine whether overdeflection had caused ***154** the tire's tread to separate from its steel-belted carcass. Rather, it was the reasonableness of using such an approach, along with Carlson's particular method of analyzing the data thereby obtained, to draw a conclusion regarding *the particular matter to which the expert testimony was directly relevant*. That matter concerned the likelihood that a defect in the tire at issue caused its tread to separate from its carcass. The tire in question, the expert conceded, had traveled far enough so that some of the tread had been worn bald; it should have been taken out of service; it had been repaired (inadequately) for punctures; and it bore some of the very marks that the expert


said indicated, not a defect, but abuse through overdeflection. See *supra*, at 1172; App. 293–294. The relevant issue was whether the expert could reliably determine the cause of *this* tire's separation.

Nor was the basis for Carlson's conclusion simply the general theory that, in the absence of evidence of abuse, a defect will normally have caused a tire's separation. Rather, the expert employed a more specific theory to establish the existence (or absence) of such abuse. Carlson testified precisely that in the absence of *at least two* of four signs of abuse (proportionately greater tread wear on the shoulder; signs of grooves caused by the beads; discolored sidewalls; marks on the rim flange), he concludes that a defect caused the separation. And his analysis depended upon acceptance of a further implicit proposition, namely, that his visual and tactile inspection could determine that the tire before him had not been abused despite some evidence of the presence of the very signs for which he looked (and two punctures).

For another thing, the transcripts of Carlson's depositions support both the trial court's initial uncertainty and its final conclusion. Those transcripts cast considerable doubt upon the reliability of both the explicit theory (about the need for two signs of abuse) and the implicit proposition (about the significance of visual inspection in this case). Among other things, the expert could not say whether the tire had traveled ***155** more than 10, or 20, or 30, or 40, or 50 thousand miles, adding that 6,000 miles was “about how far” he could “say with any certainty.” *Id.*, at 265. The court could reasonably have wondered about the reliability of a method of visual and tactile inspection sufficiently precise to ascertain with some certainty the abuse-related significance of minute shoulder/center relative tread wear differences, but insufficiently precise to tell “with any certainty” from the tread wear whether a tire had traveled less than 10,000 or more than 50,000 miles. And these concerns might have been augmented by Carlson's repeated reliance on the “subjective[ness]” of his mode of analysis in response to questions seeking specific information regarding how he could differentiate between a tire that actually had been overdeflected and a tire that merely looked as though it had been. *Id.*, at 222, 224–225, 285–286. They would have been further augmented by the fact that Carlson said he had inspected the tire itself for the first time the morning of his first deposition, and then only for a few hours. (His initial conclusions were based on photographs.) *Id.*, at 180.


****1178** Moreover, prior to his first deposition, Carlson had issued a signed report in which he concluded that the tire had “not been ... overloaded or underinflated,” not because of the absence of “two of four” signs of abuse, but simply because “the rim flange impressions ... were normal.” *Id.*, at 335–336. That report also said that the “tread depth remaining was $\frac{3}{32}$ inch,” *id.*, at 336, though the opposing expert's (apparently undisputed) measurements indicate that the tread depth taken at various positions around the tire actually ranged from $\frac{.5}{32}$ of an inch to $\frac{4}{32}$ of an inch, with the tire apparently showing greater wear along *both* shoulders than along the center, *id.*, at 432–433.

Further, in respect to one sign of abuse, bead grooving, the expert seemed to deny the sufficiency of his own simple visual-inspection methodology. He testified that most tires have some bead groove pattern, that where there is reason ***156** to suspect an abnormal bead groove he would ideally “look at a lot of [similar] tires” to know the grooving's significance, and that he had not looked at many tires similar to the one at issue. *Id.*, at 212–213, 214, 217.



Finally, the court, after looking for a defense of Carlson's methodology as applied in these circumstances, found no convincing defense. Rather, it found (1) that “none” of the *Daubert* factors, including that of “general acceptance” in the relevant expert community, indicated that  Carlson's testimony was reliable, 923 F.Supp., at 1521; (2) that its own analysis “revealed no countervailing factors operating in favor of admissibility which could outweigh those identified in *Daubert*,” App. to Pet. for Cert. 4c; and (3) that the “parties identified no such factors in their briefs,” *ibid.* For these three reasons *taken together*, it concluded that Carlson's testimony was unreliable.

Respondents now argue to us, as they did to the District Court, that a method of tire failure analysis that employs a visual/tactile inspection is a reliable method, and they point both to its use by other experts and to Carlson's long experience working for Michelin as sufficient indication that that is so. But no one denies that an expert might draw a conclusion from a set of observations based on extensive and specialized experience. Nor does anyone deny that, as a general matter, tire abuse may often be identified by qualified experts through visual or tactile inspection of the tire. See Affidavit of H.R. Baumgardner 1–2, cited in Brief for National Academy of Forensic Engineers as *Amicus Curiae* 16 (Tire engineers rely on visual examination and process of elimination to analyze

experimental test tires). As we said before, *supra*, at 1977, the question before the trial court was specific, not general. The trial court had to decide whether this particular expert had sufficient specialized knowledge to assist the jurors “in deciding the particular issues in the case.” 4 J. McLaughlin, Weinstein's Federal Evidence ¶ 702.05[1], p. 702–33 (2d ed.1998); see also Advisory ***157** Committee's Note on Proposed Fed. Rule Evid. 702, Preliminary Draft of Proposed Amendments to the Federal Rules of Civil Procedure and Evidence: Request for Comment 126 (1998) (stressing that district courts must “scrutinize” whether the “principles and methods” employed by an expert “have been properly applied to the facts of the case”).

The particular issue in this case concerned the use of Carlson's two-factor test and his related use of visual/tactile inspection to draw conclusions on the basis of what seemed small observational differences. We have found no indication in the record that other experts in the industry use Carlson's two-factor test or that tire experts such as Carlson normally make the very fine distinctions about, say, the symmetry of comparatively greater shoulder tread wear that were necessary, on Carlson's own theory, to support his conclusions. Nor, despite the prevalence of tire testing, does anyone refer to any articles or papers that validate Carlson's approach. Cf. Bobo, Tire Flaws and Separations, in *Mechanics of Pneumatic Tires* 636–637 (S. Clark ed.1981); C. Schnuth, R. Fuller, G. Follen, G. Gold, & J. Smith, Compression Grooving and Rim Flange Abrasion as Indicators of Over-Deflected Operating Conditions in Tires, presented to Rubber Division of the American Chemical Society, Oct. 21–24, 1997; J. Walter & R. Kiminecz, Bead ****1179** Contact Pressure Measurements at the Tire-Rim Interface, presented to the Society of Automotive Engineers, Inc., Feb. 24–28, 1975. Indeed, no one has argued that Carlson himself, were he still working for Michelin, would have concluded in a report to his employer that a similar tire was similarly defective on grounds identical to those upon which he rested his conclusion here. Of course, Carlson himself claimed that his method was accurate, but, as we pointed out in *Joiner*, “nothing in either *Daubert* or the Federal Rules of Evidence requires a district court to admit opinion evidence that is connected to existing data only by the *ipse dixit* of the expert.”  522 U.S., at 146, 118 S.Ct. 512.

***158** Respondents additionally argue that the District Court too rigidly applied *Daubert's* criteria. They read its opinion to hold that a failure to satisfy any one of those criteria automatically renders expert testimony inadmissible. The

District Court's initial opinion might have been vulnerable to a form of this argument. There, the court, after rejecting respondents' claim that Carlson's testimony was "exempted from *Daubert*-style scrutiny" because it was "technical analysis" rather than "scientific evidence," simply added that "none of the four admissibility criteria outlined by the  *Daubert* court are satisfied." 923 F.Supp., at 1521. Subsequently, however, the court granted respondents' motion for reconsideration. It then explicitly recognized that the relevant reliability inquiry "should be 'flexible,' " that its " 'overarching subject [should be] ... validity' and reliability," and that "*Daubert* was intended neither to be exhaustive nor to apply in every case." App. to Pet. for Cert. 4c (quoting  *Daubert*, 509 U.S., at 594–595, 113 S.Ct. 2786). And the court ultimately based its decision upon Carlson's failure to satisfy either *Daubert's* factors or any other set of reasonable reliability criteria. In light of the record as developed by the parties, that conclusion was within the District Court's lawful discretion.


In sum, Rule 702 grants the district judge the discretionary authority, reviewable for its abuse, to determine reliability in light of the particular facts and circumstances of the particular case. The District Court did not abuse its discretionary authority in this case. Hence, the judgment of the Court of Appeals is


Reversed.

Justice SCALIA, with whom Justice O'CONNOR and Justice THOMAS join, concurring.

I join the opinion of the Court, which makes clear that the discretion it endorses—trial-court discretion in choosing the manner of testing expert reliability—is not discretion to *159 abandon the gatekeeping function. I think it worth adding that it is not discretion to perform the function inadequately. Rather, it is discretion to choose among reasonable means of excluding expertise that is *fausse* and science that is junky. Though, as the Court makes clear today, the *Daubert* factors are not holy writ, in a particular case the

failure to apply one or another of them may be unreasonable, and hence an abuse of discretion.

Justice STEVENS, concurring in part and dissenting in part. The only question that we granted certiorari to decide is whether a trial judge "[m]ay ... consider the four factors set out by this Court in  *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469 (1993), in a Rule 702 analysis of admissibility of an engineering expert's testimony." Pet. for Cert. i. That question is fully and correctly answered in Parts I and II of the Court's opinion, which I join.


Part III answers the quite different question whether the trial judge abused his discretion when he excluded the testimony of Dennis Carlson. Because a proper answer to that question requires a study of the record that can be performed more efficiently by the Court of Appeals than by the nine Members of this Court, I would remand the case to the Eleventh Circuit to perform that task. There are, of course, exceptions to most rules, but I firmly believe that it is neither fair to litigants nor good practice for this Court to reach out to decide questions not raised by the certiorari petition. See  *General Electric Co. v. Joiner*, 522 U.S. 136, 150–151, 118 S.Ct. 512, 139 L.Ed.2d 508 (1997) **1180 (STEVENS, J., concurring in part and dissenting in part).

Accordingly, while I do not feel qualified to disagree with the well-reasoned factual analysis in Part III of the Court's opinion, I do not join that Part, and I respectfully dissent from the Court's disposition of the case.

All Citations

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Footnotes

- * The syllabus constitutes no part of the opinion of the Court but has been prepared by the Reporter of Decisions for the convenience of the reader. See  [United States v. Detroit Timber & Lumber Co., 200 U.S. 321, 337, 26 S.Ct. 282, 50 L.Ed. 499.](#)

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234 Ariz. 289

Court of Appeals of Arizona,
Division 1.

STATE of Arizona ex rel. William G. MONTGOMERY,
Maricopa County Attorney, Petitioner,

v.

The Honorable Phemonia L. MILLER, Commissioner
of the Superior Court of the State of Arizona, in and for
the County of Maricopa, Respondent Commissioner,
Suzanne Racquel Madrid, Real Party in Interest.

No. 1 CA-SA 13-0132.

|

March 28, 2014.

Synopsis

Background: State petitioned for special action relief, challenging trial court's exclusion of expert testimony in prosecution on two counts of aggravated driving under the influence (DUI).

Holdings: The Court of Appeals, Gould, J., held that:

[1] testimony of state's expert with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC) was reliable and reliably applied to facts of case, and

[2] probative worth of expert's testimony was not substantially outweighed by danger of unfair prejudice resulting from its admission.

Relief granted; order of trial court vacated.

West Headnotes (41)

[1] **Criminal Law** 🔑 Intoxication

“Retrograde extrapolation” or “retroactive extrapolation” is a method by which a person's blood alcohol content (BAC) at an earlier point in time is calculated based on his BAC from a later blood test.

5 Cases that cite this headnote

[2] **Courts** 🔑 Issuance of Prerogative or Remedial Writs

Court of appeals accepted jurisdiction over state's petition for special action relief from trial court's grant of defendant's motion in limine, precluding introduction of testimony concerning her blood alcohol content (BAC) based upon retrograde extrapolation calculation, as state had no equally plain, speedy, and adequate remedy by appeal and case involved issues of statewide importance. 17A A.R.S. Rules of Evid., Rule 702; 17B A.R.S. Special Actions Rules of Proc., Rule 1(a).

[3] **Criminal Law** 🔑 Review De Novo **Criminal Law** 🔑 Admissibility

Court of appeals reviews the interpretation of court rules de novo, and a trial court's decision to admit or preclude expert testimony for an abuse of discretion.

2 Cases that cite this headnote

[4] **Criminal Law** 🔑 Reception and Admissibility of Evidence **Criminal Law** 🔑 Evidence in general **Criminal Law** 🔑 Exclusion of Evidence

Appellate court will not disturb a trial court's rulings on the admission or exclusion of evidence unless the court finds a clear abuse of discretion and resulting prejudice, or finds that the trial court misapplied the law.

4 Cases that cite this headnote

[5] **Criminal Law** 🔑 Subjects of Expert Testimony **Criminal Law** 🔑 Preliminary evidence as to competency

Party seeking to admit expert testimony must prove, by a preponderance of the evidence, that the testimony is both relevant and reliable. 17A A.R.S. Rules of Evid., Rule 702.

4 Cases that cite this headnote

[6] **Criminal Law** 🔑 Subjects of Expert Testimony

In evaluating the admissibility of expert testimony, courts must remain cognizant of the separate functions of judge and jury; the court's role as gatekeeper does not supplant or replace the adversary system. 17A A.R.S. Rules of Evid., Rule 702.

1 Cases that cite this headnote

[7] **Criminal Law** 🔑 Experts

Criminal Law 🔑 Opinion evidence

Where there is contradictory, but reliable, expert testimony, it is the province of the jury to determine the weight and credibility of the testimony and to decide between competing methodologies within a field of expertise. 17A A.R.S. Rules of Evid., Rule 702.

4 Cases that cite this headnote

[8] **Criminal Law** 🔑 Cross-examination and redirect examination

Criminal Law 🔑 Experts

Criminal Law 🔑 Presumptions and Burden of Proof

Cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible expert evidence. 17A A.R.S. Rules of Evid., Rule 702.

3 Cases that cite this headnote

[9] **Criminal Law** 🔑 Aid to jury

To be admissible, expert testimony must assist the trier of fact in understanding the evidence or a fact in issue; expert testimony which does not relate to any issue in the case is not relevant and, ergo, non-helpful. 17A A.R.S. Rules of Evid., Rule 702(a).

2 Cases that cite this headnote

[10] **Criminal Law** 🔑 Necessity and sufficiency

Assessment of the sufficiency of the facts and data upon which proffered expert testimony is based is a quantitative, not qualitative analysis. 17A A.R.S. Rules of Evid., Rule 702.

1 Cases that cite this headnote

[11] **Criminal Law** 🔑 Sources of data

Facts or data underlying an expert's testimony may include inadmissible evidence, hypothetical facts, and other experts' opinions. Fed. Rules Evid. Rule 702, 28 U.S.C.A.; 17A A.R.S. Rules of Evid., Rule 702.

[12] **Criminal Law** 🔑 Necessity and sufficiency

In order for expert testimony to be admissible, the expert must be able to explain how his methods, reasoning and opinions are based on an accepted body of learning or experience. Fed. Rules Evid. Rule 702, 28 U.S.C.A.; 17A A.R.S. Rules of Evid., Rule 702.

2 Cases that cite this headnote

[13] **Criminal Law** 🔑 Necessity and sufficiency

While an expert's methodology must be based on more than speculation, its reliability need not be established to a degree of scientific certainty. 17A A.R.S. Rules of Evid., Rule 702.

1 Cases that cite this headnote

[14] **Criminal Law** 🔑 Necessity and sufficiency

In evaluating the reliability of expert testimony, courts may consider, inter alia: (1) whether the expert's theory or technique can be or has been tested; (2) whether the theory or technique has been subjected to peer review and publication; (3) whether the technique or theory is generally accepted within the relevant scientific community; (4) the known or potential rate of error of the technique or theory when applied; and (5) the existence and maintenance of standards controlling application

of the technique. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#); [17A A.R.S. Rules of Evid., Rule 702.](#)

[5 Cases that cite this headnote](#)

[15] Criminal Law 🔑 [Necessity and sufficiency](#)

No single factor relevant to the reliability of expert testimony is dispositive, and not all of the *Daubert* factors will apply to all experts or in every case. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#); [17A A.R.S. Rules of Evid., Rule 702.](#)

[5 Cases that cite this headnote](#)

[16] Criminal Law 🔑 [Necessity and sufficiency](#)

In evaluating the reliability of expert testimony, courts may consider, inter alia, whether: (1) the expert's testimony is prepared solely in anticipation of litigation, or is based on independent research; (2) the expert's field of expertise or discipline is known to produce reliable results; (3) other courts have determined that the expert's methodology is reliable; and (4) non-judicial uses for the expert's methodology or science. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#); [17A A.R.S. Rules of Evid., Rule 702.](#)

[2 Cases that cite this headnote](#)

[17] Criminal Law 🔑 [Necessity and sufficiency](#)

In evaluating whether proposed expert testimony reliably applies relevant principles and methods to the facts of the case, the court must determine whether the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion, as conclusions and methodology are not entirely distinct from one another; a court may conclude that there is simply too great an analytical gap between the data and the opinion offered. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#); [17A A.R.S. Rules of Evid., Rule 702.](#)

[3 Cases that cite this headnote](#)

[18] Criminal Law 🔑 [Necessity and sufficiency](#)

In assessing the reliability of an expert's conclusions and opinions, courts may consider such factors as whether: (1) the expert employs

the same care as a litigation expert as he would in his regular professional work outside the courtroom; (2) the expert has accounted for obvious alternative explanations, and (3) the expert's opinion adequately accounts for available data and unknown variables. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#); [17A A.R.S. Rules of Evid., Rule 702.](#)

[2 Cases that cite this headnote](#)

[19] Criminal Law 🔑 [Necessity and sufficiency](#)

First *Daubert* factor for the admissibility of expert testimony, that of testability, focuses on whether a method or theory can be or has been tested; the inquiry is whether the expert's theory can be challenged in some objective sense, or whether it is instead simply a subjective, conclusory approach that cannot reasonably be tested to determine its reliability. [Fed.Rules Evid.Rule 702, 28 U.S.C.A.](#); [17A A.R.S. Rules of Evid., Rule 702.](#)

[20] Criminal Law 🔑 [Intoxication](#)

For purposes of determining admissibility of testimony of state's expert in prosecution for aggravated driving while under the influence of alcohol (DUI) with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC), expert's assumption that average person reaches his peak BAC within two hours of driving was testable; expert testified that he had participated in workshops testing absorption rates of individuals dosed with alcohol, and testified about numerous studies and tests conducted with respect to absorption rates. [17A A.R.S. Rules of Evid., Rule 702.](#)

[21] Criminal Law 🔑 [Necessity and sufficiency](#)

In evaluating the admissibility of expert testimony, flaws in a methodology uncovered by peer review do not necessarily equate to a lack of scientific validity, and may be relevant to the weight, not the admissibility, of the evidence; rather, peer review and publication should be viewed as evidence that the theory and

methodology are scientific knowledge capable of being scrutinized by the scientific community. 17A A.R.S. Rules of Evid., Rule 702.

2 Cases that cite this headnote

[22] Criminal Law 🔑 Necessity and sufficiency

In evaluating the admissibility of expert testimony, publication is not the sine qua non of admissibility of expert testimony, as there are some instances in which well-grounded but novel theories will not have been published; in addition, courts should take into account that some methods or theories are of limited public interest, and are therefore less likely to be published. 17A A.R.S. Rules of Evid., Rule 702.

[23] Criminal Law 🔑 Necessity and sufficiency

In evaluating the admissibility of expert testimony, widespread acceptance of a scientific technique can be an important factor in ruling particular evidence admissible, and a known technique which has been able to attract only minimal support within the community may properly be viewed with skepticism.

[24] Criminal Law 🔑 Necessity and sufficiency

In evaluating the admissibility of expert testimony, the absence of a consensus or acceptance by a majority of the relevant scientific community does not necessarily rule out general acceptance, as in some instances there may be several different theories, all of which are generally accepted. 17A A.R.S. Rules of Evid., Rule 702.

[25] Criminal Law 🔑 Necessity and sufficiency

In evaluating the admissibility of expert testimony, substantial criticism of a particular theory does not mean the theory or technique lacks general acceptance; only when a theory or procedure does not have the acceptance of most of the pertinent scientific community, and in fact a substantial part of the scientific community disfavors the principle or procedure, will it not be

deemed generally accepted. 17A A.R.S. Rules of Evid., Rule 702.

[26] Criminal Law 🔑 Intoxication

For purposes of determining admissibility of testimony of state's expert in prosecution for aggravated driving while under the influence of alcohol (DUI) with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC), expert's methodology was generally accepted as valid in relevant scientific community, despite existence of arguable flaws in methodology and some disagreement in scientific community as to most accurate method of performing retrograde analysis, where expert testified that several studies and scholarly publications supported his opinion that average person reaches peak BAC within two hours of their last drink, and state presented several articles in support of expert's testimony. 17A A.R.S. Rules of Evid., Rule 702.

[27] Criminal Law 🔑 Necessity and sufficiency

Fourth *Daubert* factor relevant to the admissibility of expert testimony, rate of error, examines whether an expert's methodology can be objectively evaluated for known or potential error rates, and whether the rate of error is acceptable in the relevant scientific community. 17A A.R.S. Rules of Evid., Rule 702.

1 Cases that cite this headnote

[28] Criminal Law 🔑 Intoxication

For purposes of determining admissibility of testimony of state's expert in prosecution for aggravated driving while under the influence of alcohol (DUI) with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC), expert's methodology reliably accounted for potential rate of error in his retrograde analysis; expert relied upon conservative peak absorption rate to account for lack of information about defendant's last meal, accounted for lack of information regarding defendant's drinking history by using

conservative alcohol elimination rate, and did not provide specific value for defendant's BAC, but rather provided range of values. 17A A.R.S. Rules of Evid., Rule 702.

[29] Criminal Law 🔑 Necessity and sufficiency

In evaluating the admissibility of expert testimony, maintenance of industry standards is a strong factor in favor of admissibility; however, the lack of a universal standard for application of a technique is troubling but not fatal because a court may admit well-founded testimony based on specialized training and experience. 17A A.R.S. Rules of Evid., Rule 702.

[30] Criminal Law 🔑 Intoxication

For purposes of determining admissibility of testimony of state's expert in prosecution for aggravated driving while under the influence of alcohol (DUI) with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC), general scientific standards governed use of retrograde extrapolation; state's expert and defendant's expert agreed on validity and standard use of basic science underlying retrograde analysis, both experts agreed that some accepted standards, such as average elimination rates, were used in retrograde extrapolation, and several studies produced standards and guidelines for making retrograde calculation. 17A A.R.S. Rules of Evid., Rule 702.

[7 Cases that cite this headnote](#)

[31] Criminal Law 🔑 Necessity and sufficiency

In addition to the *Daubert* factors, a court evaluating the admissibility of expert testimony may consider whether an expert developed his opinion based on independent research, or whether the expert developed his opinion expressly for purposes of testifying; the focus of this factor is whether legitimate, independent research has been conducted in an area, or whether the expert's methodology and opinions

have solely been prepared to provide expert testimony for the courtroom. 17A A.R.S. Rules of Evid., Rule 702.

[1 Cases that cite this headnote](#)

[32] Criminal Law 🔑 Necessity and sufficiency

For purposes of evaluating the admissibility of expert testimony, expert testimony based on independent research is generally considered more reliable than testimony prepared for litigation; however, an exception to this rule applies to forensic sciences such as fingerprint analysis, voice recognition, DNA, and a variety of other endeavors closely tied to law enforcement that may indeed have the courtroom as a principle theatre of operations. 17A A.R.S. Rules of Evid., Rule 702.

[1 Cases that cite this headnote](#)

[33] Criminal Law 🔑 Intoxication

For purposes of determining admissibility of testimony of state's expert in prosecution for aggravated driving while under the influence of alcohol (DUI) with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC), factor of whether expert's methodology and opinions were prepared solely to provide expert testimony for the courtroom did not weigh strongly for or against admission; while retrograde extrapolation was forensic science primarily used to establish person's BAC for purposes of criminal DUI prosecution, relevant theory and methodology had undergone great deal of testing and study outside courtroom. 17A A.R.S. Rules of Evid., Rule 702.

[1 Cases that cite this headnote](#)

[34] Criminal Law 🔑 Necessity and sufficiency

In evaluating the admissibility of expert testimony, a court may consider whether the expert's field of expertise is known to reach reliable results, and in so doing may examine whether an expert's technique or methodology has been found to be reliable by other courts. 17A A.R.S. Rules of Evid., Rule 702.

[1 Cases that cite this headnote](#)**[35] Criminal Law** 🔑 Intoxication

For purposes of determining admissibility of testimony of state's expert in prosecution for aggravated driving while under the influence of alcohol (DUI) with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC), retrograde analysis was generally considered to be reliable scientific discipline, and courts previously considering such methodology determined that it was reliable.

[4 Cases that cite this headnote](#)**[36] Criminal Law** 🔑 Necessity and sufficiency

In evaluating the admissibility of expert testimony, in considering the reliability of a methodology as applied to a particular case, courts will examine whether the expert has adequately accounted for obvious alternative explanations. 17A A.R.S. Rules of Evid., Rule 702.

[37] Criminal Law 🔑 Necessity and sufficiency

Mere existence or possibility of an alternative explanation does not render an expert opinion or theory inadmissible; rather, it is sufficient if the expert has at least considered the alternative explanation, and has ruled it out in reaching his opinion.

[2 Cases that cite this headnote](#)**[38] Criminal Law** 🔑 Intoxication

For purposes of determining admissibility of testimony of state's expert in prosecution for aggravated driving while under the influence of alcohol (DUI) with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC), state's expert adequately accounted for obvious alternative explanations, by considering effect defendant's eating and drinking history would have had on her BAC and whether his analysis produced an artificially

high BAC based on possibility defendant was not fully absorbed within two hours of driving, and based his retrograde analysis on conservative absorption and elimination rates and provided range for defendant's BAC rather than specific value. 17A A.R.S. Rules of Evid., Rule 702.

[1 Cases that cite this headnote](#)**[39] Criminal Law** 🔑 Intoxication

For purposes of determining admissibility of testimony of state's expert in prosecution for aggravated driving while under the influence of alcohol (DUI) with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC), expert adequately took into account unknown variables of defendant's drinking and eating history and gave defendant benefit of the doubt as to unknown variables; expert had, and took into account, some information about defendant's eating and drinking history, accounted for lack of additional information by using reasonable assumptions based on average absorption and elimination rates, and based all his assumptions on conservative estimates that erred in favor of defendant. 17A A.R.S. Rules of Evid., Rule 702.

[40] Criminal Law 🔑 Intoxication

Testimony of state's expert with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC) was reliable, was reliably applied to facts of case, and was admissible in prosecution for aggravated driving while under the influence of alcohol (DUI). Fed.Rules Evid.Rule 702, 28 U.S.C.A.; 17A A.R.S. Rules of Evid., Rule 702.

[41] Criminal Law 🔑 Intoxication

Probative worth of testimony of state's expert with respect to retrograde extrapolation calculation of defendant's blood alcohol content (BAC) was not substantially outweighed by danger of unfair prejudice resulting from its admission, where testimony was reliable and no

unfair prejudice would result from its admission.
17A A.R.S. Rules of Evid., Rules 403, 702.

Attorneys and Law Firms

****459** Maricopa County Attorney's Office By Lisa Marie Martin, Phoenix, Counsel for Petitioner.

Law Offices of Neal W. Bassett By Neal W. Bassett, Phoenix, Shell & Nermyr PLLC By Mark A. Nermyr, Chandler, Co-Counsel for Real Party in Interest.

Presiding Judge [ANDREW W. GOULD](#) delivered the opinion of the Court, in which Judge [MARGARET H. DOWNIE](#) and Judge [PATRICIA A. OROZCO](#) joined.

OPINION

GOULD, Judge.

***294** ¶ 1 The State seeks special action relief from the trial court's order granting Defendant's motion in limine. The trial court's order precluded the State's expert from testifying that, based on his retrograde extrapolation calculation, Defendant's blood alcohol concentration (BAC) was above the legal limit within two hours of driving. Because we conclude the expert's testimony is admissible under [Arizona Rule of Evidence 702](#), we accept jurisdiction and grant relief.

Facts and Procedural Background

¶ 2 In May 2009, Suzanne Racquel Madrid ("Defendant") was stopped by the police on suspicion of driving under the influence of alcohol. The traffic stop occurred at 2:20 a.m. Defendant was arrested, and at 6:15 a.m. her blood was drawn. Defendant's blood test showed her BAC was .127.

¶ 3 Defendant was eventually indicted on two counts of aggravated driving while under the influence of alcohol ("DUI"). Count One charged Defendant with driving under the influence of alcohol while her ability to drive was impaired by alcohol "to the slightest degree." [Arizona Revised Statutes \("A.R.S."\) section 28-1381\(A\)\(1\)](#) (2012).¹ Count Two charged Defendant with driving while her BAC

was .08 or greater within two hours of driving. [A.R.S. § 28-1381\(A\)\(2\)](#) (2012).²

****460 *295** ¶ 4 Because Defendant's blood was drawn almost four hours after she was stopped by the police, the State did not have a blood test showing her BAC within two hours of driving. [A.R.S. § 28-1381\(A\)\(2\)](#). In order to prove what Defendant's BAC would have been within two hours of driving, the State was required to perform a retrograde extrapolation. *See State v. Claybrook*, 193 Ariz. 588, 590, ¶ 14, 975 P.2d 1101, 1103 (App. 1998) (stating that "[w]hen a defendant's BAC test does not occur within two hours of driving ... the State may still meet its burden of proving that the defendant had a BAC" above the legal limit within two hours of driving by using retrograde extrapolation).³

[1] ¶ 5 A retrograde, or retroactive extrapolation, is a method by which a person's BAC at an earlier point in time is calculated based on his BAC from a later blood test. *Claybrook*, 193 Ariz. at 590, ¶¶ 14-15, 975 P.2d at 1103; [Ring](#), 141 Ariz. at 69, 685 P.2d at 134. Here, the State's expert planned to use retrograde extrapolation to calculate Defendant's blood alcohol content within two hours of the stop based on the blood draw taken at 6:15 a.m.


¶ 6 Prior to trial, Defendant filed a motion requesting an evidentiary hearing to determine the admissibility of the State's proffered retrograde extrapolation testimony. The trial court held an evidentiary hearing on the motion, during which the State's expert, John Musselman, and Defendant's expert, Chester Flaxmayer, testified about the science of retrograde extrapolation.

¶ 7 Both Musselman and Flaxmayer agreed on the validity of the basic science underlying retrograde extrapolation. The experts testified that when individuals drink alcohol, it is absorbed into their blood stream. After they stop drinking, their blood alcohol concentration will continue to rise until it reaches a "peak," or maximum concentration in their blood. After a person's BAC reaches its peak, it will then begin to fall as their body eliminates alcohol faster than it absorbs it.

¶ 8 Musselman and Flaxmayer agreed that there are two key factors in making a retrograde calculation: (1) the amount of time it takes a person to fully absorb alcohol and reach a "peak" BAC, and (2) the rate at which a person eliminates

alcohol from his body. Flaxmayer agreed that the alcohol elimination rate used by Musselman in his retrograde analysis was scientifically valid.⁴ Both experts also agreed that in order to make a valid retrograde analysis, an individual must have been “fully absorbed,” or have reached a peak BAC at the relevant time period.⁵ Otherwise, the retrograde analysis may overestimate a person's BAC. Finally, both Musselman and Flaxmayer testified that a number of variables affect how long it takes an individual to reach their peak BAC, including drinking history (time of last drink, how much they drank and over what time period, what type of alcohol they drank, whether they are a heavy or social drinker), eating history (when they ate, what they ate and how much food they consumed before they were stopped), and personal characteristics (height, weight, gender).


****461 *296 ¶ 9** One area addressed by the experts was the application of retrograde extrapolation to the “time of test” and the “time of driving.” The phrase “time of driving” refers to the last point in time when a defendant is driving or in actual physical control of a vehicle. Kurt M. Dubowski, Article: *Time-of-Test DUI Laws vs. BAC Extrapolation*, December 2006, pp. 3–13 (Presented at The Robert F. Borkenstein Course on Alcohol and Highway Safety, Indiana University/Bloomington). In this case, the time of driving was 2:20 a.m., when Defendant was stopped by the police. The phrase “time of test” refers to a defendant's BAC measured at a specific time interval after the time of driving, e.g., after the time of the traffic stop/arrest. *Id.* In many states, this time interval is set by statute. *Id.* Such statutes are referred to as “per se” DUI statutes, because a defendant is presumed to be impaired from alcohol if his BAC is above the legal limit at the specified time interval. *Id.* at 3. The statutory interval for a per se DUI offense in Arizona is designated as “within two hours of driving or being in actual physical control” of a vehicle.

 **A.R.S. § 28–1381(A)(2).** Here, the time of the test refers to Defendant's BAC within two hours of driving, or immediately before 4:20 a.m.

¶ 10 Musselman agreed with Flaxmayer that a scientifically valid retrograde analysis could not be related back to Defendant's time of driving without knowing what she ate and drank, and when, before she was arrested. However, Musselman testified that a valid retrograde analysis could be performed to within two hours of Defendant's driving even without information concerning Defendant's eating and drinking history. Musselman's opinion was based on three assumptions: (1) Defendant consumed no alcohol or food in

the two hour interval after she was stopped; (2) the average person is fully absorbed and reaches peak BAC within two hours after consuming their last drink, which in this case would have been no later than the time of the traffic stop; and (3) a range of BAC is used rather than a specific value. Based on these assumptions, Musselman testified that Defendant's BAC within two hours of driving was .127 to .177, well above the legal limit of .08.

¶ 11 Flaxmayer testified that a valid retrograde analysis could not be performed to within two hours of driving without knowing Defendant's eating and drinking history prior to the traffic stop. He opined that it is not reasonable to assume the average person reaches peak BAC within two hours of consuming their last drink, because “large numbers of individuals” do not reach peak BAC within this time period. Flaxmayer stated that it is critical to know a person's eating and drinking history in order to determine when a person reaches his peak BAC and that any assumptions about a person's peak BAC without this information are speculative.

¶ 12 The trial court granted Defendant's motion in limine, finding that Musselman's retrograde analysis was not reliable under the “*Daubert* standards” set forth in “amended [Arizona Rules of Evidence 702](#).” The trial court found that Musselman failed to account for important unknown variables affecting Defendant's BAC, such as Defendant's eating and drinking history before the traffic stop. The trial court also relied on literature authored by Dr. Alan Wayne Jones for the proposition that alcohol absorption differs among individuals and that many factors play a role in when an individual's “peak BAC” occurs. It also found persuasive  [State v. Armstrong, 267 P.3d 777 \(Nev.2011\)](#), in which the Nevada Supreme Court held that a retrograde extrapolation is unreliable if it is insufficiently tied to important variables affecting the calculation, such as the drinking and eating history of a defendant. The trial court concluded that the State's retrograde analysis was “unreliable and highly prejudicial,” and “[t]hough relevant, the probative value is outweighed by the prejudicial effect.” Based on these findings, the trial court issued an order “precluding the retrograde extrapolation and any testimony that the defendant was above the legal limit within two hours of driving.”

¶ 13 The State filed this special action challenging the trial court's order and requesting a stay of the jury trial. We previously granted the State's stay request.

****462 *297 Jurisdiction**

[2] ¶ 14 We accept jurisdiction of this special action because the State has no immediate right to appeal the trial court's preclusion order; as a result, the State has no "equally plain, speedy, and adequate remedy by appeal." *Ariz. R.P. Spec.*

Act. 1(a); *State v. Bernstein*, 234 Ariz. 89, 93, ¶¶ 6–7, 317 P.3d 630, 634 (App.2014) (State has no immediate right to appeal from an order precluding evidence at trial); *State v. Bejarano*, 219 Ariz. 518, 522, ¶ 11, 200 P.3d 1015, 1019 (App.2008) (same). In addition, this case involves issues that are of statewide importance: the interpretation of Arizona Rule of Evidence 702 and the admissibility of retrograde extrapolation evidence. *BT Capital, LLC v. TD Serv. Co. of Ariz.*, 229 Ariz. 299, 300, ¶ 7, 275 P.3d 598, 599 (2012) (stating that appellate courts will accept special action jurisdiction on issues of statewide importance); *Bernstein*, 234 Ariz. at 93–94, ¶¶ 6, 9, 317 P.3d at 634–35 (stating that interpretation of Arizona Evidence Rule 702 as amended January 1, 2012 involves an issue of statewide importance).

Standard of Review

[3] [4] ¶ 15 We review the interpretation of court rules de novo, and a trial court's decision to admit or preclude expert testimony for an abuse of discretion. *General Electric Co. v. Joiner*, 522 U.S. 136, 139, 118 S.Ct. 512, 139 L.Ed.2d 508 (1997); *Bernstein*, 234 Ariz. at 94, ¶ 10, 317 P.3d at 635. An appellate court "will not disturb a trial court's rulings on the admission or exclusion of evidence unless [the court] finds a clear abuse of discretion and resulting prejudice, or finds that the trial court misapplied the law." *Lohmeier v. Hammer*, 214 Ariz. 57, 61, ¶ 7, 148 P.3d 101, 105 (App.2006).

Discussion

¶ 16 The State contends the trial court abused its discretion in precluding the State's expert witness testimony. The State argues that the retrograde extrapolation methodology used by its expert is scientifically valid and reliable, and that the trial court abused its role as gatekeeper under Arizona Rule of Evidence 702 by precluding its expert's testimony. Defendant, on the other hand, contends the court properly precluded

the State's expert testimony because his methodology was scientifically invalid and unreliable.

I. Rule 702 and Daubert

¶ 17 Prior to 2010, Arizona's standard for the admissibility of scientific expert testimony was the general acceptance test set forth in *Frye v. United States*, 293 F. 1013 (D.C.Cir.1923). *Logerquist v. McVey*, 196 Ariz. 470, 1 P.3d 113 (2000). Effective January 1, 2012, the Arizona Supreme Court amended Arizona Rule of Evidence 702 and adopted Federal Rule of Evidence 702, which embodies the principles set forth in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469 (1993). *Ariz. R. Evid. 702*, comment to 2012 amendment; *Fed.R.Evid. 702*, advisory committee's notes, 2000 amendments. The amended version of Arizona Rule of Evidence 702 states:

A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:

- (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
- (b) the testimony is based on sufficient facts or data;
- (c) the testimony is the product of reliable principles and methods; and
- (d) the expert has reliably applied the principles and methods to the facts of the case.

¶ 18 Because Arizona Rule of Evidence 702 is now identical to Federal Rule of Evidence 702, we may look to the federal advisory committee notes for guidance in interpreting the Arizona rule. *Bernstein*, 234 Ariz. at 95, ¶ 11, 317 P.3d at 636; *Ariz. State Hosp./Ariz. Cmty. Protection and Treatment Cntr. v. Klein*, 231 Ariz. 467, 473, ¶ 26, 296 P.3d 1003, 1009 (App.2013). In addition, federal decisions interpreting Federal Rule 702 "are persuasive but not binding" authority in interpreting Arizona Rule of Evidence 702. ***298 **463** *Bernstein*, 234 Ariz. at 95, ¶ 11, 317 P.3d at 636 (internal citations omitted); *Klein*, 231 Ariz. at 473, ¶ 26, 296 P.3d at 1009.

[5] ¶ 19 Like its federal counterpart, Arizona Rule of Evidence 702 provides that a trial judge serves as a

“gatekeeper” who makes a preliminary assessment as to whether the proposed expert testimony is relevant and reliable. *Ariz. R. Evid. 702*, comment to 2012 amendment. See *Fed.R.Evid. 702*, advisory committee's notes, 2000 amendments; *Daubert*, 509 U.S. at 597, 113 S.Ct. 2786; *Kumho Tire Co., Ltd. v. Carmichael*, 526 U.S. 137, 119 S.Ct. 1167, 143 L.Ed.2d 238 (1999) (holding that a judge's gatekeeping function under *Daubert* applies to all types of expert testimony, not just scientific testimony). As a result, the party seeking to admit expert testimony must prove, by a preponderance of the evidence, that the testimony is both relevant and reliable. *Daubert*, 509 U.S. at 592 & n. 10; *Bernstein*, 234 Ariz. at 94, ¶ 10, 317 P.3d at 635.

[6] [7] [8] ¶ 20 In evaluating admissibility, courts must remain cognizant of the separate functions of judge and jury. The court's role as gatekeeper does not supplant or replace the adversary system. *Ariz. R. Evid. 702*, comment to 2012 amendment. “Where there is contradictory, but reliable, expert testimony, it is the province of the jury to determine the weight and credibility of the testimony” and to decide between “competing methodologies within a field of expertise.” *Id.*; see also *Heller v. Shaw Industries, Inc.*, 167 F.3d 146, 152 (3rd Cir.1999) (expert testimony shall not be excluded because the expert uses one test in lieu of another, when both tests are accepted in the field and reach reliable results). Moreover, “cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible [expert] evidence.” *Heller*, 167 F.3d at 152.

[9] ¶ 21 The initial consideration under amended *Rule 702* is whether the proffered expert is qualified to testify about a particular issue. *Ariz. R. Evid. 702*. Subsection (a) of amended *Rule 702* primarily relates to relevancy, or what *Daubert* described as “fit.” *Daubert*, 509 U.S. at 591, 113 S.Ct. 2786. To be admissible, expert testimony must assist the trier of fact in understanding the evidence or a fact in issue. “Expert testimony which does not relate to any issue in the case is not relevant and, ergo, non-helpful.” *Daubert*, 509 U.S. at 591, 113 S.Ct. 2786 (internal citations omitted).

[10] [11] ¶ 22 Under *Rule 702*, subsection (b), the court examines whether the expert obtained enough information or data to make the proffered opinion reliable. *U.S. v.*

Crabbe, 556 F.Supp.2d 1217, 1223 (D.Colo.2008). The assessment of the sufficiency of the facts and data is a quantitative, not qualitative analysis. *Fed.R.Evid. 702*, advisory committee's notes, 2000 amendments; cf. *Crabbe*, 556 F.Supp.2d at 1228 (in prosecution of company owners for tax evasion, government expert's testimony that owners understated employees' wages in their tax returns and filings was not reliable under *Rule 702* because sample of wages paid to agency's employees “was not sufficiently large or diverse enough to permit [expert's] methodology to reliably model the accuracy of the information”). Thus, the facts or data underlying an expert's testimony may include inadmissible evidence, hypothetical facts, and other experts' opinions. *Fed.R.Evid. 702*, advisory committee's notes, 2000 amendments.

[12] [13] ¶ 23 Subsection (c) of *Rule 702* requires an expert's testimony to be based on “reliable principles and methods.” Under this requirement, an expert must be able to explain how his methods, reasoning and opinions are based on “an accepted body of learning or experience.” *Fed.R.Evid. 702*, advisory committee's notes, 2000 amendments. See *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 43 F.3d 1311, 1319 n. 11 (9th Cir.1995) (“*Daubert II*”) (“[T]he party proffering the evidence must explain the expert's methodology and demonstrate in some objectively verifiable way that the expert has both chosen a reliable scientific method and followed it faithfully.”). While the expert's methodology must be based on more than speculation, its reliability need not be established to a degree of scientific certainty. *Daubert*, 509 U.S. at 590, 113 S.Ct. 2786.

**464 [14] *299 ¶ 24 To assist courts in evaluating the reliability of expert testimony, *Daubert* set forth a non-exclusive list of factors. *Daubert*, 509 U.S. at 593, 113 S.Ct. 2786. The specific factors articulated by *Daubert* are: (1) whether the expert's theory or technique can be or has been tested; (2) whether the theory or technique has been subjected to peer review and publication; (3) whether the technique or theory is generally accepted within the relevant scientific community; (4) the known or potential rate of error of the technique or theory when applied; and (5) the existence and maintenance of standards controlling application of the technique. *Id.* at 593–94, 113 S.Ct. 2786.

[15] [16] ¶ 25 No single *Daubert* factor is dispositive of the reliability of an expert's testimony, and not all of the *Daubert* factors will apply to “all experts or in every

case.” [Kumho Tire](#), 526 U.S. at 141–42, 152, 119 S.Ct. 1167; Fed.R.Evid. 702, advisory committee's notes, 2000 amendments; [Bernstein](#), 234 Ariz. at 95, ¶ 12, 317 P.3d at 636; see e.g., [Tyus v. Urban Search Management](#), 102 F.3d 256, 263 (7th Cir.1996) (stating that the *Daubert* factors did not precisely apply to the proffered sociologist's expert testimony). Moreover, courts since *Daubert* have identified other factors for judges to consider in determining reliability, including whether: (1) the expert's testimony is prepared solely in anticipation of litigation, or is based on independent research; (2) the expert's field of expertise/discipline is known to produce reliable results; (3) other courts have determined that the expert's methodology is reliable; and (4) non-judicial uses for the expert's methodology/science. Fed.R.Evid. 702, advisory committee's notes, 2000 amendments; [Kumho Tire](#), 526 U.S. at 152, 119 S.Ct. 1167; [Oddi v. Ford Motor Co.](#), 234 F.3d 136, 156 (3rd Cir.2000); [Daubert II](#), 43 F.3d at 1317.

[17] ¶ 26 Finally, subsection (d) of Rule 702 requires an expert to reliably apply “the principles and methods to the facts of the case.” Ariz. R. Evid. 702(d). As the United States Supreme Court recognized in *Joiner*, “conclusions and methodology are not entirely distinct from one another,” and “[a] court may conclude that there is simply too great an analytical gap between the data and the opinion offered.” [Joiner](#), 522 U.S. at 146, 118 S.Ct. 512. Stated another way, the court must determine “[w]hether the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion.” Fed.R.Evid. 702, advisory committee's notes, 2000 amendments.

[18] ¶ 27 In assessing the reliability of an expert's conclusions and opinions under Rule 702(d), courts have considered a variety of factors, including whether: (1) the expert employs the same care as a litigation expert as he would in his regular professional work outside the courtroom; (2) the expert has accounted for obvious alternative explanations, and (3) the expert's opinion adequately accounts for available data and unknown variables. [Crabbe](#), 556 F.Supp.2d at 1223–24; Fed.R.Evid. 702, advisory committee's notes, 2000 amendments; see [Kumho Tire](#), 526 U.S. at 152, 119 S.Ct. 1167 (the trial court must make certain the expert employs “the same level of intellectual rigor” in the courtroom as in practice); [Sheehan v. Daily Racing Form, Inc.](#), 104

F.3d 940, 942 (7th Cir.1997) (stating that expert statistician's opinion in age discrimination case was not admissible under *Daubert* standard where the expert used standard statistical methods to show a correlation between age and the employer's decision to retain or discharge employees, but failed to adjust his statistical analysis by accounting for other variables, such as an employee's computer skills, that would have a bearing on the employer's retention/discharge decisions); [Claar v. Burlington N.R.R. Co.](#), 29 F.3d 499, 502 (9th Cir.1994) (testimony excluded when expert failed to consider obvious alternative causes for the plaintiff's ailments).

II. Analysis

¶ 28 There is no contention in this case that the State's expert lacked the qualifications to render an opinion regarding Defendant's BAC using retrograde extrapolation. In addition, it is undisputed that Musselman's testimony is relevant. As the trial court noted, Musselman's retrograde analysis would assist the jury in determining whether Defendant had a BAC above the legal limit *300 **465 (.08) within two hours of driving, an element of the offense as alleged in Count Two.

[A.R.S. § 28–1381\(A\)\(2\)](#). See *supra*, at ¶ 12.

¶ 29 Moreover, while Defendant's contention that Musselman based his opinion on insufficient facts (e.g., concerning her eating and drinking history) arguably falls under Rule 702(b), subsection (b) is not, under the facts of this case, the proper rule to assess the reliability of his opinion. Rule 702(b) examines the quantity of information possessed by an expert, not the reliability or admissibility of the information itself. See *supra*, at ¶ 22. Here, Musselman possessed sufficient information to perform a retrograde extrapolation based on a combination of known variables (Defendant's time of driving and her BAC results), assumptions about when Defendant reached her peak BAC (within two hours of driving), and standard alcohol elimination rates.

¶ 30 The core dispute in this case is the reliability of Musselman's methodology and opinions under [Arizona Rules of Evidence 702\(c\) and \(d\)](#). Defendant contends, and the trial court agreed, that Musselman's retrograde extrapolation to within two hours of driving is unreliable because (1) it is based on the faulty assumption that Defendant reached her peak BAC within two hours of driving and (2) Musselman could not perform a valid retrograde analysis without Defendant's drinking and eating history.

A. Rule 702(c) Factors

1. Testing

[19] ¶ 31 The first *Daubert* factor, “testability,” focuses on whether a method or theory “can be (or has been) tested.” [Daubert](#), 509 U.S. at 593, 113 S.Ct. 2786; see [United States v. Bonds](#), 12 F.3d 540, 559 (6th Cir.1993). The inquiry is “whether the expert’s theory can be challenged in some objective sense, or whether it is instead simply a subjective, conclusory approach that cannot reasonably” be tested to determine its reliability. Fed. R. Evid. 702 advisory committee’s notes, 2000 amendments; see, e.g., [United States v. Mitchell](#), 365 F.3d 215, 235 (3rd Cir.2004) (explaining that the hypothesis “all crows are black” is testable because a white crow could be found, whereas a clairvoyant’s statement that he communicates with the dead is not testable because there is no way for the dead to claim otherwise).

[20] ¶ 32 In this case, the issue of testing focuses on Musselman’s assumption that the average person reaches his peak BAC within two hours of driving. This assumption can be and has been tested. Musselman testified that he has participated in workshops testing the absorption rates of individuals “dosed” with alcohol. In addition, Musselman testified about numerous studies and tests that have been conducted concerning absorption rates.

2. Peer Review and Publication

[21] ¶ 33 The second *Daubert* factor addresses whether a theory or technique has been subjected to peer review and publication. [Daubert](#), 509 U.S. at 593, 113 S.Ct. 2786. *Daubert* noted that “submission to the scrutiny of the scientific community is a component of ‘good science,’ in part because it increases the likelihood that substantive flaws in methodology will be detected.” [Daubert](#), 509 U.S. at 593, 113 S.Ct. 2786. Under this factor, it is important to recognize that flaws in a methodology “uncovered by peer review do not necessarily equate to a lack of scientific validity,” and may be relevant to “the weight, not the admissibility, of the evidence.” [Bonds](#), 12 F.3d at 559. Rather, “peer review and publication should be viewed as evidence that the theory and methodology are scientific knowledge capable of being scrutinized by the scientific community.” *Id.*

[22] ¶ 34 The *Daubert* court was cognizant of the fact that publication is not the *sine qua non* of admissibility of expert testimony, as there are some instances in which “well-grounded” but novel theories will not have been published.

[Daubert](#), 509 U.S. at 593, 113 S.Ct. 2786. See also [Kannankeril v. Terminix Int’l. Inc.](#), 128 F.3d 802, 809 (3rd Cir.1997) (holding that peer review or publication are not necessary conditions of reliability when an expert’s opinion is supported by “widely accepted scientific knowledge”). In addition, courts should take into account that some methods or theories are of limited public interest, and are therefore less likely to be published. [Bonds](#), 12 F.3d at 559.

¶ 35 Here, Musselman testified that his methodology of performing retrograde extrapolation calculations based on average absorption rates has been peer reviewed in several scholarly journals. In addition, the State submitted several peer reviewed publications discussing the use of average absorption rates in performing retrograde extrapolations.

3. General Acceptance

[23] [24] [25] ¶ 36 The next *Daubert* factor is general acceptance within the relevant scientific community. “Widespread acceptance can be an important factor in ruling particular evidence admissible, and ‘a known technique which has been able to attract only minimal support within the community’ may properly be viewed with skepticism.”

[Daubert](#), 509 U.S. at 594, 113 S.Ct. 2786 (internal citations omitted). The absence of a consensus or acceptance by a majority of the relevant scientific community does not necessarily rule out general acceptance, as in some instances there may be several different theories, all of which are generally accepted. [Bonds](#), 12 F.3d at 562. Moreover, substantial criticism of a particular theory does not mean the theory or technique lacks general acceptance. *Id.* “Only when a theory or procedure does not have the acceptance of most of the pertinent scientific community, and in fact a substantial part of the scientific community disfavors the principle or procedure, will it not be generally accepted.” *Id.* (citing [Novak v. United States](#), 865 F.2d 718, 725 (6th Cir.1989)).

[26] ¶ 37 The State presented evidence that Musselman’s methodology has been generally accepted within the relevant scientific community. Musselman testified that several studies and scholarly publications support his opinion that

the average person reaches peak BAC within two hours of their last drink. In addition, the State presented several articles in support of Musselman's testimony. For example, the State presented publications by Dr. Kurt Dubowski and Dr. Alan Jones, both of whom were cited by Flaxmayer and Musselman as well-recognized experts in the field of retrograde extrapolation, as support for Musselman's claim that his methodology was generally accepted in the relevant scientific community.⁶

¶ 38 While the record shows arguable flaws in Musselman's methodology, and disagreement in the scientific community as to whether Musselman's method is the most accurate method to perform a retrograde analysis, we conclude that his methodology is generally accepted as valid in the relevant scientific community.

4. Rate of Error

[27] ¶ 39 The fourth *Daubert* factor, rate of error, examines whether an expert's methodology can be objectively evaluated for known or potential error rates, and whether the rate of error is acceptable in the relevant scientific community.

📄 *Daubert*, 509 U.S. at 594, 113 S.Ct. 2786; 📄 *Bonds*, 12 F.3d at 560.

¶ 40 In the instant case, the potential rate of error for Musselman's retrograde analysis is dependent upon the accuracy of his assumption that Defendant, like the average person, reached her peak BAC within two hours of driving. Flaxmayer testified that *302 **467 this assumption was too speculative. According to Flaxmayer, “there are a large number of individuals who haven't reached” their peak BAC within a two hour period, and that the relevant literature states that a valid retrograde analysis cannot be performed without knowing a person's drinking and eating history.

¶ 41 Musselman, however, cited several studies showing that most people reach their peak BAC within two hours of their last drink. For example, Musselman cited a study by Jones and Neri showing that 87.5% (14 of 16) of participants reached peak BAC within two hours of their last drink. In addition, the State presented evidence from another study by Jones showing the absorption rates for 1000 participants on an empty stomach. See Jones, *supra* note 6, at 376. The results of the tests showed that 77% of the participants reached peak BAC within 0–45 minutes of drinking and 92% reached peak BAC within 0–75 minutes of drinking. *Id.* at 378–79. In his study, Jones also references another study where 81% of the

participants reached peak BAC within 30 minutes of drinking. *Id.* at 383. Based on these and other studies, Musselman testified that while some persons can take more than two hours to reach peak BAC, these individuals are “outliers,” and do not reflect the absorption rates for the typical individual.

¶ 42 Flaxmayer's testimony partially corroborated Musselman's on the issue of average absorption rates. Flaxmayer testified that based on the studies he had reviewed, the average person on an empty stomach reaches peak BAC in 50–51 minutes, with “one person” reaching peak BAC in 14 minutes, and “at least one person [taking] 138 minutes.” Flaxmayer testified that the average person who has consumed one pound of food will reach peak BAC within two hours, with the range being anywhere from 30 minutes to three hours. Finally, Flaxmayer testified that a person eating a heavy, 2000 calorie meal will average approximately three hours to reach his peak, with a range of 45 minutes to over four hours.

¶ 43 Musselman accounts for the potential rate of error in his methodology in a number of ways. First, he relies upon a conservative peak absorption rate of two hours, rather than the average of 30 minutes to an hour, to account for the lack of information about Defendant's last meal. See 📄 *United States v. Tsosie*, 791 F.Supp.2d 1099, 1115–16 (D.N.M.2011) (expert's assumption that defendant was fully absorbed within two hours of driving was a reasonable assumption to account for expert's lack of information about defendant's last meal);

📄 *Commonwealth v. Senior*, 433 Mass. 453, 744 N.E.2d 614, 619–20 (2001) (same). Second, Musselman accounted for the lack of information regarding Defendant's drinking history by using a conservative alcohol elimination rate.

📄 *Tsosie*, 791 F.Supp.2d at 1115–16 (expert's assumption that the “general population eliminates alcohol at a rate between .01 and .03 mg/mL/h” was a reasonable assumption to account for expert's lack of information about defendant's drinking history); 📄 *Senior*, 744 N.E.2d at 619 (same). Using this conservative elimination rate, Musselman calculated that the low end of Defendant's BAC range within two hours of driving would have been .143. Musselman, however, took this conservative elimination rate even further, using Defendant's actual BAC of .127 approximately four hours after driving as the low end of Defendant's range. Finally, to further account for variations in Defendant's eating and drinking history, Musselman did not provide a specific value for Defendant's BAC, but rather provided a range of values. 📄 *Tsosie*,

791 F.Supp.2d at 1115–16 (range of values for BAC is scientifically valid where expert relies upon assumptions as to average absorption and elimination rates); [Senior](#), 744 N.E.2d at 620 (same).

[28] ¶ 44 Based on the foregoing, we conclude Musselman's methodology reliably accounted for the potential rate of error in his retrograde analysis.

5. Professional Standards

[29] ¶ 45 The fifth *Daubert* factor inquires whether there are universal standards that govern the application of a technique or method. [Daubert](#), 509 U.S. at 594, 113 S.Ct. 2786. Maintenance of industry standards is a strong factor in favor of admissibility. [*303 **468 United States v. Monteiro](#), 407 F.Supp.2d 351, 369 (D.Mass.2006). However, “[t]he lack of a universal standard [for application of a technique] is troubling but not fatal under [Daubert](#)/[Kumho](#) because a court may admit well-founded testimony based on specialized training and experience.” [Id.](#) at 371.

[30] ¶ 46 While Defendant contests the accuracy of Musselman's retrograde calculation, both Musselman and Flaxmayer agreed on the validity and standard use of the basic science underlying retrograde analysis. *See supra*, at ¶ 7. Moreover, both experts agreed that some accepted standards, such as average elimination rates, are used in retrograde extrapolation. The record also reflects that several studies have produced standards and guidelines for making a retrograde calculation. *See supra*, ¶¶ 7–8, 37, 41–43. Accordingly, we conclude that there are general scientific standards that govern the use of retrograde extrapolation.

6. Independent Studies/Non–Judicial Uses

[31] [32] ¶ 47 In addition to the *Daubert* factors, courts may also consider whether an expert developed his opinion based on independent research, or whether the expert developed his opinion “expressly for purposes of testifying.” [Daubert II](#), 43 F.3d at 1317; *see Fed.R.Evid. 702*, advisory committee's notes, 2000 amendments. The focus of this factor is whether legitimate, independent research has been conducted in an area, or whether the expert's methodology and opinions have solely been prepared to provide expert testimony for the courtroom. [Daubert II](#), 43 F.3d at

1317; [Tsosie](#), 791 F.Supp.2d at 1107; *Fed.R.Evid. 702*, advisory committee's notes, 2000 amendments. Generally, expert testimony based on independent research is considered more reliable than testimony prepared for litigation; however, one exception to this rule applies to forensic sciences such as “[f]ingerprint analysis, voice recognition, DNA ... and a variety of other endeavors closely tied to law enforcement [that] may indeed have the courtroom as a principle theatre of operations.” [Daubert II](#), 43 F.3d at 1317, n. 5.

[33] ¶ 48 The record reflects that retrograde extrapolation is a forensic science primarily used to establish a person's BAC for the purpose of criminal DUI prosecution.⁷ We note, however, that the theory and methodology of retrograde extrapolation has undergone a great deal of testing and study outside the courtroom. As a result, we conclude this factor does not weigh strongly either for or against the reliability of Musselman's testimony.

7. Reliability of Discipline/Determinations by Other Courts

[34] ¶ 49 Another factor is whether the expert's field of expertise is known to reach reliable results. *Fed.R.Evid. 702*, advisory committee's notes, 2000 amendments; *see* [Kumho Tire](#), 526 U.S. at 151, 119 S.Ct. 1167 ([Daubert](#)'s general acceptance factor does not help to show reliability where the expert's discipline lacks reliability). In conjunction with this factor, courts have examined whether an expert's technique or methodology has been found to be reliable by other courts. [Olson v. Ford Motor Co.](#), 481 F.3d 619, 628 (8th Cir.2007); *see* [Senior](#), 744 N.E.2d at 620 (In determining that retrograde extrapolation is reliable expert testimony under *Daubert*, the court relied, in part, upon the fact that “[s]everal other jurisdictions have admitted similar evidence.”); *State v. Burgess*, 188 Vt. 235, 5 A.3d 911, 916–17 (2010) (same).

¶ 50 The State emphasizes that Arizona courts have recognized the utility and admissibility of retrograde extrapolation for many years. *See, e.g., State v. Stanley*, 217 Ariz. 253, 258, ¶ 24, 172 P.3d 848, 853 (App.2007) (stating that an expert “must use retroactive extrapolation to determine blood alcohol content” if the defendant's blood sample is drawn more than two hours after driving); [*469 *304 Claybrook](#), 193 Ariz. at 590, ¶ 15, 975 P.2d at 1103 (“The scientific community has generally accepted” retrograde

extrapolation); [Ring](#), 141 Ariz. at 69, n. 6, 685 P.2d at 134, n. 6 (stating that retrograde extrapolation has “achieved general acceptance in the scientific field”). However, none of the Arizona cases cited by the State specifically addresses the reliability of the methodology used by Musselman.

¶ 51 Several courts from other jurisdictions have found the methodology used by Musselman to be reliable. [Tsosie](#), 791 F.Supp.2d at 1115–16 (holding that retrograde analysis to time of test is a reliable methodology, where, in the absence of information about the defendant's eating and drinking history, an expert relies upon reasonable assumptions as to the average absorption and elimination rates of the general population); [Burgess](#), 188 Vt. 235, 5 A.3d at 916–17 (retrograde analysis to the time of test is a reliable methodology despite the absence of information about the defendant's eating and drinking history; while such information “would undoubtedly make for a more accurate analysis, that is an issue that goes to the weight of the evidence” and not its admissibility); [Senior](#), 744 N.E.2d at 620–21 (stating that retrograde analysis based on average absorption and elimination rates is reliable).

¶ 52 However, as noted earlier, the trial court and Defendant rely upon [State v. Armstrong](#), 267 P.3d 777 (Nev.2011), for the proposition that retrograde extrapolation is unreliable if it is insufficiently tied to the drinking and eating history of a defendant. We conclude that *Armstrong* is not persuasive authority for three reasons. First, Nevada has not adopted the *Daubert* standard, and as a result *Armstrong* did not determine the admissibility of retrograde analysis under a standard comparable to [Arizona Evidence Rule 702](#). [Id.](#) at 780–81. Rather, *Armstrong* analyzed the admissibility of the proffered expert's testimony using the relevance and prejudice standards of [Rules 401 and 403](#). [Id.](#) Second, the retrograde analysis excluded in *Armstrong* was used to calculate defendant's BAC at the time of driving, and not the time of the test—something even Musselman conceded could not be done accurately without Defendant's eating and drinking history.⁸ [Armstrong](#), 267 P.3d at 779.

¶ 53 Third, *Armstrong* relied upon the analysis used by the Texas Court of Criminal Appeals in [Mata v. State](#), 46 S.W.3d 902 (Tex.Crim.App.2001), a case we find readily distinguishable. Like *Armstrong*, *Mata* analyzed the use of retrograde analysis to determine a defendant's BAC at the

time of driving, rather than the time of the test. [Mata](#), 46 S.W.3d at 905, 908–09, 913. The *Mata* court stated that it was not addressing “whether test results showing a defendant's BAC at some time after the alleged offense are admissible at trial in the absence of retrograde extrapolation.” [Id.](#) at 910. Moreover, the decision in *Mata* was based on Texas' clear and convincing standard for proving the admissibility of expert testimony, rather than the preponderance standard used in Arizona. [Id.](#) at 908, 917. Finally, many of the concerns of the *Mata* court were based on specific problems with the State's expert and his ability to explain his methodology, a problem that is not present in the instant case. [Id.](#) at 914–16.

[35] ¶ 54 Accordingly, we conclude that (1) retrograde analysis is generally considered to be a reliable scientific discipline, and (2) courts that have considered the methodology used by the State's expert have determined that it is reliable.

B. Rule 702(d) Factors

1. Obvious Alternative Explanations

[36] [37] ¶ 55 In considering the reliability of a methodology as applied to a particular case, courts will examine whether the expert “has adequately accounted for obvious alternative explanations.” [Fed.R.Evid. 702](#), advisory committee's note, 2000 amendments. The mere existence or possibility of an alternative explanation does not render an opinion *305 **470 or theory inadmissible; rather, it is sufficient if the expert has at least considered the alternative explanation, and has ruled it out in reaching his opinion. *Id.*; [Tsosie](#), 791 F.Supp.2d at 1114.

[38] ¶ 56 Our review of the record shows that Musselman adequately accounted for obvious alternative explanations in reaching his opinion. Musselman considered the effect Defendant's eating and drinking history would have had on her BAC, including a scenario where Defendant may have consumed a large amount of alcohol immediately before the traffic stop. Musselman also considered whether his retrograde extrapolation produced an artificially high BAC based on the possibility Defendant was not fully absorbed within two hours of driving. Musselman adequately accounted for this possibility by basing his retrograde analysis on conservative absorption and elimination rates, as well as

providing a range for Defendant's BAC rather than a specific value. *See supra*, ¶¶ 40–44.

2. Adequately Accounting for Unknown Variables

¶ 57 The trial court determined that Musselman's testimony was unreliable because he (1) failed to take into account the “unknown variables” of Defendant's drinking and eating history, and (2) he did not give “the defendant the benefit of the doubt” as to these unknown variables. We disagree.

[39] ¶ 58 First, Musselman did have some information about Defendant's eating and drinking history; he knew that Defendant's last drink was before 2:20 a.m., and that Defendant did not eat any significant amount of food after that time. *See supra*, ¶ 10. Second, Musselman accounted for his lack of additional information about Defendant's eating and drinking history by using reasonable assumptions based on average absorption and elimination rates. *See supra*, ¶ 43. Third, all of the assumptions used by Musselman, as well as the range of Defendant's BAC, were based on conservative estimates that erred in favor of Defendant, e.g., calculated a lower BAC for Defendant. *See supra*, ¶ 43.

[40] ¶ 59 Based upon our analysis of the relevant factors under [Rule 702](#), subsections (c) and (d), we conclude that Musselman's retrograde extrapolation methodology was reliable, and that he reliably applied this methodology to the

facts of this case. As a result, his retrograde extrapolation testimony is admissible, and the trial court erred in precluding it under [Arizona Evidence Rule 702](#).

C. Rule 403 Balancing

[41] ¶ 60 The trial court determined that because Musselman's retrograde analysis was unreliable and inadmissible under [Arizona Evidence Rule 702](#), its probative worth was substantially outweighed by its danger for unfair prejudice. *Ariz. R. Evid. 403*. We disagree. Musselman's testimony is reliable under [Rule 702](#), and therefore there is no danger of unfair prejudice. As a result, the trial court erred in precluding his testimony under [Rule 403](#).






Conclusion



¶ 61 For the foregoing reasons, we grant relief and vacate the trial court's order precluding the State's expert from testifying that, based on his retrograde extrapolation, Defendant's blood alcohol concentration was above the legal limit within two hours of driving. In addition, the stay previously issued in this matter is vacated.

All Citations

234 Ariz. 289, 321 P.3d 454, 683 Ariz. Adv. Rep. 49

Footnotes

- 1  [A.R.S. § 28–1381\(A\)\(1\)](#) states, in relevant part, “It is unlawful for a person to drive a vehicle or be in actual physical control of a vehicle in this state ... while under the influence of intoxicating liquor ... if the person is impaired to the slightest degree.” Here, Defendant was charged with aggravated DUI, a class four felony, because her “driver[’s] license or privilege to drive [was] suspended, canceled, revoked or refused ...” or restricted at the time of the offense. [A.R.S. § 28–1383\(A\)\(1\)](#).
- 2  [A.R.S. § 28–1381\(A\)\(2\)](#) states, in relevant part, “It is unlawful for a person to drive a vehicle or be in actual physical control of a vehicle in this state ... if the person has an alcohol concentration of 0.08 or more within two hours of driving or being in actual physical control of the vehicle ...”
- 3 Under the current version of  [A.R.S. § 28–1381\(A\)\(2\)](#), no impairment from alcohol need be shown if the defendant's BAC is 0.08 or more within two hours of driving. Prior to 1990, our statute required the State to prove a defendant's BAC was above the legal limit at the time of driving. *See* [A.R.S. § 28–692\(A\)\(2\)](#) (1988);  [Desmond v. State](#), 161 Ariz. 522, 528, 779 P.2d 1261, 1267 (1989);  [Ring v. Taylor](#), 141 Ariz. 56, 69,

- 685 P.2d 121, 134 (App.1984). Under this prior version of the statute, the State was required to perform a retrograde extrapolation to the time of driving.  *Desmond*, 161 Ariz. at 528–29, 779 P.2d at 1267–68. The statute was amended in 1990, requiring the State to establish a defendant's BAC within two hours of driving. *Williams v. Thude*, 180 Ariz. 531, 536 n. 2, 885 P.2d 1096, 1101 n. 2 (App.1994); Laws 1990, Ch. 375, § 8.
- 4 Musselman testified that the general population eliminates alcohol at a rate between .09 to .29 mg/mL per hour, and that he used a range of .08 to .25 mg/mL per hour in his retrograde calculation.
 - 5 Musselman and Flaxmayer agreed that a valid retrograde analysis can also be performed if a person has reached a “plateau” where their absorption rate and elimination rate are in equilibrium, and their BAC is no longer rising.
 - 6 Dubowski and Jones state that retrograde analysis is valid based on the time of test, because unlike a time of driving analysis, a time of test analysis measures a person's peak BAC following a time interval where they have not consumed any food or alcohol. See Dubowski, *Time-of-Test DUI Laws vs. BAC Extrapolation*, p. 28 (“I join in and support the position of the NSC/CAOD Subcommittee on Alcohol Technology, Pharmacology, and Toxicology, which advocates adoption of Time-of-Test DUI laws and found them to be scientifically sound and supported by the scientific literature.”); Alan W. Jones, Article: *Peak Blood-Ethanol Concentration and the Time of Its Occurrence after Rapid Drinking on an Empty Stomach*, 36 J. Forensic Science 376, 384 (1991) (“The status of ethanol absorption in drunk drivers at the time of the offense is a more difficult question to tackle. In practice, it will depend on such circumstances as the previous drinking spree—the duration and quantities consumed—and the time lapse from the end of drinking to the time of arrest ... speculation about the status of alcohol absorption in drunk drivers can be avoided by statutory definition of the analytical result *at the time of the test as the relevant figure* for prosecution. This approach is highly recommended when per se statutory limits of alcohol concentration are enforced.”) (emphasis added).
 - 7 We are unable to conclude from this record whether the science of retrograde extrapolation has a non-judicial use or purpose. *Fed.R.Evid. 702*, advisory committee's notes, 2000 amendments. Similarly, because retrograde extrapolation appears to primarily be a forensic science, another potential *Rule 702(c)* factor—whether the expert exercises the same degree of care in his litigation testimony as he does in his regular, non-litigation work—is not a relevant factor in this case. *Id.*
 - 8 Although Nevada has a per se DUI statute that defines DUI as having a BAC .08 or greater within two hours of driving, the defendant in *Armstrong* was not charged with that offense.  *Armstrong*, 267 P.3d at 779 & n. 1; see *Nevada Revised Statutes (“N.R.S.”) section 484C.430(1)(c) (2011)* (stating that a person commits the offense of driving under the influence causing death and/or substantial bodily harm if they have a BAC of .08 or greater within two hours of driving).

237 Ariz. 226
Supreme Court of Arizona.

STATE of Arizona, Petitioner,

v.

The Honorable Jerry BERNSTEIN, Judge Pro Tempore
of the Superior Court of the State of Arizona, In
and for the County of Maricopa, Respondent Judge
Doreen Lynn Herman; Ramsey Tohannie; Armen
Aslayan; Keith Porter; Mara Hall; Shyla Rotmil; Robert
R. Farinas; Kymberly Crowley; [Jason Quan](#); Michael
Dinola; Kelly Lewis Day, Real Parties in Interest.

No. CV–14–0057–PR.

|

April 23, 2015.

Synopsis

Background: In multiple prosecutions for driving while intoxicated (DWI), defendants filed motions in limine with respect to results of blood alcohol testing from Scottsdale Crime Laboratory (SCL). The Superior Court, Maricopa County, Nos. CR2010–126778–001, CR2010–158681–001, CR2011–113050–001, CR2011–116266–001, CR2011–132750–001, CR2011–152826–001, CR2011–161795–001, CR2012–110698–001, CR2012–112612–001, CR2012–112620–001, and CR2012–119408–001, Jerry Bernstein, J., issued minute entry granting motions. State brought petition for special action challenging exclusion of BAC test results.

The Court of Appeals, Thuma, J., [234 Ariz. 89, 317 P.3d 630](#), granted relief, vacated minute entry and stay, and remanded. Further review was sought.

[Holding:] The Supreme Court, [Bales](#), C.J., held that the State met its burden under rule governing expert testimony that gas chromatography had been reliably applied to analyze defendants' blood alcohol content (BAC).

Superior Court order vacated; Court of Appeals opinion vacated in part; case remanded to Superior Court.

West Headnotes (10)

[1] **Criminal Law**  Review De Novo

Criminal Law  Reception and Admissibility of Evidence


The Supreme Court reviews the interpretation of court rules de novo, but it reviews a trial court's exclusion of evidence for an abuse of discretion.

[12 Cases that cite this headnote](#)

[2] **Courts**  Abuse of discretion in general

An error of law constitutes an “abuse of discretion.”

[15 Cases that cite this headnote](#)

[3] **Criminal Law**  Preliminary evidence as to competency

As the proponent of the expert testimony, the State bears the burden of establishing its admissibility by a preponderance of the evidence. 17A A.R.S. Rules of Evid., Rule 702.

[3 Cases that cite this headnote](#)

[4] **Criminal Law**  Basis of Opinion

Challenges to an expert's application of a methodology are a proper subject of the trial court's gatekeeping inquiry. 17A A.R.S. Rules of Evid., Rule 702.

[7 Cases that cite this headnote](#)

[5] **Criminal Law**  Subjects of Expert Testimony

The overall purpose of rule governing expert testimony is simply to ensure that a fact-finder is presented with reliable and relevant evidence, not flawless evidence. 17A A.R.S. Rules of Evid., Rule 702.

[9 Cases that cite this headnote](#)

[6] Criminal Law 🔑 Subjects of Expert Testimony

Rule governing expert testimony must be interpreted and applied with some flexibility to encompass the multitude of scenarios that may be presented and to maintain the division in function between the fact-finder and gatekeeper. 17A A.R.S. Rules of Evid., Rule 702.

3 Cases that cite this headnote

[7] Criminal Law 🔑 Necessity and sufficiency

Errors in an expert witness's application of a generally reliable methodology should not serve to exclude evidence unless they are so serious as to render the results themselves unreliable. 17A A.R.S. Rules of Evid., Rule 702.

3 Cases that cite this headnote

[8] Criminal Law 🔑 Necessity and sufficiency**Criminal Law** 🔑 Credibility of Witnesses

Whether errors in application of a reliable expert methodology render evidence unreliable will not always be clear, and in close cases, the trial court should allow the jury to exercise its fact-finding function, for it is the jury's exclusive province to assess the weight and credibility of evidence. 17A A.R.S. Rules of Evid., Rule 702.

15 Cases that cite this headnote

[9] Criminal Law 🔑 Necessity and sufficiency

As long as an expert's scientific testimony rests upon good grounds, it should be tested by the adversary process, competing expert testimony and active cross-examination, rather than excluded from jurors' scrutiny for fear that they will not grasp its complexities or satisfactorily weigh its inadequacies. 17A A.R.S. Rules of Evid., Rule 702.

4 Cases that cite this headnote

[10] Automobiles 🔑 Conduct and Proof of Test; Foundation or Predicate

Automobiles 🔑 Reliability of particular testing devices

Automobiles 🔑 Identification and integrity of sample

For purposes of determining admissibility of blood alcohol content (BAC) test results in prosecutions for driving while intoxicated (DWI), state met its burden under rule governing expert testimony that gas chromatography had been reliably applied to analyze BAC, despite the trial court's concern with data drops, mislabeling, and laboratory's failure to remove the testing instrument from service; the state presented evidence that incidents of mislabeling could readily be corrected based on the printing sequence, no evidence suggested that the defendants' samples were misidentified, and the jury could consider the test instrument's malfunctioning and the laboratory staff's related concerns when assessing the weight or reliability of the test results. 17A A.R.S. Rules of Evid., Rule 702(d).

2 Cases that cite this headnote

Attorneys and Law Firms

****201** W. Clifford Girard, Jr., Mark D. DuBiel, Lawrence Koplow, Joseph P. St. Louis (argued), Phoenix, Attorneys for Doreen Lynn Herman, et al.

William G. Montgomery, Maricopa County Attorney, Lisa Marie Martin (argued), Deputy County Attorney, Phoenix, Attorneys for State of Arizona.

Bruce Washburn, Scottsdale City Attorney, Ken Flint, Assistant City Prosecutor, Scottsdale, Attorneys for Amicus Curiae City of Scottsdale.

Alan B. Kelly, Scottsdale, Attorney for Amicus Curiae Scottsdale Lincoln Health Network.

Chief Justice BALES authored the opinion of the Court, in which Vice Chief Justice PELANDER, and Justices BERCH, BRUTINEL, and TIMMER joined.

Opinion

Chief Justice BALES, Opinion of the Court.

*227 ¶ 1 Arizona Rule of Evidence 702 requires a trial court to act as a gatekeeper to ensure that only reliable expert witness testimony is admitted for the jury's consideration. This case concerns the trial court's role under Rule 702(d) when a party contends that an expert has not properly applied generally reliable principles or methods. We hold that courts, as gatekeepers, should consider whether a methodology has been correctly applied. But we conclude that errors in application should result in the exclusion of evidence only if they render the expert's conclusions unreliable; otherwise, the jury should be allowed to consider whether the expert properly applied the methodology in determining the weight or credibility of the expert testimony.

I.

¶ 2 Real parties in interest are eleven defendants charged with aggravated driving under the influence. The Scottsdale Crime Laboratory ("SCL") tested each defendant's blood for blood alcohol concentration ("BAC"). As described by the court of appeals:

To test the blood, the SCL used a Clarus 500 gas chromatograph serial number 650N9042003 manufactured by PerkinElmer (the 2003 Instrument), an autosampler, a personal computer and a printer. Stated simply, after calibration, several dozen vials are placed in the carousel of the 2003 Instrument. The vials contain blood samples (each individual has two samples tested at a time, with the second sample called a replicate) along with control samples. The vials are sampled, one by one, and analyzed by the 2003 Instrument, a process that takes several hours. The data are then processed (creating graphs showing the chemical properties of *228 **202 the compounds tested for called chromatograms) and results are calculated and printed. The output is

checked for consistency with expected results, control samples and quality controls, and replicates are checked to make sure that results are within plus or minus five percent of each other according to SCL protocol. A second analyst then performs a technical review, which is followed by an administrative review.

State v. Bernstein, 234 Ariz. 89, 92 ¶ 2, 317 P.3d 630, 633 (App.2014).

¶ 3 Defendants moved to exclude evidence of their BAC results under Rule 702, arguing that the instrument had unresolved flaws that undermined its reliability. They pointed primarily to "data drops," a term they use to describe the instrument's occasional failure to produce any results for a sample, mislabeling of vials, and emails among SCL staff expressing concerns about the instrument.

¶ 4 After a seventeen-day evidentiary hearing held pursuant to Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469 (1993), the court found that "[n]o testimony has shown that any of the consolidated defendants' tests were inaccurate. The State, in fact, presented evidence to the contrary." Only one defendant's test had been performed improperly, and that sample was later rerun. The court also observed that "because [the instrument] is non-conforming doesn't necessarily mean the results are inaccurate."

¶ 5 The trial court then discussed the data drops, the mislabeling, and the staff emails. The court found it significant that the instrument was still being used even though the lab's accreditation standards required non-conforming instruments to be removed from service to evaluate a malfunction. In the emails, SCL staff expressed concern that the cause of the malfunctions had not been determined or the problem resolved, raising potential legal issues. The court concluded that "[i]nherent in the concept of reliability is confidence," and that, in light of the emails, "confidence in the reliability of [the instrument] is clearly undermined."

¶ 6 Although the court found that the State met its burden under Rule 702(a) through (c) for establishing the

admissibility of the BAC results, the court ruled that the State failed to show that the testing methodology had been reliably applied as required by subsection (d). The court thus excluded evidence of the results as to all defendants.

¶ 7 The State petitioned for special action relief in the court of appeals, which granted relief. [Bernstein](#), 234 Ariz. at 100 ¶ 29, 317 P.3d at 641. The court of appeals focused on the data drops but concluded that “[t]here was no showing ... that such failures to provide test results meant that usable BAC test results [that were] produced by the 2003 Instrument were not reliable.” [Id.](#) at 98 ¶ 22, 317 P.3d at 639. The court thus held that the State met its burden as to Rule 702(d) and vacated the trial court’s order excluding the evidence. [Id.](#) at 100 ¶ 27, 317 P.3d at 641.

¶ 8 We granted review because the application of Rule 702(d) is a recurring issue of statewide importance. We have jurisdiction pursuant to Article 6, Section 5(3) of the Arizona Constitution and A.R.S. § 12–120.24.

II.

[1] [2] [3] ¶ 9 We review the interpretation of court rules de novo, [State v. Salazar–Mercado](#), 234 Ariz. 590, 592 ¶ 4, 325 P.3d 996, 998 (2014), but we review a trial court’s exclusion of evidence for an abuse of discretion, [State v. Davolt](#), 207 Ariz. 191, 209 ¶ 66, 84 P.3d 456, 474 (2004). An error of law constitutes an abuse of discretion. [Twin City Fire Ins. Co. v. Burke](#), 204 Ariz. 251, 254 ¶ 10, 63 P.3d 282, 285 (2003). Because Rule 702 mirrors its federal counterpart, we may look to the federal rule and its interpretation for guidance. [Salazar–Mercado](#), 234 Ariz. at 592 ¶ 7, 325 P.3d at 998. As the proponent of the expert testimony, the State bears the burden of establishing its admissibility by a preponderance of the evidence. [Id.](#) at 593–94 ¶ 13, [325 P.3d at 999–1000](#).

III.

¶ 10 Rule 702, which governs expert witnesses testimony, provides that:

****203 *229** A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:

- (a) the expert’s scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
- (b) the testimony is based on sufficient facts or data;
- (c) the testimony is the product of reliable principles and methods; and
- (d) the expert has reliably applied the principles and methods to the facts of the case.

¶ 11 The rule “recognizes that trial courts should serve as gatekeepers in assuring that proposed expert testimony is reliable and thus helpful to the jury’s determination of facts at issue.” [Ariz. R. Evid. 702](#) cmt. (2012). But the comment also observes that “[t]he trial court’s gatekeeping function is not intended to replace the adversary system.” [Id.](#) Rather, “[c]ross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence.” [Id.](#); cf. [Daubert](#), 509 U.S. at 596, 113 S.Ct. 2786.

¶ 12 [Daubert](#) left unclear whether the particular application of a generally reliable methodology should be assessed by the trial court as part of its gatekeeper role or instead by the jury in determining the weight to give expert testimony. Courts and commentators have continued to suggest different approaches to the issue. See, e.g., [United States v. McCluskey](#), 954 F.Supp.2d 1224, 1243–55 (D.N.M.2013) (discussing cases); 29 Charles Alan Wright & Victor James Gold, *Federal Practice & Procedure* § 6266 (1st ed.2014) (distinguishing between “broad” and “narrow” views regarding the scope of the gatekeeping inquiry).

[4] ¶ 13 Rule 702(d), however, recognizes that a trial court must consider whether an expert reliably applied the pertinent methodology when expert testimony concerns the facts of a particular case. Cf. [Salazar–Mercado](#), 234 Ariz. at 593 ¶¶ 10–11, 325 P.3d at 999 (holding that “cold” expert testimony not based on the facts of a case may be admissible if it satisfies Rule 702(a)-(c)). Thus, the rule by its terms forecloses the approach of leaving challenges to an expert’s application

of a methodology exclusively to the jury. Such challenges are instead a proper subject of the trial court's gatekeeping inquiry. But *cf.* [United States v. Bonds](#), 12 F.3d 540, 563 (6th Cir.1993) (holding, under earlier version of Federal Rule 702, that “in general, criticisms touching on whether the lab made mistakes in arriving at its results are for the jury”).

[5] [6] ¶ 14 But not all errors in the application of reliable principles or methods will warrant exclusion. Rule 702 contemplates that expert testimony can be “shaky” yet admissible. *Ariz. R. Evid. 702* cmt. (2012). “The overall purpose of Rule 702 ... is simply to ensure that a fact-finder is presented with reliable and relevant evidence, not flawless evidence.” *State v. Langill*, 157 N.H. 77, 945 A.2d 1, 10 (2008). Rule 702(d) “must be interpreted and applied with some flexibility to encompass the multitude of scenarios that may be presented and to maintain the division in function between the fact-finder and gatekeeper.” *Id.*

[7] ¶ 15 Errors in the application of a generally reliable methodology, therefore, should not serve to exclude evidence unless they are so serious as to render the results themselves unreliable. *See id.* (“[I]t would be unreasonable to interpret [Rule 702(d)] as requiring that a single flaw or even multiple flaws in an expert's application of a particular methodology in all instances renders inadmissible the expert's entire testimony.”). With respect to test results, for example, the omission of a step necessary to obtain valid results or a procedural misstep that plausibly could skew the outcome might justify excluding the results and any opinion based on them.

¶ 16 Several courts have attempted to describe the point at which errors in application warrant the exclusion of expert testimony. The Third Circuit held that a trial judge “should only exclude evidence if the flaw is large enough that the expert lacks ‘good grounds’ for his or her conclusions.” [In re *230 **204 Paoli R.R. Yard PCB Litig. \(Paoli\)](#), 35 F.3d 717, 746 (3d Cir. 1994). In the Eighth Circuit, “[a]n alleged error in the application of a reliable methodology should provide the basis for exclusion of the opinion only if that error negates the basis for the reliability of the principle itself.” [United States v. Martinez](#), 3 F.3d 1191, 1198 (8th Cir.1993); *see also United States v. Gipson*, 383 F.3d 689, 697 (8th Cir.2004) (“[O]utright exclusion of the evidence in question is warranted only if the methodology was so altered by a deficient application as to skew the methodology itself.”). Although worded somewhat differently, the Eighth

Circuit's test is essentially the same as the Third Circuit's. *See* [McChuskey](#), 954 F.Supp.2d at 1249.

¶ 17 We agree with this approach and that stated by the New Hampshire Supreme Court: alleged flaws in the application of a reliable methodology should not result in exclusion of evidence unless they “so infect[] the procedure as to make the results unreliable.” *Langill*, 945 A.2d at 10 (quoting [Martinez](#), 3 F.3d at 1198); *cf. Fed.R.Evid. 702* Advisory Comm. Notes (2000) (noting that changing or misapplying a reliable methodology so that analysis is unreliable will render expert testimony inadmissible (citing [Paoli](#), 35 F.3d at 745)).

[8] [9] ¶ 18 Whether errors in application render evidence unreliable will not always be clear. In close cases, the trial court should allow the jury to exercise its fact-finding function, for it is the jury's exclusive province to assess the weight and credibility of evidence. *State v. Clemons*, 110 Ariz. 555, 556–57, 521 P.2d 987, 988–89 (1974). “[A]s long as an expert's scientific testimony rests upon good grounds, ... it should be tested by the adversary process—competing expert testimony and active cross-examination—rather than excluded from jurors' scrutiny for fear that they will not grasp its complexities or satisfactorily weigh its inadequacies.” *Langill*, 945 A.2d at 11 (quoting *United States v. Vargas*, 471 F.3d 255, 265 (1st Cir.2006)).

III.

[10] ¶ 19 The parties do not dispute that gas chromatography is a reliable methodology for determining BAC and that expert testimony on that topic is relevant and helpful, so the State has met its burden as to Rule 702(a) through (c). Relying on Rule 702(d), defendants argue that their BAC results must be excluded because the instrument's faults establish that the methodology was not reliably applied. The trial court properly considered defendants' challenges as part of its gatekeeping inquiry. But the court applied the wrong legal standard under Rule 702(d) and thereby abused its discretion in excluding the evidence. *See* [Twin City Fire Ins. Co.](#), 204 Ariz. at 254 ¶ 10, 63 P.3d at 285.

¶ 20 The trial court observed that “[i]nherent in the concept of reliability is confidence,” and that the emails among SCL staff expressing concern about the instrument undermined

confidence in its reliability. The emails did not express doubt about the reliability of the results for particular samples, but instead related concerns that the data drops remained unresolved and might become subject to legal challenge. The trial court misapplied [Rule 702\(d\)](#) by concluding that the staff's general concerns established that the instrument's methodology had not been reliably applied with respect to the particular BAC results at issue.

¶ 21 The trial court also explained its ruling by noting the data drops, the mislabeling, and the laboratory's failure to remove the instrument from service. But the fact that the instrument here sometimes failed to produce a reading does not itself imply that the results it did generate were inaccurate. (A different conclusion would result if an instrument did not accurately measure a known standard or failed to produce consistent results for replicate samples within a required range.) And the State presented evidence that incidents of mislabeling could readily be corrected based on the printing sequence, and no evidence suggests that the defendants' samples were misidentified. The record does not show that the identified errors rendered the results of the defendants' tests unreliable; instead, as the trial court acknowledged, the State presented evidence supporting the accuracy of

those results. As to the defendants' results, the State met its burden under [Rule 702\(d\)](#) of showing that *231 **205 gas chromatography had been reliably applied to analyze BAC.

¶ 22 This is not to say that the malfunctions or the lab's failure to resolve them are irrelevant. The jury may consider the instrument's malfunctioning and the laboratory staff's related concerns when assessing the weight or credibility of the test results. This conclusion recognizes that “[c]ross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence.” [Ariz. R. Evid. 702](#) cmt. (2012).

IV.

¶ 23 We vacate the trial court's order excluding evidence of the BAC results, vacate ¶¶ 19–28 of the court of appeals' opinion, and remand the case to the trial court for further proceedings.

All Citations

237 Ariz. 226, 349 P.3d 200, 711 Ariz. Adv. Rep. 10



Real Estate Predictions 2020 | Article 6
Diversity & Inclusion
In the Real Estate Industry



Traditionally, real estate has been a male-dominated industry, especially in key management positions. Although various efforts have been made to develop a more inclusive environment, there is still a gap that needs filling. It's a situation that is gaining increasing visibility—as demonstrated by the 2019 publication of the book *Managing Diversity & Inclusion in the Real Estate Sector*, which focuses on unlocking the potential of diversity and inclusion (D&I) in the sector.

Unpacking the question of Diversity & Inclusion in the Real Estate Industry D&I covers a broad spectrum of topics, including gender balance, generation gap, ethnicity, disability, sexual preference, religion, and more.

But with many official definitions around, it can be agreed that a diverse and inclusive environment is an environment in which everyone is part of a whole and where individuals can participate and uncover their potential.

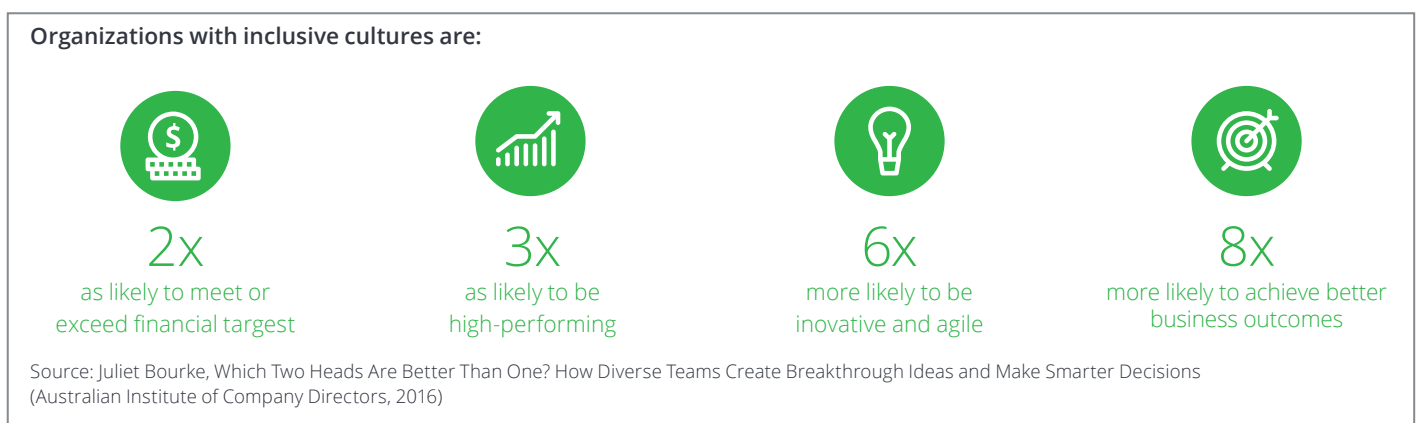
As recognized by the 2017 Deloitte Global Human Capital Survey, D&I matters critically to business performance, as it increases creativity and innovation within teams¹. In other words, D&I can bring organizational benefits that are directly linked to company performance.

Organizations with inclusive cultures are twice as likely to meet or exceed financial targets and three times as likely to be high-performing. And companies are six times more likely to be innovative and agile and

eight times more likely to achieve better business outcomes, as Deloitte partner Juliet Bourke found in her research.

Indirect effects from having a diverse and inclusive workforce include a better company image and improved transparency as well as benefitting talent attraction and retention. Also, there are external pressures driving D&I practices within companies, including potential blaming and shaming of an organization and risk mitigation.

Exhibit 1 - How Diversity and Inclusion makes sound business operations



Barriers to diversity & inclusion

Despite the evident potential of D&I, real estate companies are still struggling to take effective action due to the perceived barriers. Research shows that the first barrier companies have to face is complexity. D&I is complex and companies often don't know where to start. The very broadness of the topic can obscure how to

achieve a specific framework or pathway to a D&I culture that has not yet been defined.

An action-gap is observed as well, as companies fail to make D&I a priority. A strategic choice needs to be made by management to allocate resources to D&I initiatives. Only when there is a deep-rooted commitment to creating an inclusive

environment, lasting change can happen. This lack of prioritization can relate to unconscious bias. In order to “unlearn” this bias, an organization must take a pro-active approach that is carried throughout the whole company, with concrete milestones recognized and monitored.

¹ <https://www2.deloitte.com/us/en/insights/deloitte-review/issue-22/diversity-and-inclusion-at-work-eight-powerful-truths.html>

Exhibit 2 – Identified barriers for Diversity and Inclusion in business



Taking the first steps

As the real estate sector progresses toward a more inclusive environment, how can a company get started? Of top priority is recognizing that D&I requires a mindset change across stakeholders, management, and employees. Developing a vision statement that includes D&I as part of organizational goals can help achieve this. That vision should include three themes that are critical for change regardless of the field of business:

- **Leadership:** The value of leadership is crucial for driving change—and the complexities of D&I demand a strong leader to guide an organization. A company needs visionary leadership that can set the tone and be available for needed support. It is vital to create a working environment where all employees are heard and able to suggest and create change.
- **Commitment:** For D&I initiatives to succeed, there needs to be a sense of commitment from people throughout the entirety of the workforce. Commitment leads to action and is the first stepping stone for establishing a diverse and inclusive environment. Taking a stand on certain matters can have a catalyzing effect, and a dedicated team that can put this commitment into action will enhance the visibility of D&I endeavours. By building a team that oversees and monitors this commitment, the efforts of a company will dive deeper than just window-dressing, and, therefore, improve the organization’s reputation and brand.
- **Reflective:** A company needs to reflect D&I in its own operations and a

company-wide analysis can show what challenges need to be worked on. This analysis should focus on more than just gender in order to uncover any additional discrimination in the organization. Forms of discrimination that may be neglected through unconscious bias can then be identified and proper action taken.

As we progress...

By actively integrating the above themes into initiatives, 2020 may very well be the year D&I gains traction in the real estate industry. With its positive impact on business outcomes and talent attraction and retention, diversity and inclusion has a proven track record and it’s time real estate unlocks its potential.

Authors

Mary Enriquez – Ramones
 Manager | LU
menriquez@deloitte.lu

Christian Van Dartel
 Partner | LU
cvandartel@deloitte.lu

Chiara Schlösser
 Master Student | NL
cschlosser@deloitte.nl

Feike-Jan Nauta
 Business Analystist | NL
fnauta@deloitte.nl

Contact

Wilfrid Donkers
 Real Estate Predictions leader | NL
wdonkers@deloitte.nl

In order to put the vision to work, there are specific resources and tools needed:

- **Knowledge and skills** – First of all, there needs to be the opportunity for everyone involved to acquire the needed skills and knowledge. This starts with creating awareness on every level of the organization.
- **Engagement** – After awareness comes active engagement, which requires a continuous loop of learning and engaging with an agenda that is carried throughout the whole year and company.
- **Role models throughout** – A frequently discussed and proposed solution is representation. Representation is crucial in regard to the multiple effects it has. It holds with the idea that role models are vital for minorities to be given the confidence that it is possible to attain certain goals. Representation does not only apply to higher management as it is important for minorities to participate both vertically and horizontally.
- **Facilities** – Finally, there has to be policies and facilities catered to the needs of minorities. An example of these types of policies include paternity leave and child-care provision. Another often neglected minority group are disabled workers. Creating a work environment that not only removes the physical barriers but is also flexible in providing the policies disabled workers need to thrive and succeed in any organization will help build a diverse and inclusive culture.



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Federal Reserve Bank of Chicago

The Effects of the 1930s HOLC “Redlining” Maps

*Daniel Aaronson, Daniel Hartley,
and Bhashkar Mazumder*

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The Effects of the 1930s HOLC “Redlining” Maps*

Daniel Aaronson
Federal Reserve Bank of Chicago
daaronson@frbchi.org

Daniel Hartley
Federal Reserve Bank of Chicago
daniel.a.hartley@chi.frb.org

Bhashkar Mazumder
Federal Reserve Bank of Chicago
bhash.mazumder@gmail.com

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Abstract: We study the effects of the 1930s-era HOLC “redlining” maps on the long-run trajectories of neighborhoods. Using a boundary design along with propensity score methods, we estimate the causal effects of the maps on racial segregation, home ownership, house values, rents, and credit scores. We also compare cities on either side of a population cutoff that determined whether maps were drawn for identification. Our results suggest that the HOLC maps had an economically meaningful and lasting effect on the development of urban neighborhoods through reduced credit access and subsequent disinvestment.

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Introduction

Social scientists have long been interested in the link between place and socioeconomic success. With better data and more convincing sources of identification, there is now a greater recognition that where you grow up may causally affect academic performance, earnings, economic mobility, health, and longevity (e.g. Ludwig et al 2013; Chetty et al 2014, 2016a, 2016b; Reardon, Kalogrides, and Shores 2016). Moreover, striking racial differences in these same outcomes have been the basis of a large literature examining the role of residential segregation in explaining geographic disparities (e.g. Cutler and Glaeser 1997; Cutler, Glaeser, and Vigdor 1999; Ananat 2007; Boustan 2011; Chetty and Hendren 2017). This paper focuses on credit access, a potentially important channel that could drive both place- and race-based disparities, particularly with respect to wealth where the black-white gap is enormous (Dettling et al. 2017).

In the aftermath of the Great Depression, the Federal Government undertook dramatic reforms to limit foreclosures and stabilize the housing market. One seemingly innocuous initiative was the overhaul of property appraisal practices. The Home Owners Loan Corporation (HOLC), a now-defunct federal agency, drew maps for over 200 cities to document the relative riskiness of lending across neighborhoods. Neighborhoods were classified based on detailed risk-based characteristics, including housing age, quality, occupancy, and prices. However, non-housing attributes such as race, ethnicity, and immigration status were influential factors as well. Since the lowest rated neighborhoods were drawn in red and often had the vast majority of African American residents, these maps have been associated with the so-called practice of “redlining” in which borrowers are denied access to credit due to the demographic composition of their neighborhood. However, credit was also potentially restricted to neighborhoods scoring in the next lowest neighborhood grade marked in yellow, which has received much less public and academic attention. To complement the narrative history, we provide novel archival evidence from pre-WWII Baltimore showing a drop in private lending and FHA mortgage insurance in low-graded neighborhoods after the creation of that city’s HOLC map.

A voluminous literature studies the channels through which restricted access to credit can limit economic opportunities.¹ In total, that work makes a compelling case that policies that improperly restrict credit are potentially objectionable on the grounds of both equity and efficiency. Moreover, entire neighborhoods that are inappropriately deprived of credit could suffer from insufficient investment and become further magnets for an array of social problems related to poverty.

Our study attempts to estimate the causal effects of the HOLC maps on neighborhood development across the urban U.S. We merge 149 geocoded city maps digitized by the Digital Scholarship Lab at the University of Richmond with (a) address level data from the 100 percent count of the 1910 to 1940 U.S. decennial Censuses (Minnesota Population Center and Ancestry.com 2013), (b) census tract-level data from the 1950 to 1980 Censuses, and (c) block- and block group-level data from the 1990 to 2010 Censuses. This combination results in a century of data on neighborhood characteristics including race, homeownership, house values, rents, and population. We further merge block-level data on Equifax Risk Scores™ (credit scores) from the 1999 to 2016 Federal Reserve Bank of New York Consumer Credit Panel/Equifax (CCP).

Since our analysis is non-experimental, our methodology must address confounding factors for valid inference. A key concern is that the maps may have simply reflected and codified pre-existing differences in neighborhoods but didn't actually *cause* any changes in credit access. We address this concern through a multi-pronged approach. We begin by considering changes over time in the difference in outcomes between neighbors that live on either side of an HOLC boundary within a tightly defined geographic band, typically a few city blocks. Comparisons of spatially proximate neighbors address some confounding factors like access to labor markets, public transportation, or other local amenities that might differentially influence neighborhood growth. However, a border design on its own is insufficient since, as we document, there were pre-existing differences and differential trends even among nearby neighbors.

¹ A small sampling includes Cameron and Taber (2004) on skill investment, Black and Strahan (2002) on entrepreneurship, Carroll (2001) on consumption, and Breza and Kinnan (2017) on economic activity.

To address this problem, our main strategy compares “treated” boundaries with a set of comparison boundaries using propensity score weighting. The weighting ensures that the patterns in race and housing characteristics in our weighted comparison boundaries in the pre-period are virtually identical to the treated boundaries. Our second strategy limits our sample to a subset of the HOLC borders that are least likely to have been predicted to be drawn based on our propensity score analysis. We hypothesize that the demarcation of many of these borders reflected idiosyncratic factors. For example, they may have been drawn simply to close a polygon and therefore may not reflect a gap in creditworthiness. Reassuringly, this sample of low propensity score borders exhibits *no* pre-existing differences or trends across the two sides of the boundaries and therefore eliminates the need for a comparison group.

We find that the maps affected the degree of racial segregation as measured by the fraction of African American residents on each side of a neighborhood boundary. Areas graded “D” (most risky) became more heavily African American than nearby C-rated areas over the 20th century. This gap rises steadily from 1930 until about 1970 or 1980 before declining thereafter. Moreover, we find a markedly similar pattern in “C” neighborhoods that bordered “B” neighborhoods. The C-B result is particularly noteworthy given there were virtually no black residents in either C or B neighborhoods prior to the maps. We believe these results reveal for the first time the importance of “yellow-lining” as a historical phenomenon.

The maps also had a meaningful negative effect on homeownership, house values, rents, and vacancy rates with comparable time patterns to the effects on racial segregation. This suggests that there was significant housing disinvestment in the wake of restricted credit access.² These effects were larger and a bit more persistent along the

² We discuss how reduced credit access and higher borrowing costs may lead to disinvestment in section VI. Appel and Nickerson (2016), which was written contemporaneously, also find that the HOLC maps affected home prices. Their analysis differs from ours in several important respects: 1) they use a regression discontinuity strategy that relies on the assumption of no pre-existing discontinuities along HOLC borders which we show does not hold in the data; 2) they combine all HOLC border types in their analysis, our results show that there are important differences across border types; 3) they do not analyze patterns of segregation, home ownership, rents, vacancies, or credit scores; 4) they only examine home prices in one year, 1990, which misses interesting dynamics over the 20th century; 5) their data only go back to 1940

C-B boundaries than the D-C boundaries. We consider some plausible explanations for the additional impact along C-B boundaries but are unable to come to any firm conclusions. We also show that our boundary results are robust to a number of reasonable modifications to measurement, sampling, and estimation approaches.

Lastly, we use a discontinuity strategy that exploits the HOLC's decision to limit maps to cities with a population of 40,000 or more. We compare the outcomes of cities with a population between 30,000 and 39,999 to cities with a population between 40,000 and 49,999 in 1930. Like our border design, we find that the cities with HOLC maps experienced a relative decline in home ownership, house values, and rents, which was accompanied by a rise in the share of African Americans. No analogous race or housing differential arises in a placebo experiment based on cities on either side of a 25,000 population cutoff. That our border results can be broadly replicated at the aggregate city level, at least for small urban areas, suggests that our localized estimates may not necessarily be offset in the aggregate due to other countervailing forces.

Indeed, looking across entire neighborhoods (not just across narrow boundaries), our findings suggest that the maps could account for between 15 and 30 percent of the D-C gap in share African-American and homeownership and 40 percent of the gap in house values over the 1950 to 1980 period. The maps account for roughly half of the homeownership and house value gaps along the C-B borders over the same period.

After 1970, many of our border estimates wane, perhaps indicating that federal policies designed to expand access to lending markets to low and moderate income households — such as the 1968 Fair Housing Act (FHA), the 1974 Equal Credit Opportunity Act (ECOA), and the 1977 Community Reinvestment Act (CRA) — may have played a role in reversing the influence of the HOLC maps. Using more aggregate measures of segregation, Glaeser and Vigdor (2012) document a similar hump-shaped

which they consider to be a pre-treatment period, even though maps were completed before then. This sample period does not allow them to consider pre-existing trends; and 6) they use a much smaller set of cities. Krimmel (2017) also looks at the impact of the maps on a small set of cities but faces some of the same issues as Appel and Nickerson. Other studies, such as Hillier's (2005) seminal study of Philadelphia and Fishback's (2014) on New York, focus on individual cities.

secular pattern and likewise speculate that housing policies may have contributed to the decline in segregation post-1970. However, other factors undoubtedly contributed to these trends and this reversal clearly remains an important topic for future research.³

Our study contributes to several important literatures. The HOLC maps highlight how credit access influences the growth of urban neighborhoods (Rossi-Hansberg, Sarte, and Owens 2010; Autor, Palmer, and Pathak 2014; Diamond and McQuade 2017; Owens, Rossi-Hansberg, and Sarte 2018). Similar to other recent papers (Hornbeck 2012; Hornbeck and Keniston 2016; Feigenbaum, Lee, and Mezzanotti 2017; Shertzer, Twinam, and Walsh 2016), we document how an intervention can have a large and strikingly persistent impact on long-run community development. Our findings may also help shed light on the role of the HOLC maps in the rise of segregation in the decades immediately following WWII (Cutler and Glaeser 1997; Cutler, Glaeser, and Vigdor 1999; Ananat 2007; Boustan 2011; Glaeser and Vigdor 2012)⁴ and the link between housing and the black-white wealth gap (Blau and Graham 1990; Conley 2001; Charles and Hurst 2002; Krivo and Kaufman 2004).

I. Background

The HOLC and the City Survey Program

After the Great Depression, house prices fell precipitously and a foreclosure crisis ensued (White 2014).⁵ To address this devastating situation, the Roosevelt Administration initiated a series of federal programs intended to alter the nature of housing finance. These policies shifted mortgages from short duration loans with balloon

³ Other factors contributing to trends in segregation and urban disinvestment include restrictive covenants, zoning regulations (Shertzer, Twinam, and Walsh 2016), the location of highway construction (Brinkman and Lin 2017), urban renewal policies (Collins and Shester 2013), the urban riots of the 1960s (Collins and Margo 2007), public housing location (Hunt 2009), and FHA policies (Rothstein 2017). Some of these forces conceivably interacted with and were a part of the long-run reduced form effect of the HOLC maps.

⁴ Segregation rose sharply from 1910 to 1930 (Glaeser and Vigdor 2012; Shertzer and Walsh 2018). We focus on post-1940 period when segregation continued to rise, albeit at a slower pace.

⁵ For example, foreclosure rates in New York City rose from essentially zero in the 1920s to as high as 7 percent in 1935 and averaged about 2 to 3 percent per year during the early and mid-1930s (Ghent 2011).

payments to fully amortized higher loan-to-value mortgages with 15 to 20-year durations. The Federal Housing Administration (FHA) introduced mortgage insurance and a secondary loan market was created by the Federal National Mortgage Agency (FNMA).⁶

In 1932, the Federal Home Loan Bank Board (FHLBB) was created to charter and oversee federal savings and loan associations. The FHLBB essentially policed the operations of the newly created federal consumer banking system. One important new agency, operating at the direction of the FHLBB, was the Home Owners' Loan Corporation (HOLC). Created in 1933, the HOLC was initially tasked with issuing bonds to buy and refinance mortgages at more favorable terms to borrowers. By 1936, the HOLC had refinanced roughly 10 percent of non-farm mortgages (Fishback et al 2011).

Our study focuses on an initiative undertaken by the HOLC at the behest of the FHLBB: to introduce a systematic appraisal process that included neighborhood-level characteristics when evaluating residential properties. The FHLBB was concerned about the long-term value of real estate now owned by the Federal Government, as well as the health of the lending industry which was devastated by the foreclosure crisis (Hillier 2005; Nicholas and Scherbina 2013). Using the new appraisal system, the HOLC drew residential “security” maps for 239 cities between 1935 and 1940 and completed more than 5 million appraisals. The maps and the appraisal process were seen as a mechanism for solving a coordination problem that would help ensure the continued stability of property values throughout the nation.⁷

The maps were based on the input of thousands of local brokers and appraisers, as well as neighborhood surveys of housing markets and demographic and economic

⁶ Several studies describe the residential real estate environment at the time and evaluate the effectiveness of HOLC and FHA initiatives to deal with the foreclosure crisis (Wheelock 2008, White 2014, Fishback et al 2011, Rose 2011, Ghent 2011, and Fishback et al 2017). Fishback et al (2017) emphasize complications in the mortgage market that slowed the 1930s housing recovery.

⁷ From Hillier (p. 210), citing an FHLBB document: “[HOLC] experts believe that since its interest is duplicated by that of all home-financing and mortgage institutions, a program can be evolved which will reclaim large residential areas which are doomed unless some concerted action is taken. Those experts believe that a joint program of Government agencies and private capital can save millions of dollars in property values now being wasted each year. If such efforts are undertaken in the future, the HOLC will be able to contribute surveys made of more than 300 cities throughout the United States—an accumulation of real estate and mortgage data never before available.”

characteristics. Neighborhoods were graded on a scale of A (least risky/most stable) to D (most risky/least stable). The appraisal manuals were candid in how they differentiated grades. Hillier (2005) quotes the 1937 FHLBB Appraisal Manual in describing neighborhood grades as follows:

- Grade A = “homogeneous,” in demand during “good times or bad.”
- Grade B = “like a 1935 automobile-still good, but not what the people are buying today who can afford a new one”
- Grade C = becoming obsolete, “expiring restrictions or lack of them” and “infiltration of a lower grade population.”
- Grade D = “those neighborhoods in which the things that are now taking place in the C neighborhoods, have already happened.”

The term “redlining” is thought by many to derive from the red shading that demarcated the lowest ranked D neighborhoods. There is clear evidence that the racial makeup of neighborhoods were explicit factors that were often pivotal in assigning grades to neighborhoods. This is apparent in the area description files (ADF) that accompanied the HOLC maps.⁸ A more formal statistical analysis in the Appendix confirms the importance of race and other economic and housing characteristics in determining HOLC grades.

How Were the HOLC Maps Used?

There is an active debate among historians about the degree to which lenders accessed the HOLC maps. Hillier (2003) stresses that access was not widespread despite

⁸ Appendix Figure A1 shows an example of an ADF for a D-graded area in Tacoma, Washington where it is stated that: “This might be classed as a ‘low yellow’ area if not for the presence of the number of Negroes and low class Foreign families who reside in the area.” In numerous other examples, race appears to be pivotal. Berkeley, California Area 2 (C-grade): “Northeastern part of area, north of University, could be classed as High Yellow, but for infiltration of Orientals and gradual infiltration of Negroes from south to north.”; Brooklyn, Bedford-Stuyvesant, Area 8 (D-grade): “Colored infiltration a definitely adverse influence on neighborhood desirability although Negroes will buy properties at fair prices and usually rent rooms.”; Oakland, Piedmont, Area 14 (B-grade): “Some parts of this area would be considered only High Yellow but for the rigid restrictions existing in Piedmont as to type of new construction and also the fact that there are no Negroes or Asiatics allowed in the city limits.”; Warren, Ohio Area 8 (C-grade): “Section is “killed” by influx of negroes from D-3 to attend Francis Willard School in C-8”; and Youngstown, Ohio Area 3 (D-grade): “Ever growing influx of Negroes and low class Jewish in the westerly end.”

high demand for the maps among private lenders. She argues that the FHLBB preserved their confidentiality as a matter of policy and allowed only a limited number of copies (50 to 60) of each map to be made. She further asserts that there is little historical record of the use of the maps prior to researchers discovering them in the U.S. National Archives.

These conclusions are disputed by Woods (2012), who argues that the FHLBB widely distributed HOLC appraisal practices and fostered close communication between the private sector and government institutions, and these interactions had a profound influence on creating a uniform appraisal process.⁹ Woods further claims that, as a matter of regulatory policy, banks were required to construct their own maps describing their geographic lending patterns.¹⁰ Therefore, it is plausible that the information in the maps filtered out and was used in lending decisions even if the actual maps were not disseminated. Given their large investment in the HOLC maps, it would seem to have been in the FHLBB's interest to share the maps' content despite its stated policy.¹¹

Moreover, there are suggestive anecdotes that some lenders accessed the maps. Jackson (1980), citing evidence from an FHLBB survey of New Jersey bankers and the participation of local realtors as consultants in constructing the St. Louis maps, argues

⁹ Examples included a) the creation of a Joint Committee on Appraisal and Mortgage Analysis in 1937 that included three private agencies whose purpose was "to share appraisal data throughout all segments of the national lending industry," and b) the dissemination of a monthly FHLBB journal entitled the *Federal Home Loan Bank Review* (circulation of 6,000) with articles "that provided painstaking detail regarding the influence of neighborhood demographics on mortgage finance." The list of subscribers "was so extensive that it reached a representative cross section of the national urban housing industry."

¹⁰ The FHLBB required that lending practices take into account neighborhood demographics. Woods specifically argues that "there existed a relationship between the HOLC security maps and FHLBB lending policies" (p. 1043). In particular, as a matter of policy, the balance sheets of lending institutions had to include a "security map of the institution's lending area" and that institutions were instructed that "the best method of grading residential neighborhoods as lending areas is to make a scientific analysis of the entire community and of each neighborhood within it." Woods further notes that "The FHLBB widely distributed the instructions necessary for creating this critical appraisal material throughout the national lending industry. The Mortgage Rehabilitation Division of the FHLBB 'has prepared simple instructions for making the security maps of residential neighborhoods' available 'to any experienced mortgage lender.' The Rehabilitation Division of the FHLBB 'recognize[d] four broad categories of lending areas, ranging from most desirable to least desirable. Each category was represented by a different color, so that the map could be read at a glance.' These four categories were identical to those created by the HOLC."

¹¹ Woods (2012) cites a 1935 Federal Home Loan Bank Review article: "[i]t is inevitable, therefore, that the HOLC's appraisals should exert a major influence in setting values on urban-home properties throughout the country. The magnitude of the operation insures that this influence shall be more than temporary, and that the Corporation's appraisals will affect all property values for many years."

that “private banking institutions were privy to and influenced by the government security maps” (p. 430). Hillier (2003) cites an example of a Chicago real estate official who wrote the following to the City Survey Program Director: “I hope to be able to ‘borrow’ a map from your portfolio when you are not looking during your journey in Chicago.” More broadly, Greer (2012) claims thousands of real estate professionals played a role in the creation of the maps and many remained involved in the industry through the post-War era. To take one publicly available example, eight of the 14 reviewers of the Cuyahoga County (Cleveland) HOLC map were from local lending institutions or appraisers.¹²

We will likely never know the degree to which lenders used the maps. It is clear, however, that the FHLBB fostered the practice of using maps to classify the credit worthiness of neighborhoods. If, in fact, the maps developed by lenders differed from the original HOLC maps such that boundaries were drawn along slightly different streets, it suggests that our estimates are, if anything, likely to *understate the overall effects of the general practice of redlining* even if they capture the effects of the HOLC maps.

FHA Manuals and Maps

The FHA created a parallel set of maps that likewise rated neighborhoods on a color-coded A to D scale and were based on a systematic appraisal process that took demographic characteristics of neighborhoods into account. Indeed, the 1930s and 1940s FHA manuals explicitly emphasize “undesirable racial or nationality groups” as one of the underwriting standards; their use was ultimately outlawed by the 1968 Federal Housing Act and the 1977 Community Reinvestment Act.¹³ The enormous influence of

¹² See https://library.osu.edu/projects/redlining-maps-ohio/area-descriptions/CuyahogaCounty_Explanation_and_A1-A31_Area_Description.pdf.

¹³ See Jackson (1980) and Light (2010) for discussions of how FHA risk maps and underwriter instructions were created. The 1934 FHA manual includes race as one of the underwriting standards to be applied to new loans: “The more important among the adverse influential factors (of a neighborhood’s character) are the ingress of undesirable racial or nationality groups...All mortgages on properties in neighborhoods definitely protected in any way against the occurrence of unfavorable influences obtain a higher rating. The possibility of occurrence of such influences within the life of the mortgage would cause a lower rating or disqualification.” See <http://archives.ubalt.edu/aclu/pdf/Plex48.pdf>. Frederick Babcock, a Chicago realtor who later became the Director of the underwriting division of the FHA wrote in a 1932 book, *The Valuation of Real Estate*: “most of the variations and differences between people are slight and value declines are, as

the FHA is highlighted by the fact that, by 1949, one-third of newly constructed homes were insured by the FHA (Woods 2012). Therefore, perhaps at least as important as whether lenders had direct access to the HOLC maps is whether the HOLC maps were shared with the FHA and thus influenced the provision of housing credit through the FHA's decisions regarding whether to insure loans in low graded neighborhoods.

On this issue, there is more agreement among historians. Light (2010) highlights "ample evidence" to support the influence of the HOLC appraisal methods and maps on the FHA's practices.¹⁴ As an example, Woods (2012) cites a 1938 FHA underwriting manual that provided examples taken directly from HOLC appraisals. Hillier (2003) also states that the HOLC maps were shared with the FHA as well as other government agencies. However, she minimizes the link between the FHA and HOLC by noting that the FHA had their own independent sources of information for developing maps.

The limited availability of FHA maps today makes a broad comparison with the HOLC maps infeasible (Light 2011). However, in one prominent and available case, there is a strong resemblance. Roughly 82 percent of population-weighted Chicago has the same grade on both maps, including 86 percent of D graded areas. However, we acknowledge that we cannot speak to the similarity of other cities, so we instead emphasize that our estimates capture the sum of any HOLC and FHA effects where the boundaries align and only the HOLC effect where the boundaries differ.

a result, gradual. But there is one difference in people, namely race, which can result in a very rapid decline. Usually such declines can be partially avoided by segregation and this device has always been in common usage in the South where white and Negro populations have been separated" (Rutan 2016, p. 36). Thurston (2018) describes how the NAACP received a number of complaints about discriminatory mortgage lending practices as early as the late 1930s and consequently confronted senior FHA leadership. For example, drawing from a 1938 letter from Roy Wilkins, Assistant Secretary of the NAACP to Stewart McDonald, Director of the FHA, Thurston states: "NAACP officials also continued with their investigation into lending practices in the Jamaica area, learning from banks and developers that lenders in the New York City area seemed to be aware of an FHA policy and rejected loans in anticipation of it, as well as an FHA practice of requiring restrictive covenants on the properties it insured" (Thurston 2018, p. 109).

¹⁴ See footnote 85 of Light (2010): "FHA records indicate the agency kept the HOLC security maps on file in connection with the construction of its Economic Data System ... and comments from Federal Home Loan Bank Board general counsel Horace Russell on how the FHA 'was fortunate in being able to avail itself of much of the (t)raining and experience in appraisal and the development of appraisal data by Home Owners Loan Corporation' underscores the two agencies' close ties."

Mortgage Lending in pre-WWII Baltimore

Ultimately, much of this historical narrative could be resolved by quantifying the maps' direct impact on access to mortgage credit. Unfortunately, that is not broadly possible due to a lack of national pre-WWII loan data. However, we can provide some insight from the flow of all new mortgage contracts in Baltimore, Maryland between 1926 and 1950 using a 1 percent random sample of city blocks digitized by Jonathan Rose of the Federal Reserve Bank of Chicago. Those data can in turn be stratified into graded neighborhoods based on Baltimore's 1937 HOLC map.

Figure 1a plots growth in mortgage originations, normalized to average annual loan flow between 1926 and 1928, by neighborhood HOLC grade. There is no meaningful difference in the *trend* in mortgage originations between B, C, and D neighborhoods prior to 1937.¹⁵ But after the Baltimore map is drawn in 1937, lending increases notably in B but remains relatively flat in C and D neighborhoods. With the unsurprising exception of WWII, this pattern continues through at least 1950.

The relative growth in B neighborhood loans is consistent with the Federal Government's intention to encourage lending in such areas. But it is somewhat surprising that there is no clear difference between C and D areas. This may be because all mortgages, not just those insured by the FHA, are included in Figure 1a. If instead, we concentrate on FHA-backed mortgages, Figure 1b shows that new lending in D neighborhoods, which already represented a small fraction of activity prior to the maps, collapses during the late 1930s.¹⁶ By contrast, FHA-insured loans increase in two of the three other graded neighborhoods (as well as those that are ungraded) in the years immediately following the map relative to the years immediately prior.

¹⁵ There are too few A-graded neighborhoods to study in light of the 1 percent sampling.

¹⁶ There were zero D-graded loans in 1940, compared to 18 in 1937. The FHA data includes all Baltimore census blocks, not just Rose's 1 percent block sample. Related, Rose collected the stock of mortgages from his 1 percent block sample for the years 1930 and 1940. Over that decade, the total number of mortgages shrunk by 31 percent in D graded blocks, 22 percent in B and C blocks, and 13 percent in A blocks.

We take the Baltimore example as highly suggestive and novel evidence that the FHA adopted essentially a ban on insuring loans to D areas while private lenders may have become more wary of both C and D neighborhoods relative to higher graded areas.

II. Data and Descriptive Facts

HOLC Maps and Area Description Files

We obtained geocoded renderings of the original HOLC maps for 149 cities from the Digital Scholarship Lab at the University of Richmond.¹⁷ Figure 2 shows that the geographic coverage is extensive. The 149 cities comprise 89 percent of residents of the 100 largest cities in 1930 and 1940, including 9 of the largest 10 and 17 of the largest 20 cities, and 30 of the 42 cities with a population above 200,000.¹⁸ The maps for three prominent cities – Chicago, New York, and San Francisco – are displayed in Figure 3. The large set of boundaries separating neighborhood types, especially evident in New York and San Francisco, illustrate our main identification strategy that takes advantage of households living in a narrow band on each side of an HOLC border.

To identify HOLC boundaries, we begin with outlines of cities from the Census 2000 place boundary shapefile. An ID is assigned to each line segment of an HOLC boundary that is at least a quarter mile long. We then draw rectangles that extend a quarter of a mile on each side of a boundary. These areas are referred to interchangeably as boundary buffer zones, buffer zones, or buffers. Each boundary has two buffers: the lower graded side (LGS) and higher graded side (HGS). We also refer to boundaries between C and D neighborhoods as “D-C” and those separating B and C areas as “C-B.”¹⁹

¹⁷ See Appendix Table A1 for the list of cities.

¹⁸ Of the 20 most populous cities, we are missing Los Angeles (#5), Washington DC (#11), and Cincinnati (#17). Our 149 cities contain over a quarter of the total U.S. population.

¹⁹ There are too few “A” areas to study B-A boundaries. In the spirit of analyzing similar neighbors, we exclude boundaries separated by more than one grade (e.g. D-B). See Appendix Figure A2 for a depiction of NYC boundary buffers as an example.

Accompanying the maps are a set of area description files (ADFs) that provide additional quantitative and qualitative detail on the neighborhoods. An example of an ADF for a Tacoma, Washington neighborhood is provided in Appendix Figure A1.

1910 to 2010 Censuses

We match the geocoded maps to the 1910 to 2010 Censuses. For 1910 to 1940, we use the 100 percent count files and are able to match between 60 and 80 percent of household heads with non-missing street addresses to modern street locations. Ultimately, roughly 50 to 80 percent of respondents are assigned HOLC neighborhoods.²⁰ We aggregate our measures to the boundary buffer level by taking means of all observations which fall inside of a buffer zone so long as it contains at least 3 households.

After 1940, we must use publicly available aggregate data. The smallest geography currently available for 1950 to 1980 is the census tract. Since tracts change over time, we overlay tract boundaries from each census with our boundary buffer shapes and calculate weighted means of any tract for which at least 15 percent of the area of the tract lies within the boundary buffer.²¹ Starting in 1990, the census provides smaller geographic tabulations called blocks, which contain on average roughly 100 people.²² Since blocks are much smaller than tracts, we use weighted means of blocks for which its area is more than 50 percent within the boundary buffer. Combined, this procedure produces a balanced panel of boundary buffer means from 1910 to 2010. In section IV,

²⁰ See Appendix Table A2. As might be expected, characteristics such as race and home ownership predict the probability of being geocoded. However, our empirical strategy (described below) of comparing changes over time in boundary differences to changes over time in control boundary differences (a triple difference) should be robust to any sample selection concerns around geocoding. Regardless, our results are robust to focusing on cities with high geocoding rates (see Section IV). Some additional detail about data consistency with regard to housing measures is provided in the Appendix.

²¹ The choice of the 15 percent threshold balances a tradeoff between sample size and measurement precision. Our results are robust to alternative census tract inclusion thresholds such as 10, 20 or 25 percent.

²² Some variables, notably house value, rent, house age, and foreign born population, are only reported at the block group level, which are aggregates of blocks and typically contain between 600 and 3,000 people. For these variables, we assign the block the values of the block group it is in. In 2000 (2010), there were over 8 (11) million blocks, 208,790 (217,740) block groups, and 65,443 (73,057) census tracts.

we explicitly show that our results are not driven by changing the underlying geography from address to tract to blocks over time or from selection into the sample.

Credit Bureau Data

We supplement the Census with credit bureau data from the Federal Reserve Bank of New York's Consumer Credit Panel (CCP). The CCP covers roughly 5 percent of the population and provides block-level credit data between 1999 and 2016. We use two measures: a) mean of the Equifax Risk Score™ and b) the share of borrowers that are subprime, traditionally measured by Equifax as a score below 620.

Summary Statistics

Table 1 shows summary statistics by neighborhood grade. Panel A reports the share of African Americans over time. Columns (1) to (4) include households in the 543 neighborhoods with an A grade, 1,351 with a B grade, 2,156 with a C grade, and 1,399 with a D grade. In 1930, before the maps were drawn, African Americans comprised 14.6 percent of residents living in D neighborhoods but only 1.5 percent of those living in C neighborhoods, a gap of 13.1 percentage points (pps). By 1980, African Americans grew to 46.2 and 30.7 percent of residents in D and C neighborhoods. These rates converged to 35.7 and 29.0 percent, respectively, by 2010. The time patterns in share African American for each neighborhood grade are shown graphically in Panel A of Figure 4.

Statistics for those living in a buffer zone on each side of the 1,965 C-B and 2,111 D-C boundaries that meet our criteria are shown in columns (5) to (8). The C-B and D-C boundary differences or gaps are reported in columns (9) and (10). As expected, the gap in the share of African Americans is always smaller along the D-C boundary buffer zones than between the full D and C neighborhoods. For example, in 1930, the gap along the D-C boundary buffers was 7.2 pps (column 10), compared to 13.1 pps across all D-C residents (columns 4 minus 3). The racial gaps within the D-C boundary peaked at between 15 and 17 pps between 1950 and 1970, before declining sharply thereafter. By 2010, the gap stood at just 3.1 pps. This secular hump-shaped pattern in the racial gap

also characterizes the C-B boundaries. There was a relatively meager 0.4 percentage point gap in 1930 that grows to 5.7 pps by 1970 and then subsequently declines.

Panel B of Table 1 and Figure 4 show corresponding patterns for home ownership. In 1930, the D-C and C-B home ownership boundary gaps were 5.2 and 4.9 pps, respectively. These gaps increased to 6.2 and 7.1 pps by 1960. Thereafter, the patterns diverge by border type. As of 2010, the homeownership gap declined to just 2.3 pps along the D-C boundaries but remained elevated at 6.4 pps for C-B borders. Panels C and D of Figure 4 plot the patterns for house values and rents. Like homeownership, we find that gaps in house values and rents continue to exist even today and are larger among the C-B borders than the D-C borders.²³

III. Identification and Methodology

Our strategy is guided by the historical narrative that the creators of the HOLC maps explicitly considered neighborhood characteristics and their trends when drawing borders. This narrative is confirmed by the HOLC's area description files that accompanied the maps and provided explanations for the grades. Therefore, we use multiple approaches to try to overcome this obstacle to identification.

Differencing

We begin by considering a naive difference-in-differences (DD) strategy. DD compares changes over time in neighborhood-level outcomes, pre- and post-construction of the HOLC maps in places that are spatially proximate but on different sides of an HOLC boundary, similar in spirit to a border regression discontinuity design (RD) used extensively elsewhere (e.g. Holmes 1998; Black 1999; Bayer, Ferreira, and McMillan 2007; Dube, Lester, and Reich 2010; and many others). Along the line segments that

²³ House values and rents become available in 1930 and are expressed in 2010 dollars. Table 1 also shows secular patterns in share immigrant and credit scores. The Appendix reports statistical models of the determinants of HOLC grades. Like Hillier (2005) and Fishback (2014), who examine single cities, we find a clear monotonic relationship between grades and nearly all the key census economic and housing measures, including those not reported in Table 1, whether considered individually or simultaneously.

make up these boundaries, we compare nearby neighbors that live within buffer zones 1/4 mile (1,320 feet) from the boundary. This allows us to remove potentially important, but typically hard to measure, confounding factors that influence residents on both sides of a border, such as access to labor markets, public transportation, retail stores, and the like.

The statistical model underlying the DD estimator is:

$$(1) \quad y_{gbt} = \sum_{t=1910}^{2010} \beta_t 1[lgs] \gamma_t + \beta_{lgs} 1[lgs] + \gamma_t + \alpha_b + \epsilon_{gbt}$$

where y_{gbt} is an outcome in geographic unit g (e.g. 1/4 mile boundary buffer) on boundary b , in census year t , $1[lgs]$ is an indicator that the geographic unit is on the lower-graded side of the HOLC boundary, γ_t are year dummies, and α_b are boundary fixed effects. Differencing across the boundary is captured by the α_b 's. Our coefficients of interest, the β_t 's, capture the change in the mean outcome in year t relative to 1930 (the census year before the maps were drawn, which we omit). The gap in the mean outcome in year t is therefore $\beta_t + \beta_{lgs}$ for years other than 1930 and β_{lgs} for 1930.

Parallel Trends Assumption Likely Violated

The DD strategy relies on the strong assumption that in the absence of the policy change, trends in characteristics would be parallel for both the treatment and comparison group. The plausibility of this assumption is typically gauged by examining trends in the pre-treatment period. In our case, we have good reason to expect that pre-trends are not parallel. We know from the area description files that the choice of the placement of borders was based in part on demographic and housing characteristics which were already diverging along these boundaries. Indeed, this divergence can be seen clearly in columns (9) and (10) of Table 1. Ideally, the 1910 to 1930 D-C and C-B outcome gaps are negligible and constant. However, as early as 1910, there was a 3 percentage point African American gap between the D and C sides, which grew to 7 pps by 1930. Similarly, there is no evidence that gaps were stable prior to 1940 in homeownership (panel B), house values (panel C), or rents (panel D). While, the racial gap along C-B

boundaries is virtually non-existent before the maps were drawn, that is not the case for home ownership, house values, and rents.

Moreover, a RD design will likely not satisfy the assumption of continuity along the borders. We show examples of several distance plots in Appendix Figure A3 where each dot represents the mean characteristic (regression adjusted for border fixed effects) in bins of $1/100^{\text{th}}$ of a mile (roughly 50 feet) of distance in each direction from the D-C or C-B border. It is clear that for several of our outcomes, even limiting our sample to observations that are just a city block away from the border would lead to meaningful discontinuities and render an RD design invalid.

We propose two strategies to address the failure of parallel trends to be a plausible assumption along the HOLC borders.

Comparison Boundaries

The first strategy creates a set of comparison boundaries with similar characteristics and trends to the HOLC treatment boundaries before the maps were drawn. We motivate this approach by what we refer to as “missing” HOLC borders. It may have been difficult to construct polygons that reflected completely homogeneous neighborhoods if there were small areas within neighborhoods that were fundamentally different. A stylized illustration is depicted in the top panel of Appendix Figure A4 where there is a small island of C type streets within a larger ocean of D. The Chicago HOLC map (Figure 3) also shows that this is plausible. Among the large swath of D (red) in the heart of Chicago, there are surely pockets that might be appropriately labeled C or higher.

We identify these potential comparison boundaries by first drawing $\frac{1}{2}$ mile by $\frac{1}{2}$ mile grids over each city. We then create $\frac{1}{4}$ mile boundary buffers around any grid line segment that does not overlap with HOLC treatment boundaries. This set of boundaries are referred to as our “grid” comparisons.²⁴ Propensity scoring methods are applied to

²⁴ See Appendix Figure A5 for an example of a grid placed over NYC. We also considered an alternative comparison boundary that uses “same-grade” (e.g. B-B, C-C or D-D) borders as a comparison group. The

construct weights for the grid comparison group. A byproduct of weighting the comparison group is that the pre-treatment differences in outcomes and covariates become very small.²⁵ We use the logic that if pre-treatment differences are eliminated using these weights, then it may be valid to interpret any post-treatment difference between treatment and comparison boundaries as an estimate of the causal effect of the HOLC grade. Since each set of treated boundaries has a side which has been deemed riskier by the HOLC (such as the D side of a D-C boundary), an analogous construct is needed for the comparison boundaries. Consequently, we randomly assign one side of each comparison boundary to be the riskier or lower graded side.²⁶ In parallel to the treatment boundaries, we then construct the difference or gap between the mean of our outcome on the “higher-graded” and “lower-graded” side.

To construct the propensity score, we pool the treatment and grid comparison boundaries, where each boundary is an observation. For each grade type difference (D-C or C-B), only comparison boundaries from the same HOLC graded areas are used. That is, when we estimate the effects of the D-C borders, we only include C-C or D-D boundaries and not A-A or B-B boundaries. We then estimate the following probit separately for D-C and C-B boundaries:

$$(2) \quad 1\{Treated\}_{b,c} = \alpha_c + \sum_{k=1}^K \beta_{1910}^k z_{b,c}^{k,1910} + \beta_{1920}^k z_{b,c}^{k,1920} + \beta_{1930}^k z_{b,c}^{k,1930} + \epsilon_{b,c}$$

HOLC often drew boundaries separating two “unique” neighborhoods with the same grade. We are not sure why this was done but we speculate that cities were first broken into neighborhoods and then each neighborhood was evaluated. Using same-grade boundaries as a comparison group yields similar, albeit less precise, estimates (Appendix Figures A7 and A8) than what we find using our grid-based comparison group where we can create much larger samples. We prefer using grids because the same-grade boundaries may induce some treatment effect due to having a boundary associated with it.

²⁵ We also tried the Synthetic Control Method (SCM) of Abadie, Diamond, and Hainmueller (2010) and found similar results. We prefer the propensity score method for our application as SCM is more difficult to implement without a balanced panel of geographic units (in our case, address-tract-block).

²⁶ Random assignment ensures that the distribution of the within boundary differences in our comparison group is representative of all comparison boundaries and is not skewed toward either tail of the distribution.

where $1\{Treated\}_{b,c}$ is an indicator variable for whether boundary b in city c is a “treated” boundary, α_c is a city fixed effect, and $z_{b,c}^{k,t} = x_{lgs,b,c}^{k,t} - x_{hgs,b,c}^{k,t}$ are the gap between an explanatory variable k on the lower-graded side (lgs) and the higher graded-side (hgs) at time $t = 1910, 1920, \text{ and } 1930$. The variables indexed by k include share African American, African American population density, white population density, share foreign born, the home ownership rate, the share of homeowner households that have a mortgage, log house value, and log rent.²⁷

Our estimate of the propensity score (pscore) is equal to the predicted probability of treatment from equation (2). Weights are then formed for the comparison boundaries as $w = \frac{pscore}{1-pscore}$ and for the “treated” boundaries as $w = 1$. This procedure produces considerable overlap in the distributions of the propensity scores for the treated and comparison groups (Appendix Figure A6, Panels A and B).²⁸ Consequently, the reweighted comparison boundaries look more comparable to the treated boundaries than the unweighted comparison boundaries. Panels C and D of Appendix Figure A6 demonstrates this critical implication for the homeownership rate.

Exploiting Idiosyncratic Borders

A second simpler strategy to eliminating confounding factors takes advantage of the possibility that some HOLC boundaries might have been more idiosyncratic in nature and were drawn simply to close a polygon. Consider the hypothetical example of a “misaligned” border where the northern part of the neighborhood contains largely red

²⁷ The model is run using a balanced panel in which at least one of the following three variables contains no missing values (on either boundary side) from 1910 through 1930: share African American, the homeownership rate, or share foreign born. House values and rents are only available in 1930. Whether the household has a mortgage is only available in 1910 and 1920. For a measure that should be available but is missing, it is recoded to a constant value and a missing indicator variable is turned on. The probit models are weighted by the log total population of the buffers on both sides of the boundary. We experimented with adding data from transcribed area description files. However, they added little explanatory power and led to a significant reduction in sample size due to spotty coverage. We also experimented with nearest neighbor matching but found our samples were too thin once we limit neighbors to the same city.

²⁸ The sample is trimmed to exclude treated borders with a propensity score above the maximum comparison border and comparison borders with a propensity score below the minimum treated border.

blocks and the southern area contains largely yellow blocks. It may not have been entirely clear where exactly to draw the southern border and the HOLC agents may have just chosen a major street several blocks from the actual red-yellow demarcation to define the neighborhood. Such “treated” boundaries may not reflect a discontinuous change in creditworthiness and would be much less likely to exhibit pre-trends in outcomes.²⁹

We identify these idiosyncratic boundaries by selecting borders whose propensity score – or predicted probability of being treated -- is below the median. This approach is akin to the method of subclassification, also known as blocking or stratification, discussed in Imbens (2015) and Imbens and Rubin (2015). Their idea is to partition the sample into subclasses based on the value of the estimated propensity score so that, within a subclass, differences in the covariate distribution are small. Causal effects can be inferred within a subclass as if assignment was random. Our particular application motivates focusing on the low propensity score subclass, as these boundaries are most likely to be idiosyncratic since they have covariate distributions similar to our comparison group of randomly drawn grid boundaries. As we show later, the low propensity score subsample of treated borders exhibits virtually no pre-trends. While this strategy is more straightforward and does not rely on the comparison group except when estimating the propensity scores, it reduces power and may not generalize to all borders if there are heterogeneous effects.

IV. Main Results

We start by describing our baseline results – a contrast of HOLC boundaries to weighted comparison boundaries -- separately for D-C and C-B. We then turn to a second

²⁹ A visual of this example is provided in the bottom panel of Appendix Figure A4. A common example of such a situation is found in the area description file for a neighborhood (D98) in Chicago where the notes mention that “The eastern portion of the area is not quite so heavily populated with foreign element.” Therefore, the particular street used to demarcate the eastern boundary may have been idiosyncratic. We considered directly trying to capture the phenomenon of “closing the polygon” by looking only at neighborhoods that had “multiple” different grade treated boundaries and then using only the boundary that had the lowest propensity score. The logic is that the lowest propensity score border within a polygon is most likely drawn to close the shape. In practice, the sample of such boundaries is too small.

set of results based on low propensity score treated boundaries that we argue were most likely idiosyncratically chosen. Finally, we consider an array of robustness checks.

Baseline Results along the D-C Boundary

To show how we arrive at our baseline specification, Table 2 walks through a detailed accounting for one particular outcome, the share African American, along one type of boundary, D-C.³⁰ Column (1) begins by comparing entire neighborhoods (D vs. C) rather than just the narrow buffer zones around HOLC borders. Specifically, we estimate a version of Equation (1) where the geographic unit g indexes HOLC neighborhoods and boundary fixed effects α_b are excluded. Consistent with Table 1, the D-C gap in the share African American is large in 1930, at 13.5 (1.4) percentage points, rises to 25 (2.1) pps in 1960, and then falls to 8.1 (1.6) pps by 2010.³¹ Adding city fixed effects (column 2) has little impact.

The consequence of using buffer zones becomes apparent when we move to column (3), which limits the analysis to households living within $\frac{1}{4}$ mile of a boundary. Now the D-C gap starts at just 6.3 (1.0) pps in 1930, rises to 13.8 (2.7) pps by 1970 and thereafter falls to 3.7 (0.8) pps points by 2010. These estimates are modestly lower when we include boundary fixed effects (column 4). However, although the variation is now restricted to comparing residents living, at most, a quarter mile from the same boundary, there are still significant pre-trends in 1910 to 1930.

To further address the pre-existing differences along our boundary buffers, column (5) shows estimates obtained from using our weighted comparison borders based on the propensity score analysis. The comparison borders successfully mimic the pre-trends in the treated boundaries. For example, they show a D-C gap in African American share of 2.4 (0.6) pps in 1920 rising to 5.4 (1.2) pps in 1930. This 3.0 pp increase is essentially equivalent to the 3.3 pp increase in the treated boundaries.

³⁰ Analogous tables for the other outcomes along the D-C borders are in Appendix Tables A3 to A5.

³¹ City-clustered standard errors are in parentheses. Bootstrapped standard errors, stratified by city, are similar in magnitude.

However, *after the maps were drawn*, the treated and comparison estimates diverge sharply. These patterns are illustrated in panel A of Figure 5, which plots the estimates and standard error bands for both the treated and comparison groups. We find that the gap in the share African American in the treated group continues to rise in subsequent decades and peaks as high as 11.3 (2.3) pps by 1970 before declining. In contrast, the analogous gap in the comparison group drops slightly to 4.0 (0.9) pps in 1940 before reverting to roughly 0 by 1960. By 2010, the estimates are 3.4 (0.7) pps in the treated group and 0.6 (0.5) pps in the comparison group.

A set of “triple difference” estimates that differences the treatment and comparison group estimates relative to 1930 are reported in column (6) of Table 2 (and plotted in Appendix Figure A7). A racial gap emerges in 1940 and continues to rise, peaking at 11.2 (3.1) pps in 1970 before beginning to converge. Nevertheless, there still remains an economically relevant 2 to 3 percentage point racial gap during 1990 to 2010, more than a half century after the maps were drawn.

A parallel analysis for our three housing related outcomes -- homeownership, house values, and rents -- is displayed in the remaining panels of Figure 5 (point estimates and standard errors are shown in Appendix Tables A3 through A5). In all three cases, we again document pre-existing gaps along the HOLC boundaries which we are able to successfully reproduce using propensity score weighting of comparison boundaries. We also find meaningful differences emerge between the treated and comparison boundaries starting in 1940, generally grow larger in subsequent decades, and persist to varying degrees through 2010.

Specifically, after the HOLC maps were drawn, the home ownership gap was relatively constant at around -3 to -4 pps through 1980 before falling to -1 to -2 pps by the 1990 to 2010 period. By contrast, the homeownership gap in the comparison boundaries closed relatively quickly and remained roughly 0 (with a standard error of around 1 pp) through 2010. The relative widening of the homeownership gap between the treatment and comparison boundaries, especially through 1980, was accompanied by parallel gaps in house values and rents. Among treated boundaries, the D-C house value

gap starts at around -16 (1.2) pps in 1930, gradually climbs to around -27 (4.0) pps by 1980, before falling to around -8 (1.3) pps by 2000 and -2.6 (1.3) pps in 2010. The house value gap in the comparison boundaries quickly reverts from a similar level to the treated boundaries in 1930 to statistically indistinguishable from zero by 1950 and after. The peak in the rent gap occurs earlier than the other outcomes and steadily declines after 1950. But as of 2010, it also remains statistically and economically meaningful.

Baseline Results along the C-B Boundary

Figure 6 presents results along the C-B boundaries. As noted earlier, the African American population was sparse in B and C neighborhoods in 1930 so as expected, pre-trends for racial gaps are not an issue (Panel A). After the maps were drawn, however, a meaningful gap of about 4 percentage points opens up by 1950 and continues to rise to a peak of over 8 percentage points by 1970 before gradually reverting to about 2 percentage points by 2010. In contrast, we estimate a virtually flat line around 0 for the comparison boundaries. These results suggest that restricted access to credit in yellow areas (“yellow-lining”) was also a meaningful phenomenon.³²

We find consistent evidence of C-B gaps opening up in housing market measures as well (Figure 6, Panels B to D). The C-B home ownership gap was roughly 5.5 pps by 1950 and peaked at around 7 to 8 pps from 1990 through 2010. By comparison, the D-C home ownership gap topped out around 4 pps and is about 2 pps as of 2010. Likewise, as of 2010, the C-B gap in house values stood at 7.5 percent, three times larger than our estimated D-C house value gap.³³ In Section VI, we consider explanations for a larger impact along the C-B borders.

Long-run Effects on Credit Scores

We used the same methods to examine the long run (post-1999) effect of the maps on modern-day credit scores, including the likelihood of being considered

³² Triple difference estimates are reported in Appendix Figure A8.

³³ Appel and Nickerson (2016) report a 4 percentage point gap in 1990 house values across all boundaries.

“subprime” (Equifax Risk Score<620). For the treated boundaries, we find statistically significant credit score gaps that are always worse on the lower-graded side (see Appendix Figure A9). As of 2016, the D-C gap stood at 8.0 (1.9) pps and the C-B gap was 9.4 (2.3) pps. Similarly, the probability of being subprime is currently just over 3 pps on the higher graded side of both boundaries. The subprime gap was larger in the 2000s, especially during the Great Recession.

Estimates from Low Propensity Score Borders

Our second strategy attempts to isolate borders that may have been more idiosyncratic in nature by honing in on the sample of low propensity score borders that our statistical models predict were least likely to have been drawn.³⁴ The low propensity point estimates for the share African American gap are shown in column (7) of Table 2 and plotted in the blue line of Figure 7’s Panel A. For ease of reference, the grey line reproduces estimates for all treated borders (column 4 of Table 2).

Perhaps what is most compelling about this strategy is that there is no longer a pre-trend for the low propensity D-C borders –the gap in 1910, 1920 and 1930 is essentially zero. If pre-trends are broadly nonexistent with this method, the low propensity method might be particularly useful in cases where we do not have pre-1940 data. Moreover, this research design also produces a smooth continuous function with no abrupt change near the border in 1930 (see Panel A of Appendix Figure A10). On the other hand, there is the possibility that the results from these borders may not generalize to the full population. If there are heterogeneous effects, we suspect that the low propensity score method could lead us to understate the average effect. This would occur if low propensity score borders had other positive features that protected the neighborhood housing stock and therefore understate the typical effect of receiving a low grade from the HOLC. We acknowledge, however, that this is just a conjecture and there may be valid reasons why effects could be larger along these borders.

³⁴ Low propensity score boundaries are somewhat more prevalent in the Northeast.

Using the low propensity score borders, we find that there is a meaningful rise in the D-C gap in share African American after the maps are drawn that peaks at a 9.1 (2.1) percentage point difference in 1970 before falling to just below 2 (0.8) percentage points by 2010. Notably, the timing and magnitude of these gaps is similar to the triple difference estimates that use the *full* sample of D-C borders.

The remaining panels of Figure 7 plot the D-C estimates for the three housing outcomes and for the corresponding race and housing outcomes along C-B boundaries. In every case the use of the low propensity boundaries largely eliminates gaps and trends in the pre-map period. Further, for most of the outcomes, the low propensity estimates after the maps were drawn are nearly identical to the estimates using all treated boundaries. An exception is home ownership along the C-B borders; here, the gap did not grow nearly as large in the post-map period using the low propensity borders. As of 2010, the C-B homeownership gap based on low propensity treated boundaries was roughly half as large (3.6 pps) as estimates using all treated boundaries (7.0 pps).

Overall, we are agnostic as to method. Regardless, the maps appear to have had economically significant negative effects on the lower graded side of the HOLC border.

Robustness Checks

We considered a number of additional robustness checks. First, we use a narrower $\frac{1}{8}$ mile-wide cutoff on each side of the boundary to construct our buffer zone. There is a tradeoff in using a narrower buffer between having a more similar across-boundary group on the one hand and having smaller samples and a greater share of the sample that is potentially contaminated by across-border spillovers. Second, we restrict our samples to cities with a high (above the median) rate of geocoding in 1920. Third, we exclude all borders with a significant overlap with rivers or railroads under the assumption that these borders may be most prone to pre-existing trends. Fourth, we use a consistent level of geography -- census tracts -- in all years. This is a potentially important check because we often find a sharp increase in outcome gaps between 1950 and 1980 which is precisely when we are using the most highly aggregated data.

In all of these exercises, which are organized by outcome and border type in Appendix Figures A11 to A14, we find that the results are broadly comparable to our benchmark estimates in Figures 5 and 6. Notably, even when we use a consistent level of geography, we continue to find that the 1950 to 1980 period remains well above the pre-period and convergence begins post-1980. As an added safeguard, however, we also constructed a “geography-consistent” time-series that adjusts the baseline 1950 to 1980 point estimates by an estimate of the bias from using tracts in these years.³⁵

V. Identification at the City Level: the 40,000 Population Cutoff

Next, we examine city-level outcomes rather than across-boundary differences by exploiting a particular program discontinuity. The FHLBB chose to draw maps only in places with a population of 40,000 or more. This cutoff enables a comparison of the outcomes of cities with a pre-map population just above 40,000 to cities just below. Our working assumption is that cities on either side of 40,000 would not be systematically different with respect to the outcomes we consider. Therefore, any relative difference that emerges over subsequent decades could be attributed to the HOLC maps. We have not encountered any anecdotal evidence that the population cutoff was a strategic choice but we assess this assumption below by analyzing placebo population cutoffs.

In principle, this research design is cleaner since we have a stronger case for exogenous treatment. But there are shortcomings, particularly with regard to statistical power and generalizability.³⁶ There may also be concern that the maps’ impact might be difficult to detect at the city level compared to precisely targeted neighborhoods around HOLC borders. Consequently, we broadly consider the city analysis a complement to our

³⁵ Specifically, we construct a block-to-tract adjustment ratio $\frac{\beta_{1990-2010,c}^{block}}{\beta_{1990-2010,c}^{tract}}$ based on block-level and census tract-level estimates derived from the 1990 to 2010 Censuses when both geographies are available and when the denominator is not very close to zero. This adjustment typically, but not always, lowers our 1950 to 1980 estimates but has little impact on the general contours of our results.

³⁶ Estimates derived from only the smallest HOLC cities might not be externally valid if there are heterogeneous effects by city size. In the Appendix, we show that there is no compelling evidence of differences by city size. However, that analysis excluded cities with very few borders, including virtually all cities with a population under 50,000 in 1930 that we use in this exercise.

preferred baseline boundary estimates. An economically significant impact at the city level could suggest that our localized estimates may not be offset in the aggregate due to other countervailing forces.

We compare 27 redlined treatment cities with a 1930 population between 40,000 and 50,000 to a comparison group of 26 non-redlined cities with a population of 30,000 to 40,000.³⁷ A list of the cities along with their 1930 population and their mean outcomes in 1930 and 1980 can be found in Appendix Table A6. Our control sample of cities (Panel A) appears to be, if anything, more negatively selected on housing characteristics and has a higher share of African Americans than the treated cities (Panel B). However, the differences are relatively small. For example, the 1930 mean home ownership rate is 46 percent in the comparison cities and 48 percent in the treated cities. By 1980, however, the comparison cities have a higher home ownership rate at 58 percent compared to 55 percent in the treated group of redlined cities. This shift in the relative gap in home ownership of 5 percentage points happens to be of a similar magnitude to the 4 and 4.5 percentage points in the 1980 D-C and C-B homeownership gap using our boundary triple difference estimates.

Figure 8 plots the results. From 1910 to 1940, housing outcomes were largely similar in both treated and untreated cities. But in subsequent decades, home ownership rates, house values, and rents grew faster in untreated cities, only reverting somewhat back to pre-1940 norms in recent decades. The racial gap also begins to diverge after 1940 but surprisingly has yet to show evidence of retreat as of 2010. Of course, to be clear, the racial composition gap we are measuring here is between entire cities rather than across borders so it is not directly comparable to the previous analysis. Nevertheless,

³⁷ We exclude any non-redlined city within 50 miles of a redlined city to avoid the possibility that it might have effectively been treated. Our redlining cities were drawn from the 149 cities that were digitized by the University of Richmond's Digital Scholarship Lab and a list of additional HOLC mapped cities from Price Fishback. The additional list resulted in the inclusion of Jamestown, NY and Perth Amboy, NJ. City population size was based on published volumes of the 1930 Census.

the figures are striking and we believe lend additional credence to the economic implications of our baseline boundary findings.³⁸

Moreover, there is little evidence of similar trends at nearby population levels. For example, Figure 9 plots the difference in outcomes between cities just above and below a 25,000 population threshold (and for easy reference, the same calculation for the HOLC 40,000 cutoff).³⁹ Again, assuming that cities on either side of 25,000 would not be systematically different with respect to the outcomes we consider, we expect this exercise to produce roughly a flat line. That is the case with three of four outcomes, and lies in sharp contrast to the patterns observed at the 40,000 cutoff. Homeownership rates increase faster for the 25-35,000 cities relative to the 15-25,000 cities between 1950 and 1970, but this pattern moves in the opposite direction to the larger (redlined) cities relative to the smaller (nonredlined) cities around the 40,000 population threshold.

VI. Discussion

Mechanisms Leading to Urban Disinvestment

The most straightforward explanation of the significant and lasting impact of the HOLC maps is reduced access to credit and higher borrowing costs. Standard theory predicts such conditions reduce the value of homes, which in turn raise the likelihood that

³⁸ The decline in aggregate homeownership may seem surprising given the program's intent to improve the functioning of lending markets. However, in smaller redlined cities, almost 90 percent of census tracts are graded either C or D, where lending was potentially restricted by the maps. Ideally, we would separately compare B, C, and D areas of these cities. Of course, by definition, grades are not available for non-mapped areas. Moreover, many of these small cities were not tracted until as late as 1990, making 1950 to 1980 especially difficult to infer. Instead, we use an ordered probit estimated on the full sample of HOLC cities to predict grades for each 1990 census tract based on 1920 to 1930 trends and 1930 levels of tract characteristics. We then compare the evolution of demographic characteristics in 1940 and 1990 by the predicted grade of the tract. Relative to non-redlined cities, we find share African American grew more in the predicted D and C neighborhoods and less in the predicted B neighborhoods in cities that were redlined, consistent with our other evidence. Unfortunately, results on housing outcomes are too imprecise to draw inferences. That imprecision may be, in part, because the housing effect had dissipated by 1990.

³⁹ As of 1930, there were 103 cities with a population between 25,000 and 35,000 and 257 cities with a population between 15,000 and 25,000. As far as we have been able to ascertain, none of the 360 small cities used for our placebo exercise were redlined. The 25,000 line in Figure 11 plots the mean outcome of the 25-35,000 cities less the mean outcome of the 15-25,000 cities.

property owners with mortgages could be left owing more than the market value of their property (Glaeser and Gyourko 2005). Homes with a market value below replacement costs are in turn much less likely to be maintained and improved (Gyourko and Saiz 2004; Haughwout, Sutherland, and Tracy 2013; Melzer 2017).⁴⁰ Disinvestment in housing occurs when investment in maintenance does not keep pace with depreciation.

Perhaps the strongest evidence of HOLC-related disinvestment is the decline in homeownership, housing values, and rents documented thus far. Other direct measures -- such as the housing vacancy rate, total housing units, and ratings of housing quality -- tend to have flaws for our purpose. Nevertheless, they also are consistent with long-run housing disinvestment in low graded neighborhoods. In particular, we took the 50 redlined cities in which there are census tract housing vacancy data available beginning in 1940. We assume our low propensity score approach in which the parallel trends assumption is fully satisfied for other housing variables would take care of the problem here as well. If so, we find that the D-C gap in vacancy rates increased from 0.1 (0.3) percentage point in 1940 to 0.6 (0.3) percentage points by 1990. Over the same period, the C-B gap increased from 0.2 (0.4) percentage points to 0.7 (0.4) percentage points. A 0.5 percentage point increase explains 8 to 16 percent of the change in vacancy rates in our buffer zones between 1940 and 1990.⁴¹ Further corroborative support of housing disinvestment is in Krimmel (2017), who finds a 20 percent reduction from 1940 to 1970 in the number of housing units in census tracts on the D side of HOLC boundaries relative to tracts on the C side. Finally, the 1960 Census asked directly about housing quality. Conditioning on a rich set of Census income, education, and occupation variables, we

⁴⁰ Moreover, disinvestment may have been exacerbated by the common pre-WWII practice of contract sales in heavily African American neighborhoods (Satter 2009). Individuals who could not obtain mortgages through the formal lending sector, in some cases because of low HOLC grades, may have instead purchased homes by entering into long-term loans known as contract sales. Under these contracts, ownership did not transfer until the final payment was made and failure to meet the terms of the loan at any point could lead residents to lose all equity in the home. Furthermore, contract sales typically had higher implicit interest rates than available in the formal lending sector.

⁴¹ The results are similar using the full sample of borders in the same cities. In 1990, the treated estimates are 0.9 (0.3) and 1.2 (0.3) for the D-C and C-B boundaries and 0.1 (0.3) and 0.5 (0.3) for the D-C and C-B grid-based controls. The mean 1940 vacancy rate is 3.6 and 4.0 percent in D-C and C-B buffer zones. The mean 1990 vacancy rate is 9.8 and 7.1 percent in D-C and C-B buffer zones.

estimate that the rate of deteriorating or dilapidated housing is 6.2 (1.1) pps higher in D than C and B neighborhoods.⁴² Together, we view these suggestive patterns as providing additional empirical support that declining investment caused long-term harm to lower graded neighborhoods after the HOLC maps were drawn.

Possible Explanations for Differences by Border Type

Our housing results, particularly for home ownership, often uncovered larger and more persistent negative effects among C-B borders. Strikingly, some estimated effects reverse course along D-C borders after 1970 or 1980 but not along C-B borders. We can think of at least three possible reasons.

One explanation could be that policies enacted later in the 20th century, such as the Fair Housing Act of 1968 and the Community Reinvestment Act (CRA) of 1977, designed to address discriminatory housing practices may have successfully targeted D but not C rated areas. CRA instituted a process whereby regulators examine whether banks were providing adequate levels of loans to low and moderate income individuals in the areas they serve. Since low and moderate income individuals are more likely to be in D-graded neighborhoods than C-graded neighborhoods, lending by banks to satisfy CRA compliance could have led to a reduction in home ownership and housing value gaps between D and C areas but less so between C and B areas. However, because CRA was instituted federally and not locally, we cannot convincingly show its passage causally led to the reversal in racial and housing gaps that began sometime in the 1970s.

A second hypothesis is that the effects of the HOLC grades may have had significantly more “bite” in C than D graded neighborhoods. If lending tended to be more restrictive in D than C areas in the pre-map period, the marginal effect of the maps might have been most pronounced in C areas, leading to a larger initial impact on the C-B boundary that also takes longer to dissipate. Relatedly, it may have been the case that the maps revealed more information concerning the long-term prospects of C neighborhoods.

⁴² The mean rate of deteriorating or dilapidated housing in 1960 is 31, 12, and 5 percent in D, C, and B neighborhoods. Of course, we acknowledge that it is difficult to interpret this result without a pre-period.

This is consistent with the fact that the pre-existing gaps between B and C areas were less pronounced than gaps between C and D areas.

A third plausible reason is that D areas were quicker to redevelop, causing D-C gaps to fade faster than C-B gaps. This pattern might arise if D areas are closer to the central business district (CBD), which can lead to earlier gentrification (Brueckner and Rosenthal 2009; Baum-Snow and Hartley 2017). That said, we found mixed evidence that proximity to the CBD played a critical role in the long-run.⁴³ Alternatively, the building stock in D areas may have depreciated more rapidly and was more suitable and less costly to redevelop; this seems consistent with significantly higher levels of older, vacant, and deteriorating and dilapidated properties in D neighborhoods by mid-century.

Population Dynamics by Race

We find strong evidence both in our border design experiments and city discontinuity design that the HOLC maps affected the rise and eventual decline of urban racial segregation during the post WWII period. There are several factors potentially driving this phenomena. One possibility is that receiving a low grade could have made a neighborhood less desirable for *every* household in the area but if black households have fewer outside options, they end up predominantly moving to (and staying in) low graded areas. In this case, older housing units would “filter down” to African Americans (Rosenthal 2014). Alternatively, it could be that a lack of credit access is less relevant for black households than for white households. This distinction could arise because many more black households had insufficient resources to purchase a house and would have been renters in any case, or perhaps because black households faced other barriers to credit even if they lived in higher graded neighborhoods and therefore did not have a differential loss by moving to a D neighborhood. Both explanations, which we cannot

⁴³ We divided the sample into terciles by distance to the CBD of the city. We then compared the first tercile to a sample combining the second and third terciles. We find suggestive evidence that the effects on segregation from 1950 to 1980 were larger along borders that were closer to the CBD. However, that difference disappears by 1990 to 2010, suggesting any gentrification effect related to proximity to the CBD happened later in the century.

separate, would suggest a pickup in black inflows was driving the maps' impact on racial segregation. On the other hand, the maps may have also acted as a coordination mechanism for the outward expansion of African American neighborhoods by lowering home values in primarily white neighborhoods that were near African American neighborhoods. This may have amplified the well-known phenomenon of white flight.⁴⁴

In Figure 10, we decompose the extent to which the maps' impact on rising segregation was driven by white outflow or black inflow. We find that the population flows responsible for the increase in share African American vary by border type.⁴⁵ A combination of increased white outflow and black inflow boosted the share African American along D-C borders (Panels B and C). In total, while black inflow initially increased the *overall* population density along the D side of the D-C boundaries (Panel A), ultimately population density reverted in subsequent decades as white flight commenced and black inflow slowed. Panel D shows that the population dynamics of immigrants followed a similar pattern as that of whites.

On the other hand, the rising share of African-Americans along the C-B borders is driven entirely by increased and persistent inflows of African American residents (Panel F). If anything, there is evidence of a relative inflow of white population along the C side compared to the B side in 1950 (Panel G), although that reverts by 1960, when African American population density begins to increase on the C side. Therefore, white flight appears to be associated with the redlined but not yellow-lined boundaries.

We also examined whether there were especially large changes in racial gaps that might occur if there were tipping points, as in Card, Mas, and Rothstein (2008). We found that to be the case, whether measured by indicators of whether African American share is at least 50, 75, or 90 percent, along both D-C and C-B boundaries. This result

⁴⁴ There is a vast literature that discusses the importance of urban white flight on racial segregation. Recent studies include Card, Mas, and Rothstein (2008), Boustan (2010), and Shertzer and Walsh (2018).

⁴⁵ We measure the across border differences in *density* rather than population *levels* to account for the different units of geography available in each census.

suggests that our mean racial gap estimates conceal an even larger impact on the upper tail of the racial gap distribution.

City Heterogeneity

We find substantial heterogeneity across cities and, in the Appendix, make a preliminary effort to try to associate this heterogeneity with pre-existing differences in bank competition, the relative coarseness of boundaries (fewer borders might make the maps less effective), city size, and the level of inflows of blacks due to the Great Migration. We find no compelling evidence that these factors played an economically important role in mediating the effects but we think more research is needed to explore these and other possible channels.

Back-of-the-Envelope Economic Impact

Finally, to provide a sense of the relative economic importance of the maps, we calculated how much our estimates could account for the overall gaps between different HOLC neighborhood grades (not just narrowly across boundary buffer zones). In particular, we divided our low propensity boundary estimates by the full neighborhood estimates for share African-American, home ownership, and house values, for each border type and by two time periods (1950 to 1980 and 1990 to 2010).⁴⁶ Overall, we conclude that the maps account for between 15 to 30 percent of the overall gap in share African American and home ownership over the 1950 to 1980 period and 40 percent of the gap in house values. If we focus just on the C versus B neighborhoods over the 1950-1980 period, the maps account for roughly half of the homeownership and house value gaps.⁴⁷ After 1980, our estimates decline in magnitude and therefore account for 0 to 20 percent of the D-C and C-B gap in each of our outcomes.

⁴⁶ We concentrate on the low propensity specifications because of the lack of a pre-trend. Nevertheless, to be conservative, we still subtract out the 1930 estimate.

⁴⁷ There are very few African Americans in C-B neighborhoods until 1960, making it somewhat difficult to interpret this calculation for share African American, at least until later years.

VII. Conclusion

In response to the Great Depression, the Federal Government fundamentally reshaped the nature of housing finance to stabilize housing markets and support the lending industry. A slew of new federal agencies were created including the FHLBB, and, under its auspices, the HOLC. Among their many initiatives, the FHLBB directed the HOLC to create a systematic and uniform scientific property appraisal process and to produce residential security maps for all major cities. Some have argued that these initiatives had a profound and long-lasting influence on the real estate industry by initiating the so-called practice of “redlining.” The residential security maps, which explicitly took into account demographic characteristics (e.g. race, ethnicity) of entire neighborhoods, were drawn for the purpose of influencing the property appraisal process. This in turn may have influenced lending as well as the provision of federal mortgage insurance. Evidence from Baltimore shows a drop in private lending and FHA mortgage insurance in low-graded neighborhoods immediately after the city’s map was drawn.

We attempt to identify the causal effects of the HOLC maps on neighborhood development from 1940 through 2010. A major challenge for our analysis is that the maps were not exogenous and instead likely reflected existing neighborhood differences and trends. Therefore, there is a concern that the evolution of gaps in the post-map period may have reflected practices that would have occurred even in the absence of the maps. To address these challenges, we use a variety of empirical approaches including the use of counterfactual boundaries that experienced the same pre-existing trends but where the HOLC did not ultimately draw borders. We also employ borders that may have been chosen for idiosyncratic reasons and where endogeneity is much less of a concern. Finally, we exploit a discontinuity in the HOLC’s decision to only create maps for cities with a population above 40,000.

Using these approaches, we consistently find a significant and persistent causal effect of the HOLC maps on the racial composition and housing development of urban neighborhoods. These patterns are consistent with the hypothesis that the maps led to

reduced credit access and higher borrowing costs which, in turn, contributed to disinvestment in poor urban American neighborhoods with long-run repercussions. We show that being on the lower graded side of D-C boundaries led to rising racial segregation from 1930 until about 1970 or 1980 before starting to decline thereafter. We also find this same pattern along C-B borders, revealing for the first time that “yellow-lining” was also an important phenomenon. That the pattern begins to revert starting in the 1970s is at least suggestive that federal interventions like the Fair Housing Act of 1968, the Equal Credit Opportunity Act of 1974, and the Community Reinvestment Act of 1977 may have played a role in reversing the increase in segregation caused by the HOLC maps. Nevertheless, racial segregation along both the C-B and D-C borders remains in 2010, almost three quarters of a century later. Moreover, we also find that the maps had sizable effects on homeownership rates, house values and rents. Intriguingly, the effects on homeownership, and to a somewhat lesser extent house values, dissipate over time along the D-C boundaries but remain highly persistent along the C-B boundaries. We believe our results highlight the key role that access to credit plays on the growth and long-running development of local communities.

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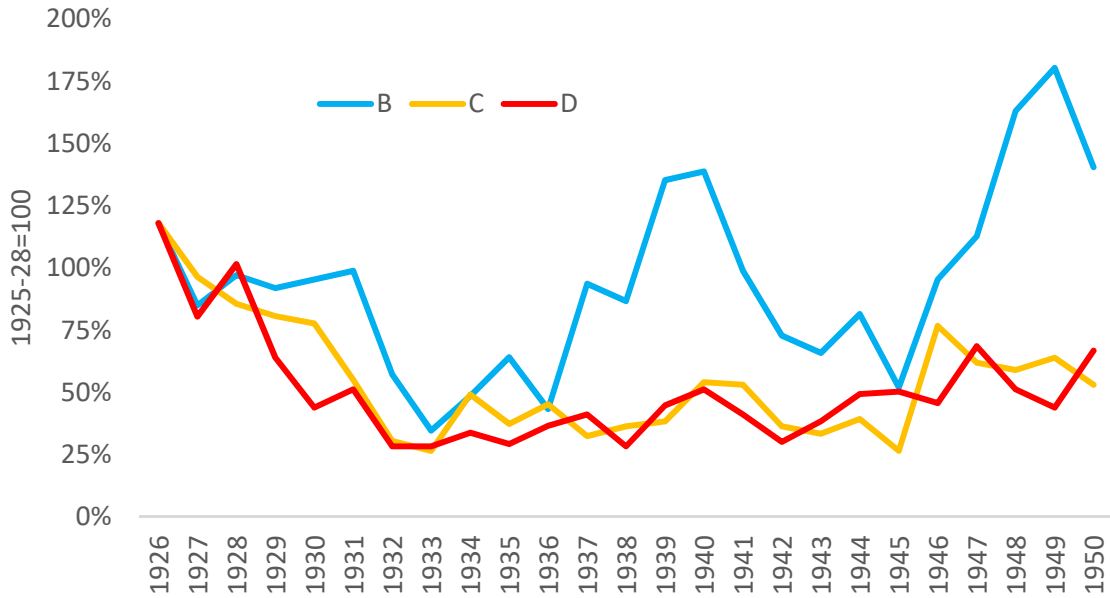
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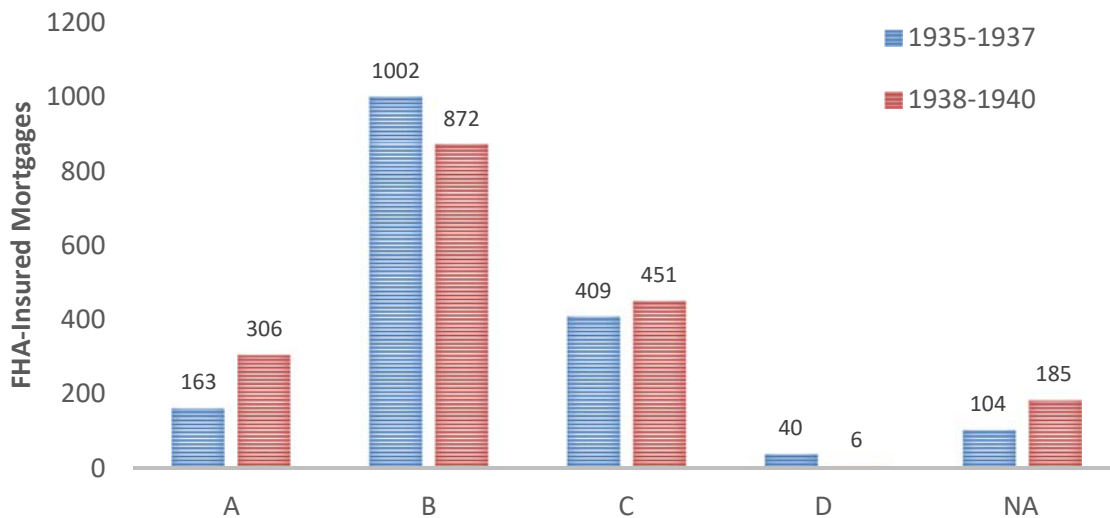
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Figure 1: Mortgage Originations in Baltimore, by HOLC Grade

Panel A: All Mortgage Originations, 1% Random Sample of Census Tracts



Panel B: FHA-Insured Mortgages, 100% Population



Notes: Panel A plots mortgage originations by HOLC grade from a 1 percent sample of Baltimore census tracts. The data is normalized so that the 1926 to 1928 average is equal to 100 percent. Panel B reports the number of FHA-insured mortgages written between 1935 and 1937 and between 1938 and 1940 in all Baltimore census tracts, again stratified by HOLC grade. Both data are from the archival work of Jonathan Rose.

Figure 2: Geographic Coverage of Digitized HOLC Maps

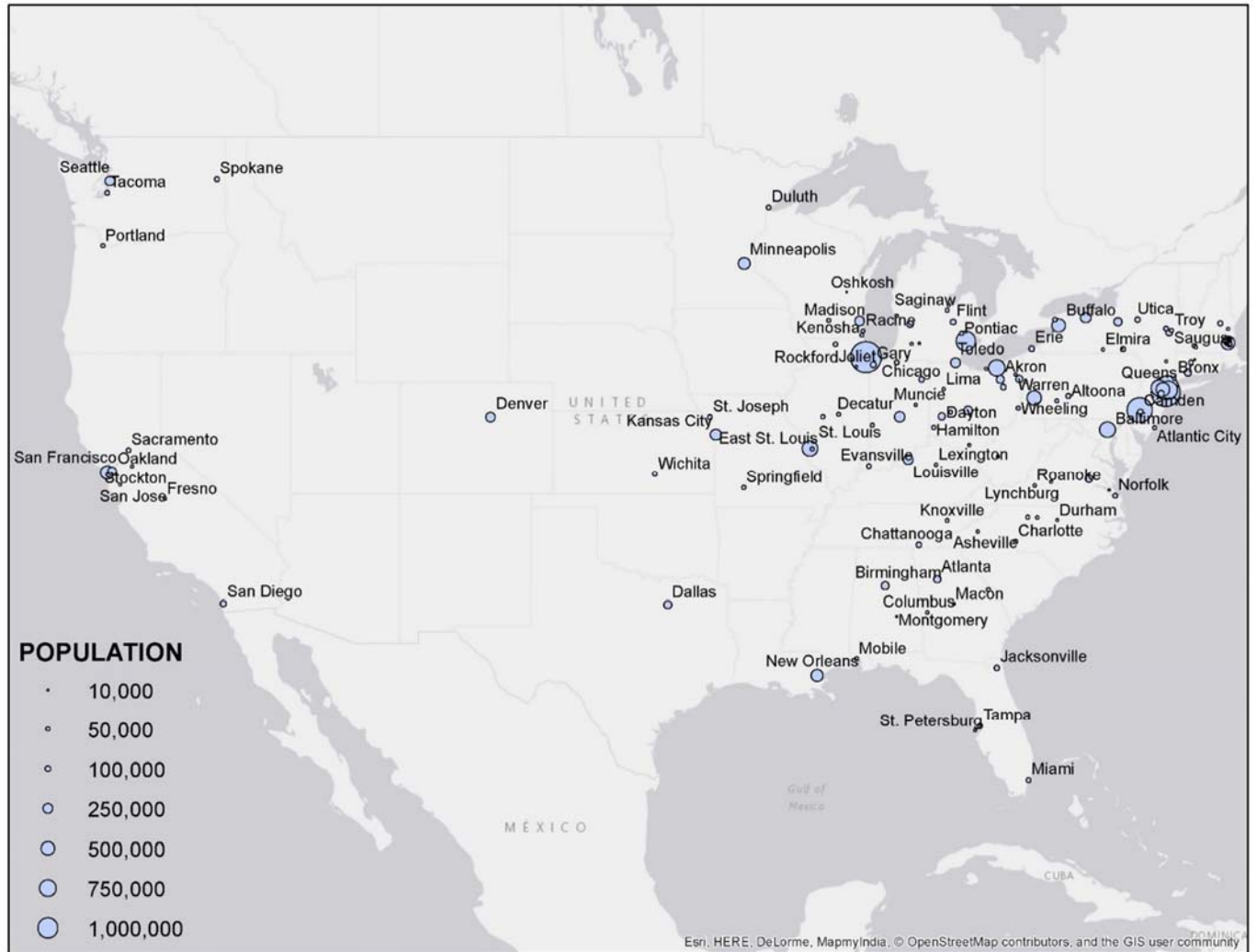
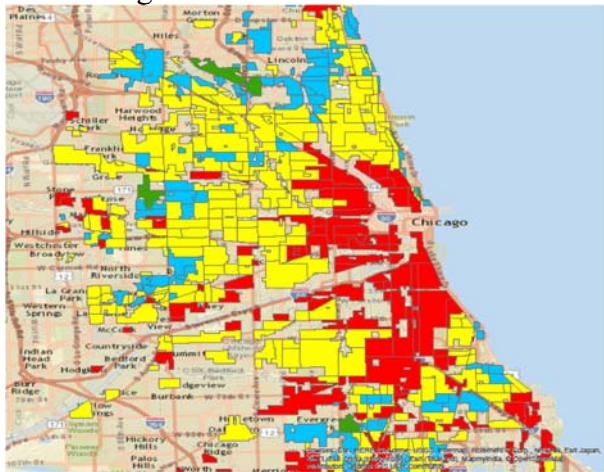
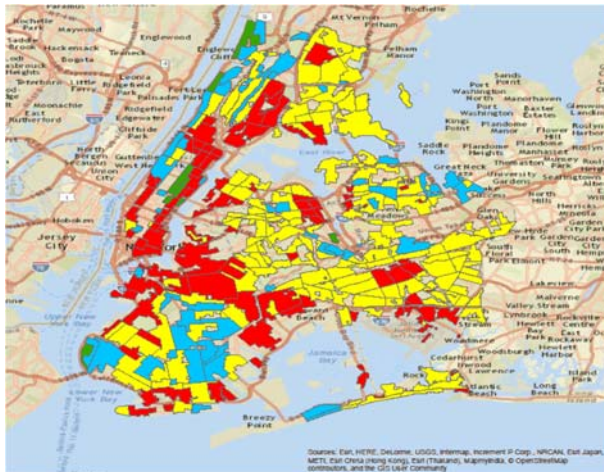


Figure 3: HOLC Maps for Chicago, New York, and San Francisco

A. Chicago



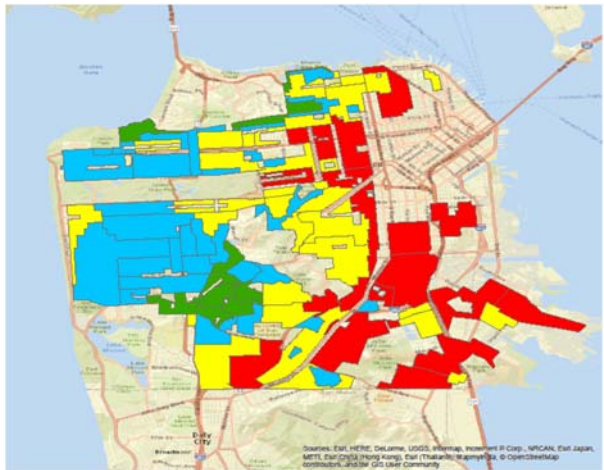
B. New York



HOLC Grades (in order of riskiness):

- A=Green (least)
- B=Blue
- C=Yellow
- D=red (most)
- Not colored=unclassified

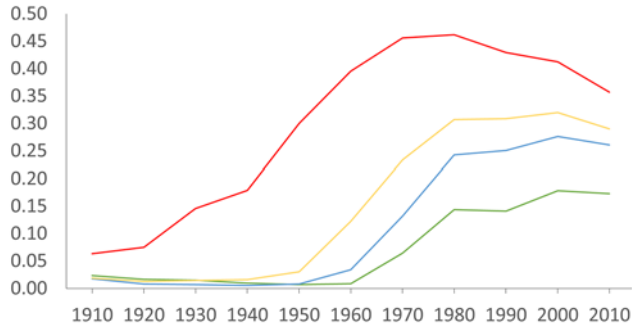
C. San Francisco



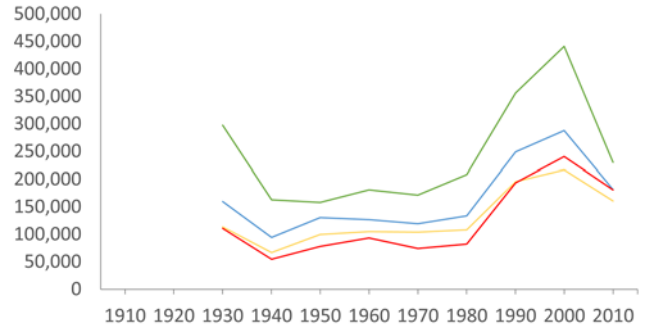
Notes: Maps digitized by the Digital Scholarship Lab at the University of Richmond.

Figure 4: Mean Outcomes, by HOLC Neighborhood Grade and Time

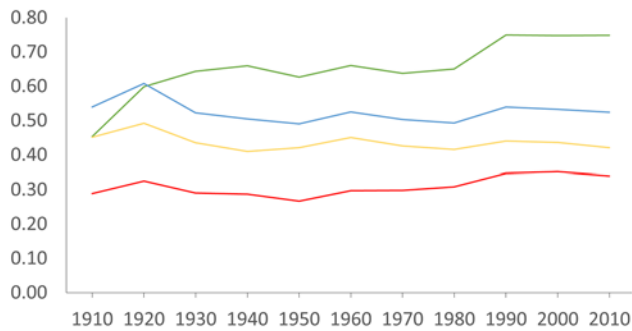
Panel A: Share African American



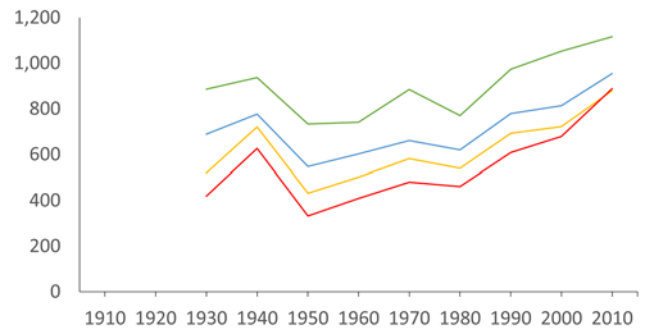
Panel C: Home Values



Panel B: Home Ownership



Panel D: Rent

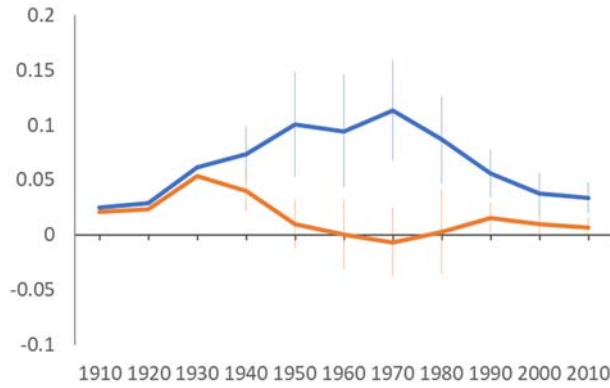


—A—B—C—D

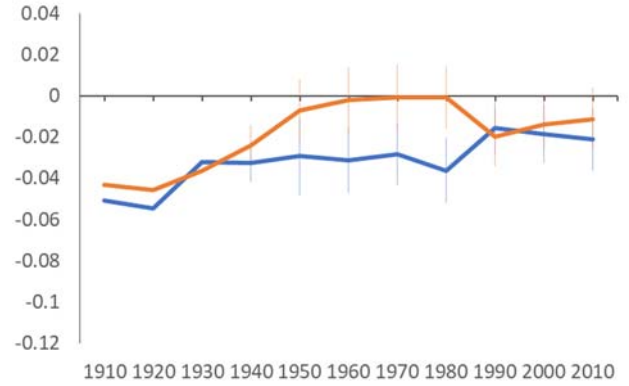
Notes: Panels A to D plot summary statistics by HOLC grade over the period 1910-2010. Colors represent those used in the HOLC maps. Summary statistics are weighted by neighborhood population. Data is drawn from the full-count U.S. Census (1910-1940), Census tracts (1950-1980), and Census blocks and block groups (1990-2010). House values and rents are in \$2010. See text for more detail.

Figure 5: Main Effects along D-C Boundaries, by Outcome

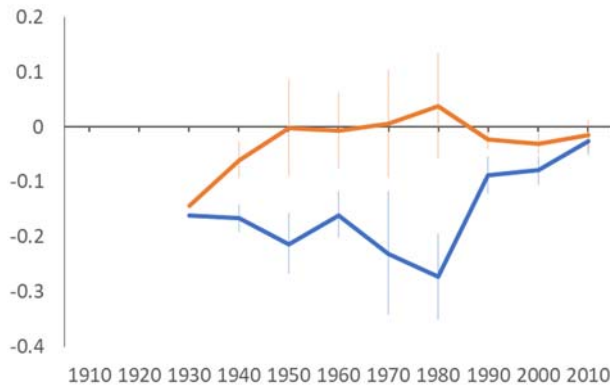
Panel A: Share African American



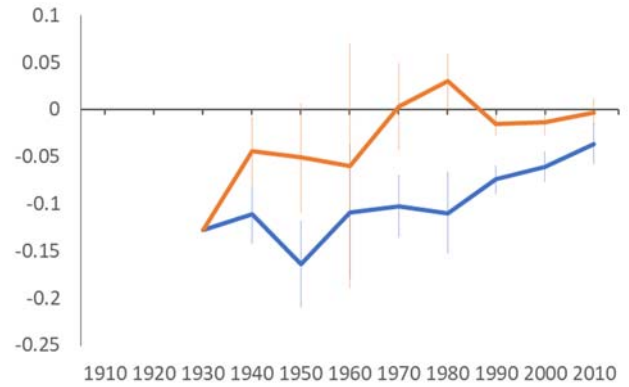
Panel B: Home Ownership



Panel C: Log House Values



Panel D: Log Rent

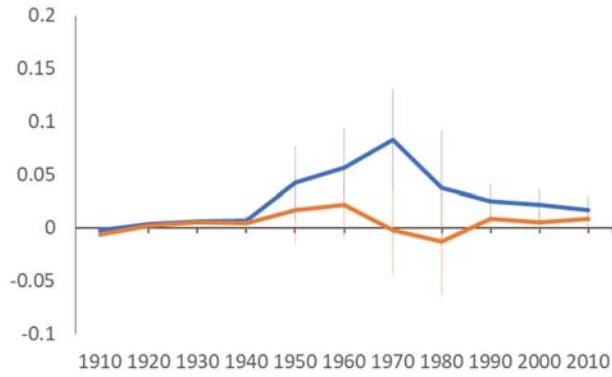


— Treated — Comparison

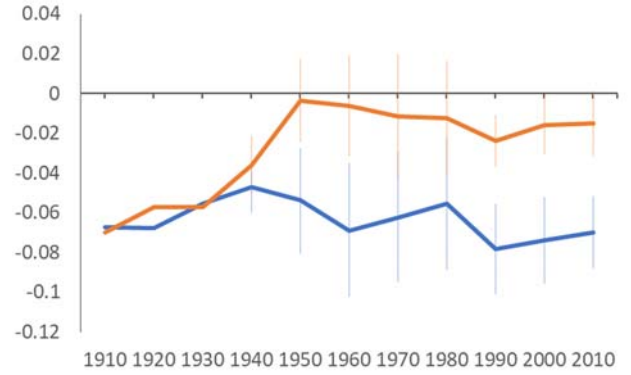
Notes: The treatment estimates (blue lines) are derived from a ¼ mile buffer zone around the D-C boundaries. The comparison boundaries are based on a ¼ mile buffer zone drawn around grids over each city and weighted by propensity scores to mirror pre-map trends (see text for more detail). Vertical bands denote 95% confidence intervals.

Figure 6: Main Effects along C-B Boundaries, by Outcome

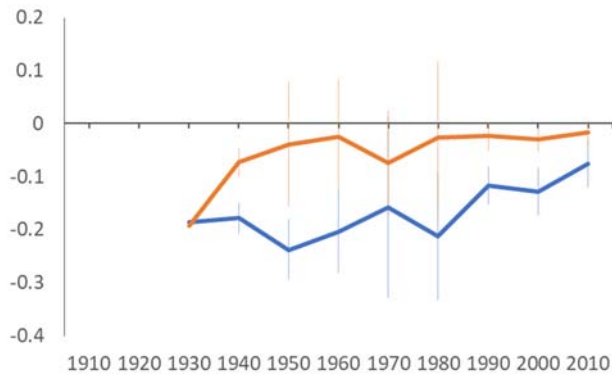
Panel A: Share African American



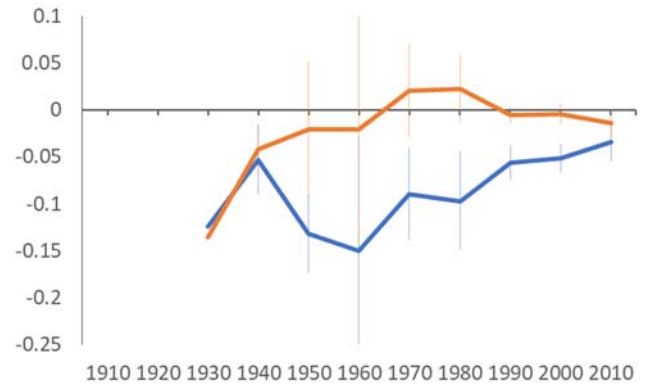
Panel B: Home Ownership



Panel C: Log House Values



Panel D: Log Rent

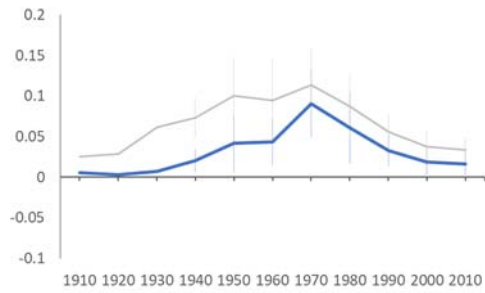


— Treated — Comparison

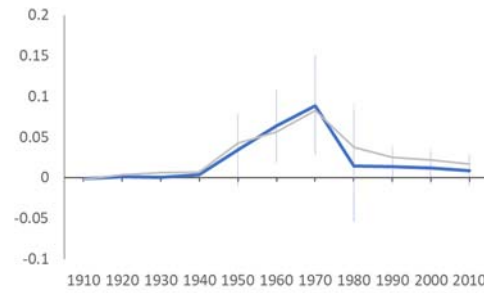
Notes: See notes to Figure 5.

Figure 7: Effects on D-C and C-B Gaps, Using Low Propensity for Treatment Boundaries

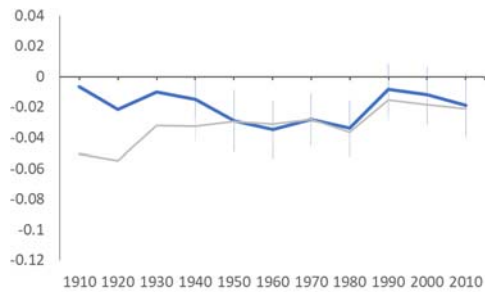
Panel A: Share African American, D-C



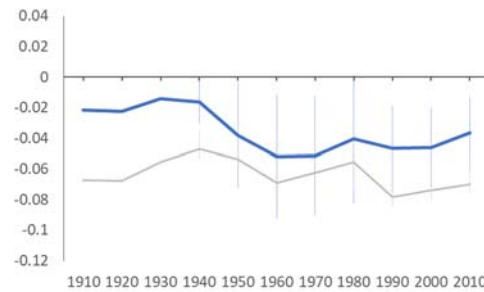
Panel E: Share African American, C-B



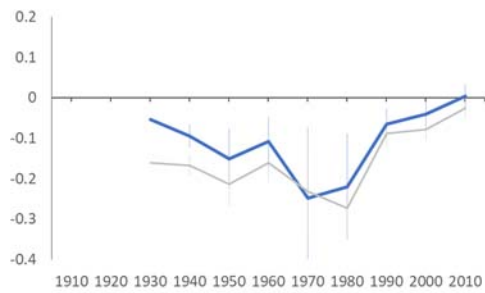
Panel B: Home Ownership, D-C



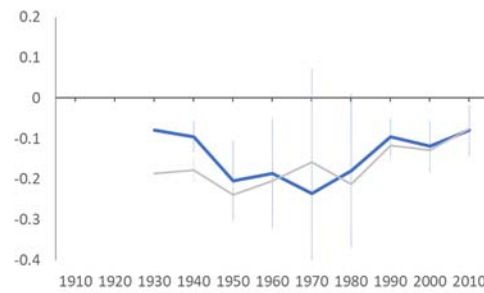
Panel F: Home Ownership, C-B



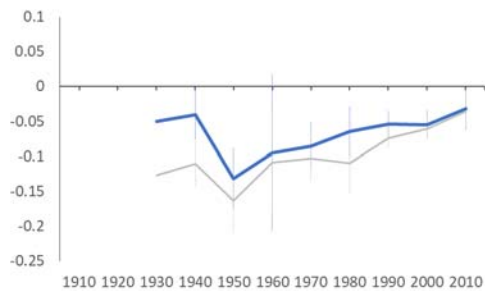
Panel C: Log House Values, D-C



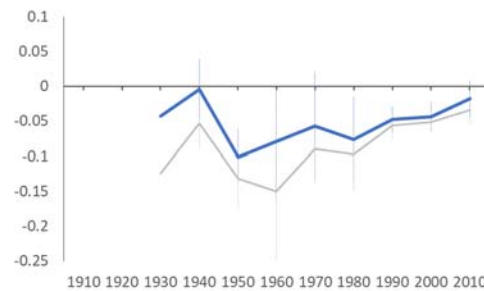
Panel G: Log House Values, C-B



Panel D: Log Rent, D-C



Panel H: Log Rent, C-B

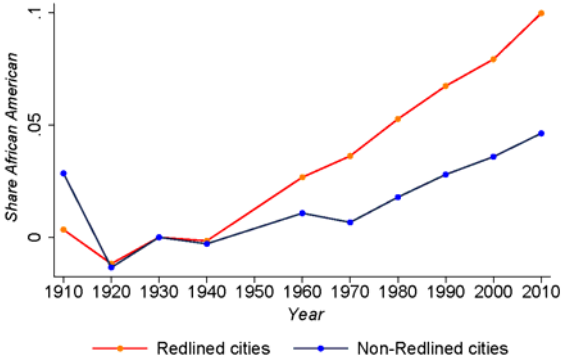


— Low Propensity Treated — All Treated

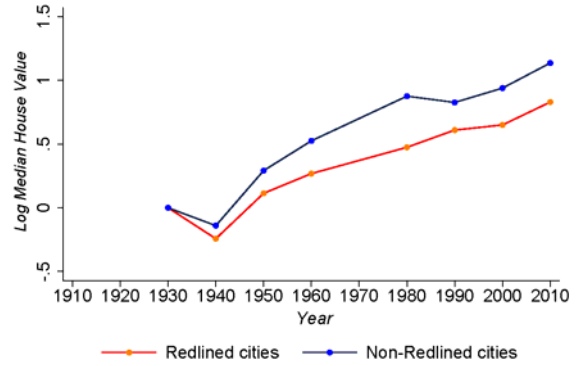
Note: The “low propensity treated” sample is restricted to boundaries with below median propensity scores. See notes to Figure 5.

Figure 8: Comparison of Redlined versus Non-Redlined Cities Using 40,000 Population Cutoff

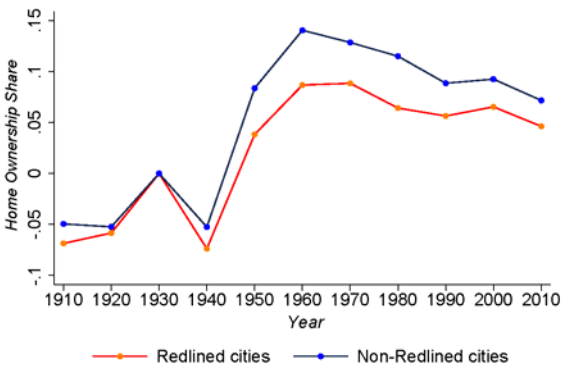
Panel A: Share African American



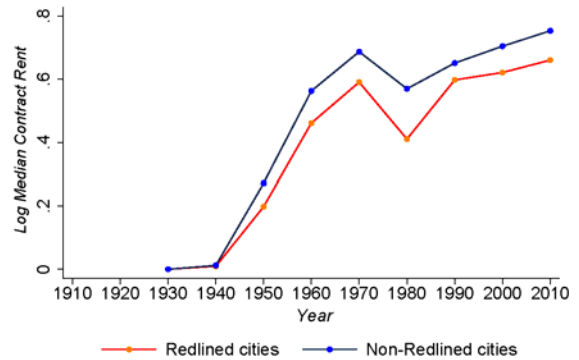
Panel C: Median House Value



Panel B: Home Ownership Rate



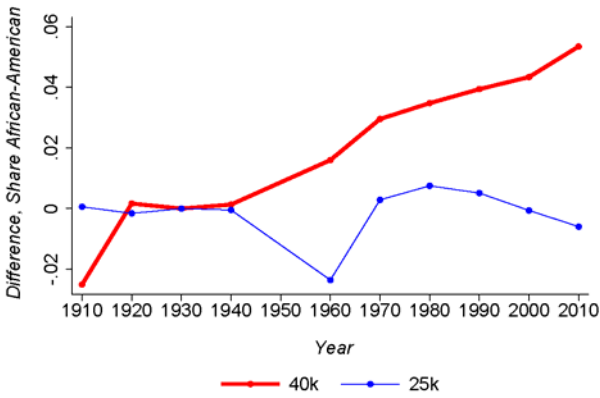
Panel D: Log Median Rent



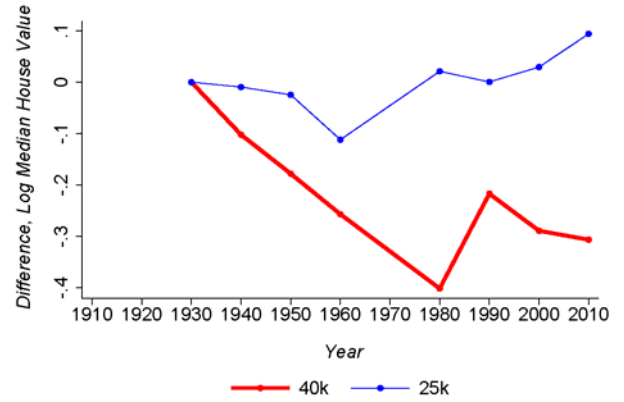
Notes: The red line shows trends in outcomes for 27 redlined cities with populations between 40,000 and 50,000 in 1930. The blue line shows trends in outcomes for 26 non-redlined cities with a population between 30,000 and 40,000 in 1930 that were located at least 50 miles away from the closest redlined city. The sample of non-redlined cities was constructed using published volumes of the 1930 U.S. Census. All estimates are normalized to equal zero in 1930 and house values and rents are in \$2010.

Figure 9: City Outcomes Using a Placebo 25,000 Population Cutoff

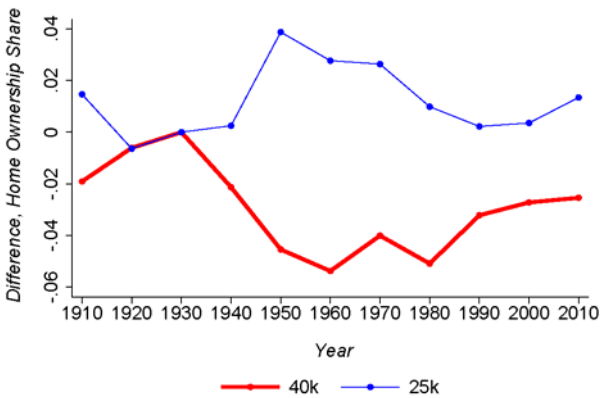
Panel A: Share African American



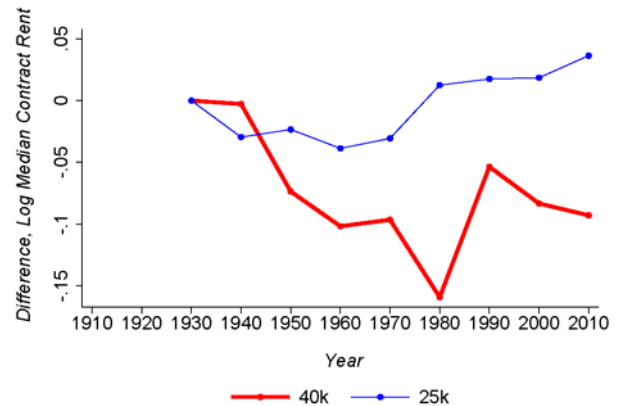
Panel C: Log Median House Value



Panel B: Home Ownership Rate



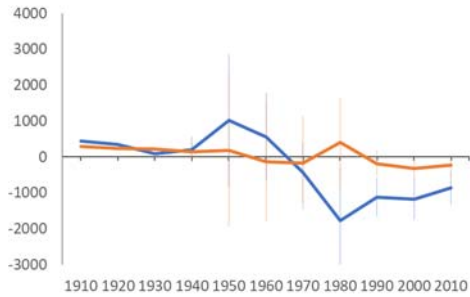
Panel D: Log Median Rent



Notes: The red lines show the difference in trends between 27 redlined cities with populations between 40,000 and 50,000 in 1930 and 26 non-redlined cities with populations between 30,000 and 40,000 in 1930 (the differences between the lines in Figure 8). The blue lines show the difference in trends between 103 cities with populations between 25,000 and 35,000 in 1930 and 257 cities with populations between 15,000 and 25,000 in 1930. The trends are normalized to zero in 1930, and house values and rents are in \$2010. See the text for additional details. Population data was drawn from published volumes of the 1930 U.S. Census.

Figure 10: Population Dynamics along the D-C and C-B Boundaries

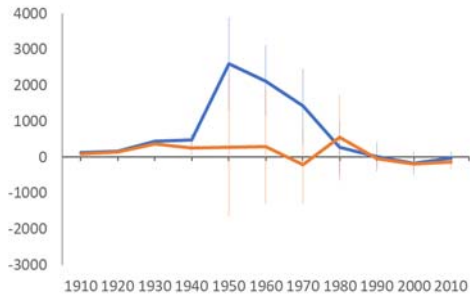
Panel A: Gap in Population Density, D-C



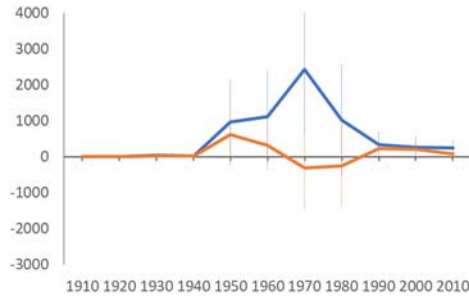
Panel E: Gap in Population Density, C-B



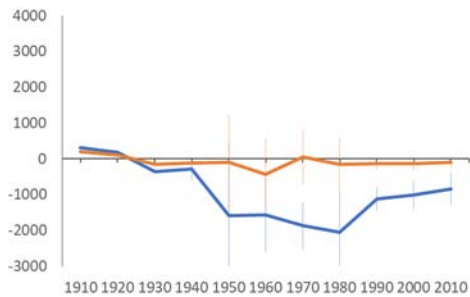
Panel B: Gap in Black Density, D-C



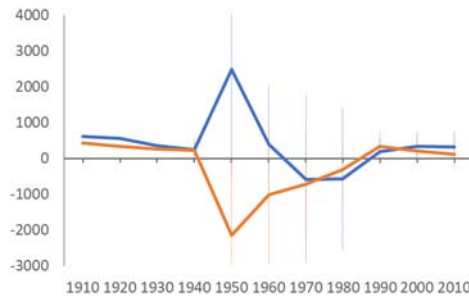
Panel F: Gap in Black Density, C-B



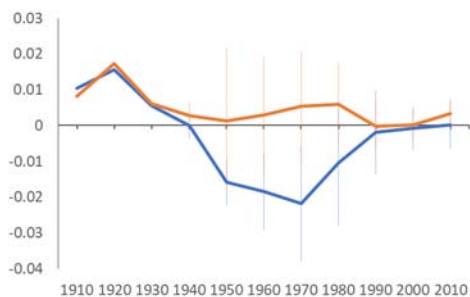
Panel C: Gap in White Density, D-C



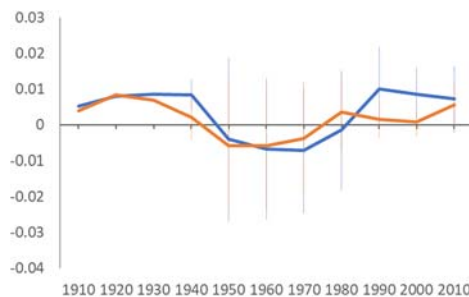
Panel G: Gap in White Density, C-B



Panel D: Gap in Foreign Born Share, D-C



Panel H: Gap in Foreign Born Share, C-B



— Treated — Comparison

Notes: See notes to Figure 5.

Table 1: Summary Statistics

Sample Type		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Full HOLC Neighborhoods				Boundary Buffer Zones				Buffer Gaps	
Grade		A	B	C	D	C-B Borders		D-C Borders		C-B	D-C
N		543	1,351	2,156	1,399	1,965	1,965	2,111	2,111	1,965	2,111
<u>Panel A.</u> year											
Share	1910	0.023	0.018	0.019	0.063	0.019	0.014	0.027	0.060	-0.005	0.034
African	1920	0.017	0.008	0.013	0.075	0.008	0.009	0.020	0.063	0.001	0.043
American	1930	0.015	0.007	0.015	0.146	0.008	0.012	0.025	0.097	0.004	0.072
	1940	0.010	0.005	0.016	0.179	0.006	0.010	0.029	0.121	0.004	0.092
	1950	0.007	0.008	0.031	0.300	0.006	0.039	0.055	0.226	0.033	0.171
	1960	0.009	0.034	0.123	0.396	0.080	0.112	0.218	0.371	0.033	0.153
	1970	0.064	0.132	0.234	0.456	0.168	0.225	0.313	0.469	0.057	0.156
	1980	0.144	0.243	0.307	0.462	0.312	0.305	0.373	0.494	-0.006	0.121
	1990	0.141	0.251	0.309	0.430	0.342	0.351	0.397	0.443	0.009	0.046
	2000	0.178	0.276	0.320	0.412	0.365	0.365	0.401	0.431	0.000	0.030
	2010	0.173	0.261	0.290	0.357	0.324	0.331	0.355	0.386	0.007	0.031
<u>Panel B.</u>											
Home	1910	0.453	0.540	0.451	0.289	0.564	0.481	0.441	0.374	-0.082	-0.067
Ownership	1920	0.599	0.608	0.492	0.326	0.600	0.535	0.467	0.395	-0.064	-0.072
Rate	1930	0.643	0.523	0.436	0.291	0.482	0.433	0.403	0.350	-0.049	-0.052
	1940	0.660	0.505	0.410	0.288	0.441	0.394	0.362	0.311	-0.047	-0.051
	1950	0.627	0.491	0.421	0.267	0.361	0.298	0.359	0.292	-0.064	-0.067
	1960	0.661	0.526	0.451	0.297	0.395	0.324	0.362	0.300	-0.071	-0.062
	1970	0.638	0.504	0.426	0.299	0.337	0.286	0.337	0.284	-0.051	-0.053
	1980	0.650	0.493	0.416	0.309	0.336	0.287	0.348	0.290	-0.049	-0.058
	1990	0.750	0.540	0.441	0.348	0.429	0.360	0.365	0.336	-0.070	-0.029
	2000	0.748	0.533	0.436	0.352	0.425	0.357	0.359	0.336	-0.068	-0.023
	2010	0.748	0.524	0.421	0.340	0.410	0.346	0.339	0.316	-0.064	-0.023
<u>Panel C.</u>											
Home	1930	297	160	113	111	168	129	112	102	-38	-10
Value	1940	163	95	67	55	93	77	63	56	-16	-7
(1000s)	1950	158	130	100	78	128	116	92	76	-12	-16
	1960	181	127	105	93	127	121	102	88	-6	-14
	1970	172	119	104	74	124	113	95	78	-11	-17
	1980	209	134	108	82	133	116	104	77	-17	-27
	1990	357	249	196	193	241	227	189	178	-14	-10
	2000	441	288	217	241	263	243	211	192	-20	-20
	2010	230	181	161	181	182	176	165	173	-6	8

Table 1: Summary Statistics, cont.

Sample Type		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Full				Boundary Buffer Zones					
		HOLC Neighborhoods				C-B Borders		D-C Borders		Buffer Gaps	
Grade		A	B	C	D	B	C	C	D	C-B	D-C
<i>N</i>		<i>543</i>	<i>1,351</i>	<i>2,156</i>	<i>1,399</i>	<i>1,965</i>	<i>1,965</i>	<i>2,111</i>	<i>2,111</i>	<i>1,965</i>	<i>2,111</i>
<u>Panel D.</u>	year										
Rent	1930	887	689	520	419	1,073	913	847	821	-159	-26
	1940	937	777	721	627	1,645	1,768	1,218	1,072	123	-146
	1950	733	548	433	333	506	462	407	340	-45	-67
	1960	742	603	503	410	571	534	493	436	-37	-57
	1970	885	662	582	480	621	589	534	480	-32	-54
	1980	770	620	541	461	586	557	506	453	-29	-53
	1990	974	779	693	609	707	690	631	598	-17	-33
	2000	1,053	814	722	679	742	724	678	644	-18	-34
	2010	1,117	955	880	889	897	884	862	844	-13	-18
<u>Panel E.</u>											
Share	1910	0.305	0.194	0.205	0.268	0.175	0.184	0.198	0.211	0.008	0.014
Foreign	1920	0.203	0.152	0.182	0.237	0.143	0.159	0.180	0.197	0.016	0.017
Born	1930	0.157	0.166	0.205	0.243	0.181	0.199	0.208	0.220	0.017	0.013
	1940	0.100	0.134	0.162	0.172	0.148	0.161	0.163	0.164	0.013	0.001
	1950	0.132	0.155	0.157	0.128	0.171	0.178	0.154	0.141	0.008	-0.013
	1960	0.113	0.141	0.132	0.099	0.156	0.152	0.127	0.104	-0.003	-0.023
	1970	0.090	0.121	0.118	0.086	0.146	0.145	0.109	0.086	-0.001	-0.023
	1980	0.095	0.140	0.145	0.116	0.177	0.186	0.121	0.113	0.009	-0.008
	1990	0.121	0.243	0.298	0.246	0.282	0.303	0.198	0.195	0.021	-0.004
	2000	0.103	0.181	0.222	0.195	0.211	0.237	0.191	0.201	0.025	0.010
	2010	0.107	0.188	0.238	0.217	0.221	0.244	0.204	0.217	0.023	0.013
<u>Panel F.</u>											
Credit	1999	709	674	653	640	659	651	641	634	-8	-6
Score	2016	729	692	671	662	682	675	665	662	-6	-3
Fraction	1999	0.122	0.218	0.306	0.384	0.246	0.286	0.373	0.418	0.040	0.046
Subprime	2016	0.105	0.173	0.232	0.281	0.19	0.199	0.252	0.257	0.009	0.004

Note: Data for Panels A to E are drawn from the full-counts of the 1910 to 1940 Censuses, the census tract aggregation of the 1950 to 1980 Censuses, and the census block and block group aggregations of the 1990 to 2010 Censuses. Panel F data is from the New York Fed Consumer Credit Panel. Columns (1) to (4) report averages by full HOLC grades. Columns (5) to (8) report averages for each side of the C-B and D-C buffer zones. Columns (9) and (10) report the simple difference or gap between each side of a border type (e.g. column (9) = Column (6) - Column (5)).

Table 2: Effects of D Versus C grade, Share African Americans

Sample Type	(1) HOLC Neighborhoods	(2) HOLC Neighborhoods	(3)	(4)	(5) 1/4 Mile D-C Boundaries	(6)	(7)
Year	D-C	D-C	D-C	D-C	Grid C.F's	Triple Diff	Low PS D-C
1910	0.061 (0.011)	0.053 (0.01)	0.026 (0.005)	0.025 (0.006)	0.021 (0.01)	-0.004 (0.008)	0.006 (0.004)
1920	0.069 (0.009)	0.063 (0.008)	0.030 (0.006)	0.029 (0.006)	0.024 (0.006)	-0.003 (0.009)	0.003 (0.004)
1930	0.135 (0.014)	0.133 (0.013)	0.063 (0.01)	0.062 (0.011)	0.054 (0.012)	-- --	0.007 (0.004)
1940	0.150 (0.015)	0.147 (0.013)	0.076 (0.012)	0.073 (0.012)	0.040 (0.009)	0.026 (0.006)	0.020 (0.007)
1950	0.224 (0.02)	0.214 (0.019)	0.119 (0.026)	0.101 (0.024)	0.010 (0.011)	0.083 (0.025)	0.042 (0.018)
1960	0.250 (0.021)	0.234 (0.018)	0.121 (0.031)	0.094 (0.026)	0.000 (0.016)	0.086 (0.03)	0.044 (0.015)
1970	0.216 (0.024)	0.203 (0.02)	0.138 (0.027)	0.113 (0.023)	-0.007 (0.016)	0.112 (0.031)	0.091 (0.021)
1980	0.172 (0.028)	0.159 (0.023)	0.107 (0.028)	0.087 (0.021)	0.003 (0.02)	0.076 (0.025)	0.061 (0.022)
1990	0.130 (0.018)	0.126 (0.014)	0.059 (0.011)	0.056 (0.011)	0.016 (0.007)	0.032 (0.013)	0.033 (0.01)
2000	0.106 (0.017)	0.103 (0.013)	0.042 (0.01)	0.038 (0.01)	0.010 (0.005)	0.019 (0.011)	0.019 (0.008)
2010	0.081 (0.016)	0.079 (0.012)	0.037 (0.008)	0.034 (0.007)	0.006 (0.005)	0.019 (0.012)	0.017 (0.008)
<i>Cities</i>	<i>148</i>	<i>148</i>	<i>115</i>	<i>115</i>	<i>115</i>	<i>115</i>	<i>97</i>
<i>Neighborhoods</i>	<i>3532</i>	<i>3555</i>	<i>--</i>	<i>--</i>	<i>--</i>	<i>--</i>	<i>--</i>
<i>Boundaries</i>	<i>--</i>	<i>--</i>	<i>--</i>	<i>1,133</i>	<i>4,214</i>	<i>5,347</i>	<i>567</i>
<i>N</i>	<i>27,814</i>	<i>27,814</i>	<i>16,676</i>	<i>16,676</i>	<i>61,415</i>	<i>78,091</i>	<i>8,519</i>
<i>R2</i>	<i>0.215</i>	<i>0.383</i>	<i>0.426</i>	<i>0.645</i>	<i>0.683</i>	<i>0.675</i>	<i>0.647</i>
<i>F.E.</i>	<i>None</i>	<i>City</i>	<i>City</i>	<i>Bound.</i>	<i>Bound.</i>	<i>Bound.</i>	<i>Bound.</i>

Note: Table entries are from regressions that estimate the gaps between D and C rated neighborhoods in the share African American. Columns (1) and (2) use entire neighborhoods. Columns (3) to (7) use 1/4 mile boundary buffer zones. Columns (3) and (4) use actual HOLC "treated" boundaries. Column (5) shows effects on counterfactual boundaries weighted by propensity scores to be similar to treated boundaries. Column (6) shows the difference in the gap between treated and comparison boundaries relative to 1930. Column (7) uses only those treated boundaries with below median propensity scores.

APPENDIX: NOT FOR PUBLICATION

Appendix

More Detail on Construction of Census Housing Variables

Whenever possible, we attempt to use consistently defined census variables from 1910 to 2010. Typically, this means relying on the version of the data cleaned and coded by IPUMS. However, we must occasionally deviate from IPUMS with regard to house values, monthly contract rent, and vacancy rates. For 1930 and 1940, we trim the bottom and top 1 percent of the national house value and rent distribution separately for each census out of concern about extreme outliers. In 1950, census tract tabulations report monthly contract rents and house values in bins. We use these bins to calculate a mean by assuming that the mean of each bin is equal to its midpoint. For the highest bin, we assume that its mean is equal to 1.5 times its lower bound. We repeat this procedure for 1960 house values. In 1970 and 1980, we calculate mean house value and mean monthly contract rent by dividing the aggregates of these variables by the number of owner-occupied units with house value reported and by the number of renter-occupied units with non-zero contract rent, respectively. For our vacancy rates, we use number of “dwelling” units in 1940 and number of “housing” units in 1990.

HOLC Grade Determinants

Appendix Table A7 shows a series of regressions that associate neighborhood grades with pre-HOLC 1930 housing and demographic characteristics, as well as changes between 1920 and 1930 when available. Columns (1) and (2) report marginal effects from an ordered logit where D is coded as 4 and A is coded as 1. Columns (3) to (8) are marginal effects of the probability of moving one grade lower: i.e. from A to B, from B to C, or from C to D, respectively. All specifications include city fixed effects and are weighted by the log of neighborhood population in 1930. Standard errors are clustered at the city level.

Like Hillier (2005) and Fishback (2014), who were only able to examine single cities, we find a clear monotonic relationship between grades and nearly all the key economic and housing covariates that are available in the census whether considered individually or, as in the table, simultaneously.⁴⁸ Unsurprisingly, a higher homeownership rate, log home value, log rent,

⁴⁸ We find weaker evidence that recent changes in housing and household characteristics between 1920 and 1930 affected HOLC grades. These coefficients are suppressed in Table 2 for space but are available on request. However,

occupational earnings, radio ownership, and literacy are associated with a higher HOLC grade. To take one example, the results in column (2) imply that a 10 percentage point increase in homeownership rates raises the probability of a being assigned one letter grade higher by 7.6 (0.7) percentage points. These results are unsurprising because they conform with what we know about the appraisal process from the detailed forms, called area description files (ADF), that were recorded at the time. The ADFs consistently document that homeownership, vacancy, housing age, housing quality, and economic and demographic characteristics of neighbors were key factors used to grade neighborhoods.

Appendix Table A7 also shows that the marginal effect of most of our observable housing and employment variables is roughly the same for grade determination between B versus C (columns 5 and 6) and C versus D (columns 3 and 4). For example, in the sample of C and D neighborhoods, a 10 percentage point increase in the homeownership rate increases the probability of a C grade by 4.5 (0.5) percentage points. Likewise, in the C-B sample, a 10 percentage point increase in the homeownership rate increases the probability of a B grade by 4.8 (0.6) percentage points.

The case of race is somewhat more complicated. Similar to previous studies, we show that a neighborhood is more likely to be graded D than C if the African-American share is higher, even after conditioning on a set of housing and economic characteristics and city fixed effects. To highlight the pivotal role of race in grading D neighborhoods, Appendix Figure A1 shows the ADF for a particular neighborhood in Tacoma, Washington which was graded D. The notes at the bottom of the document clarify: “This might be classed as a ‘low yellow’ area if not for the presence of the number of Negroes and low class foreign families who reside in the area.” It is worth noting that the fraction of African Americans in this Tacoma neighborhood was 2 percent. However, interestingly, the share African-American has the opposite effect when we examine grade determination among A versus B neighborhoods and B versus C neighborhoods. That is, B grades are more likely than C grades, and A grades are more likely than B grades, in areas with a higher share of African Americans.

it is plausible that changes between 1920 and 1930 are not the correct time frame for evaluating appraisals that were taking place in the mid-1930s.

City Heterogeneity

We next document significant heterogeneous effects across cities. In addition to its descriptive value, the variation in the magnitude of the causal effects has the potential to shed light on possible mechanisms. That said, there are some clear limitations to cutting the data by city. Many of our 149 cities have too few D-C and C-B boundaries to reliably estimate a city-specific effect. Consequently, we limit this analysis to cities with at least 5 D-C or C-B borders. For the 1950-1980 and 1990-2010 periods, that allows us to produce estimates for up to 51 and 80 cities, respectively.⁴⁹ Related, constructing comparison boundaries within a specific city has proven infeasible given the limited number of potential boundaries. Instead, we examine treated boundaries and assume that there are no effects on the comparison boundaries based on the national evidence.

Those important caveats aside, we find the D-C gaps in share African American between 1950 and 1980 (Appendix Table A9 column 1) vary from 3 pps in Chicago to 9 pps in St. Louis to 21 pps in Detroit, to take a few large Midwestern cities where the estimates are relatively more precise as examples. The comparable gaps in some Southern and Rust Belt cities (Birmingham, AL; Columbus, OH; Erie, PA; Evansville IN, Lexington KY; Mobile, AL and Toledo, OH) exceed 40 pps. By 1990 to 2010, these gaps have fallen considerably but some of the same cities continue to have the largest racial gaps along the D-C border. Along the C-B boundaries (Appendix Tables A9 and A10, column 2), we tend to see the largest African American share effects among Northeastern and Midwest cities, including St. Louis, New York, and Philadelphia. Appendix Tables A9 and A10 also report similar sized variation in city-specific estimates of homeownership, house values, and rent.

We considered several possible sources of this heterogeneity but, in the end, have been unable to find a compelling explanation. First, using 1930 county-level data on banks per capita, we tested whether larger HOLC effects appear in cities with less lending sector competition and therefore possibly greater banker discretion.⁵⁰ Second, we examined whether the coarseness of

⁴⁹ The precise number of cities depends on the outcome and the boundary type. The number of boundaries per city are shown in Appendix Table A8.

⁵⁰ We thank Price Fishback for the county bank data. It is available here: <https://econ.arizona.edu/weather-demography-economy-and-new-deal-county-level-1930-1940>. We correlated these measures with each of our outcomes for each border type at long time intervals.

boundaries in a city influenced the size of the effects. For example, perhaps cities which had fewer borders, like Chicago and its vast swath of red surrounded by a ring of yellow (Figure 3), were less able to use the maps to promote lending practices. Third, we explored whether the effects differed by city size. In all three cases, we found no consistent patterns.⁵¹

Lastly, the drawing of the maps and their aftermath coincide with the Great Migration of Southern blacks to Northern cities. Therefore, we considered whether our race results in particular might have been influenced by this major historical event. Perhaps cities where there were large inflows of African Americans were more prone to reacting through discriminatory practices. To address, this possibility, we use our city estimates for 1950-1980 and 1990-2010 and examine whether the gaps in the share African American across borders were systematically different across Northern cities depending on African American inflow during the Great Migration. We found mixed patterns depending on the border type and years considered. The most compelling evidence was a statistically significant negative correlation between black inflow and white population density gaps along D-C borders, a result that appears consistent with Boustan (2010). However, this association does not translate into a statistically significant correlation between Great Migration inflows and our estimated D-C gaps in the share of African Americans.

⁵¹ Along the C-B borders there were some outcomes in some periods where the differences were statistically significant by city size, but these also could have been due to chance.

Appendix Figure A1: Area Description File for Tacoma, Washington

FORM 8
10-1-37

AREA DESCRIPTION - SECURITY MAP OF Tacoma

1. AREA CHARACTERISTICS:

a. Description of Terrain. Low lying level.

b. Favorable Influences. Schools, churches, stores and transportation conveniently available.

c. Detrimental Influences. Unimproved streets - Heterogeneous population.

d. Percentage of land improved 50 %; e. Trend of desirability next 10-15 yrs. Static

2. INHABITANTS:

a. Occupation Laborers; b. Estimated annual family income \$ 1000 to \$ 1800

c. Foreign-born families few %; American born predominating; d. Negro Yes; 2 %

e. Infiltration of Lower classes slowly; f. Relief families Many

g. Population is increasing Slowly; decreasing ----; static ----

3. BUILDINGS:

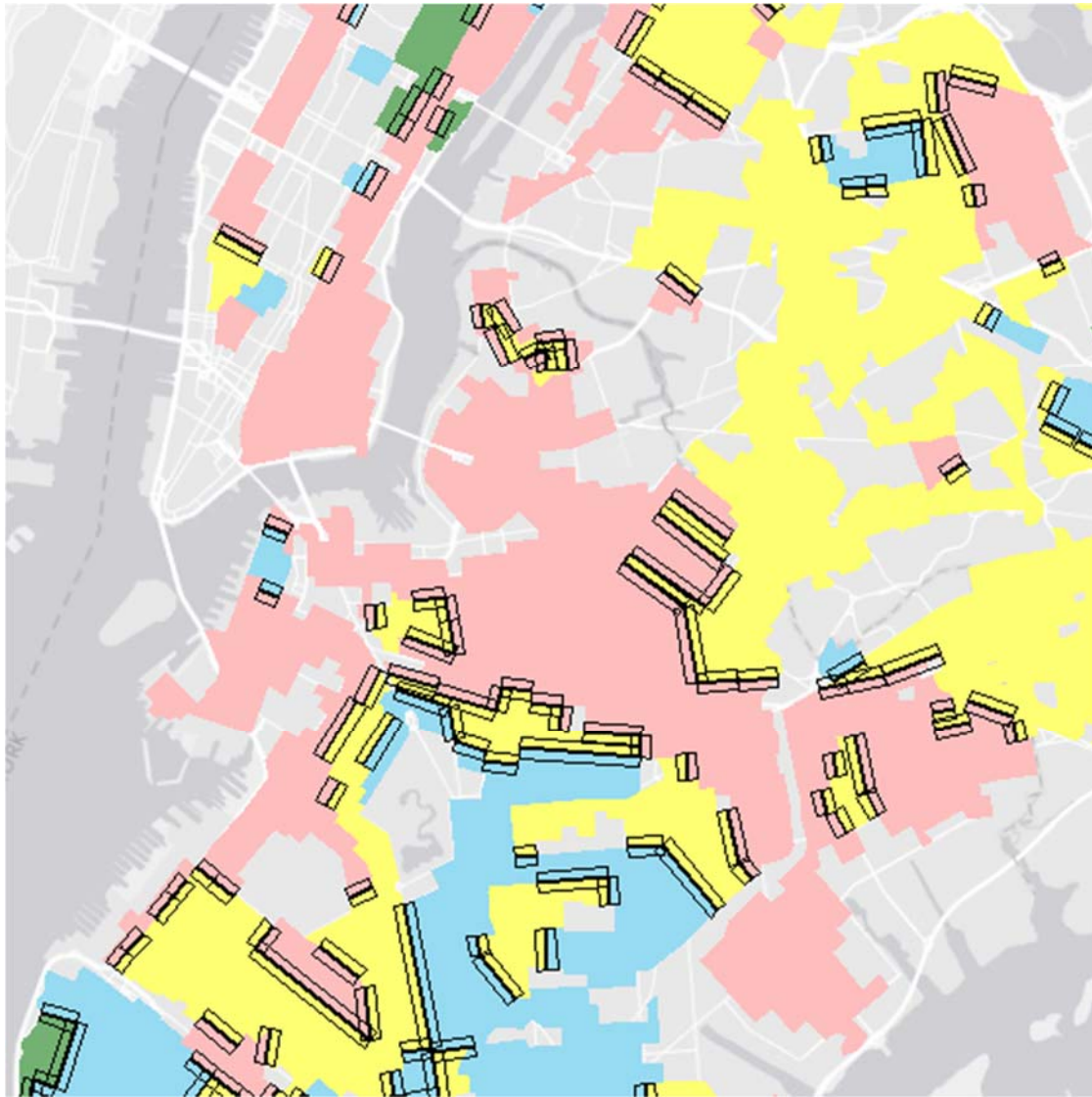
	PREDOMINATING	90 %	OTHER TYPE	10 %	OTHER TYPE	%
a. Type	<u>4 & 5 room</u>		<u>Miscellaneous</u>			
b. Construction	<u>frame</u>					
c. Average Age	<u>15</u> Years					
d. Repair	<u>poor to fair</u>					
e. Occupancy	<u>95</u> %					
f. Home ownership	<u>50</u> %					
g. Constructed past yr.	<u>None</u>					
h. 1929 Price range	\$ <u>1000</u> to \$ <u>2500</u>	<u>100</u> %	\$ _____	<u>100</u> %	\$ _____	<u>100</u> %
i. 1933 Price range	\$ <u>500</u> to \$ <u>1500</u>	<u>60</u> %	\$ _____	_____ %	\$ _____	_____ %
j. 1937 Price range	\$ <u>800</u> to \$ <u>2000</u>	<u>80</u> %	\$ _____	_____ %	\$ _____	_____ %
k. Sales demand	\$ <u>1500</u> - fair		\$ _____		\$ _____	
l. Activity	<u>fair</u>					
m. 1929 Rent range	\$ <u>10</u> to \$ <u>25</u>	<u>100</u> %	\$ _____	<u>100</u> %	\$ _____	<u>100</u> %
n. 1933 Rent range	\$ <u>5.00</u> to \$ <u>12</u>	<u>50</u> %	\$ _____	_____ %	\$ _____	_____ %
o. 1937 Rent range	\$ <u>12</u> to \$ <u>20</u>	<u>95</u> %	\$ _____	_____ %	\$ _____	_____ %
p. Rental demand	\$ <u>15</u> <u>good</u>		\$ _____		\$ _____	
q. Activity	<u>good</u>					

4. AVAILABILITY OF MORTGAGE FUNDS: a. Home purchase limited; b. Home building limited

5. CLARIFYING REMARKS: This might be classed as a 'Low Yellow' area were it not for the presence of the number of Negroes and low class Foreign families who reside in the area. Lot values run from \$2.00 to \$5.00 per front foot.

6. NAME AND LOCATION Tacoma SECURITY GRADE D AREA NO. 7

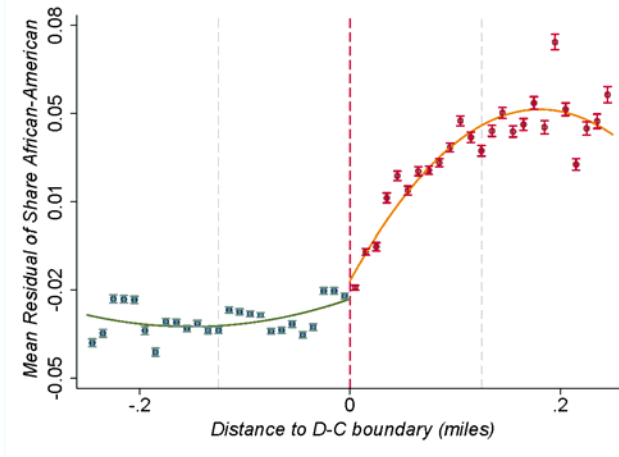
Appendix Figure A2: Boundary Buffer Zones for New York City



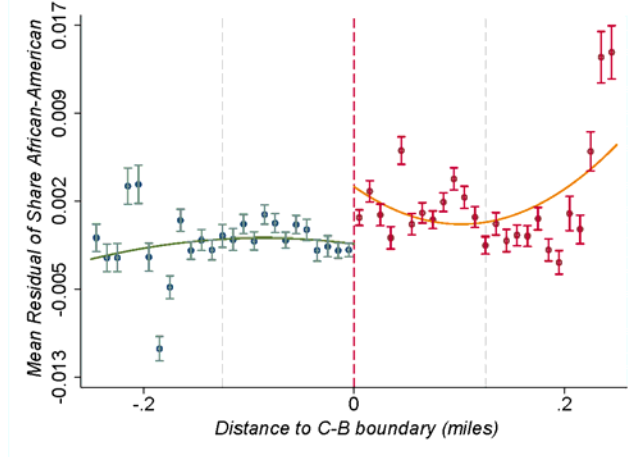
Notes: This map provides a visual depiction of the “boundary buffer zones” in part of New York City that form the main unit of our analysis. Areas shaded in red, yellow, blue, and green constitute D, C, B, and A graded neighborhoods. The thick black lines denote straight-line neighborhood boundaries that are at least ¼ mile in length. The lighter black lines outline the 1/4-mile buffer zones surrounding each boundary.

Appendix Figure A3: Distance Plots around HOLC Borders, 1930

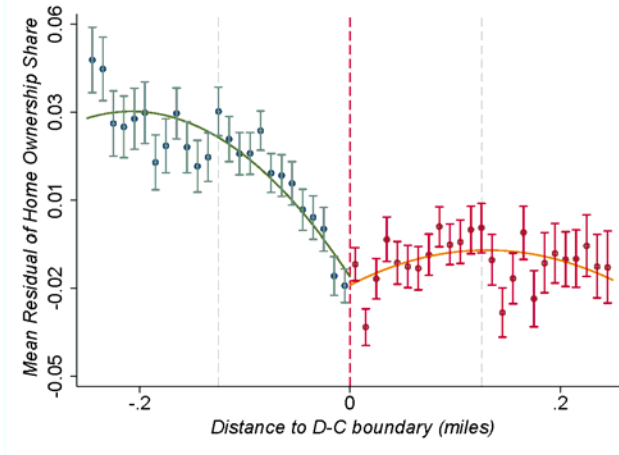
Panel A: African American Share, D-C



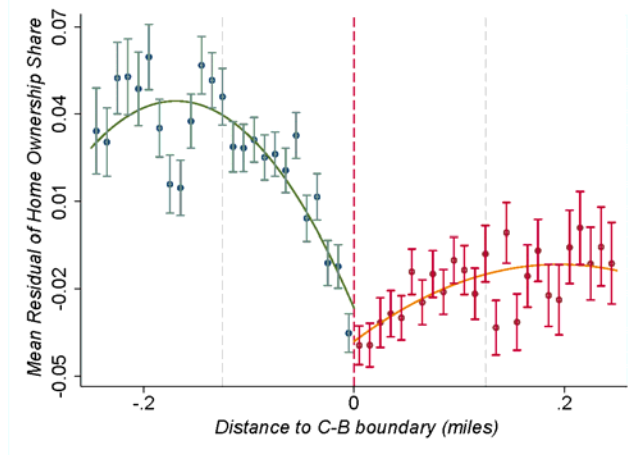
Panel B: African American Share, C-B



Panel C: Home Ownership, D-C

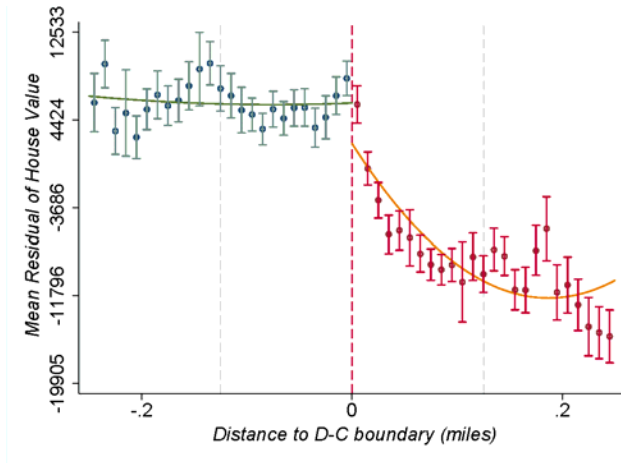


Panel D: Home Ownership, C-B

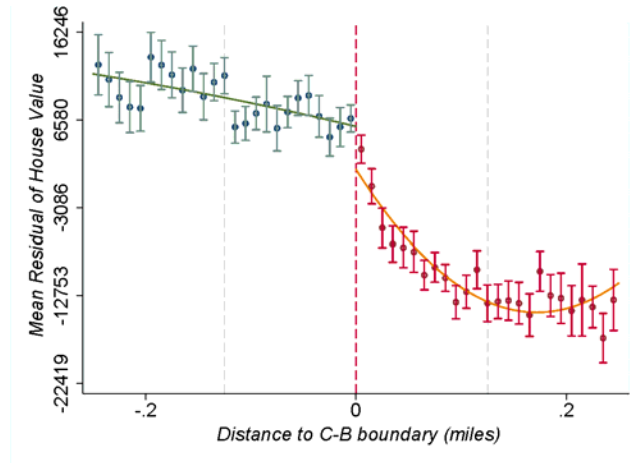


Appendix Figure A3: Distance Plots around HOLC Borders, 1930, continued

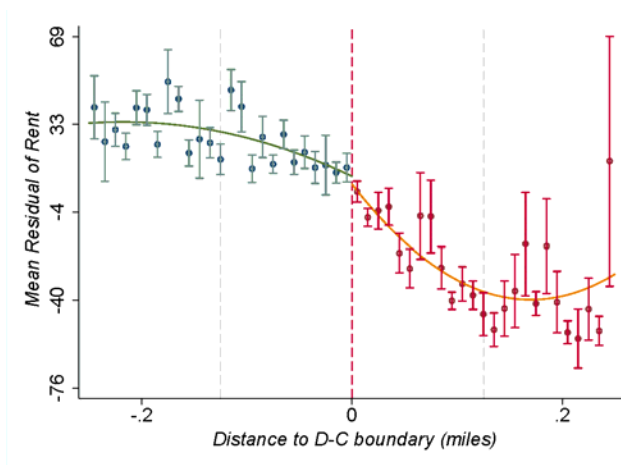
Panel E: House Values, D-C



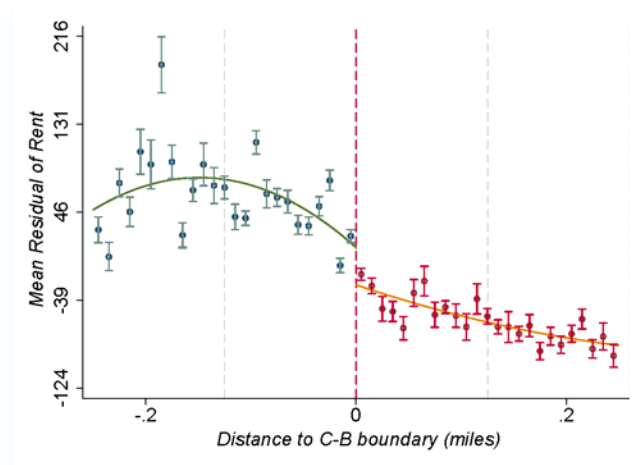
Panel F: House Values, C-B



Panel G: Rent, D-C

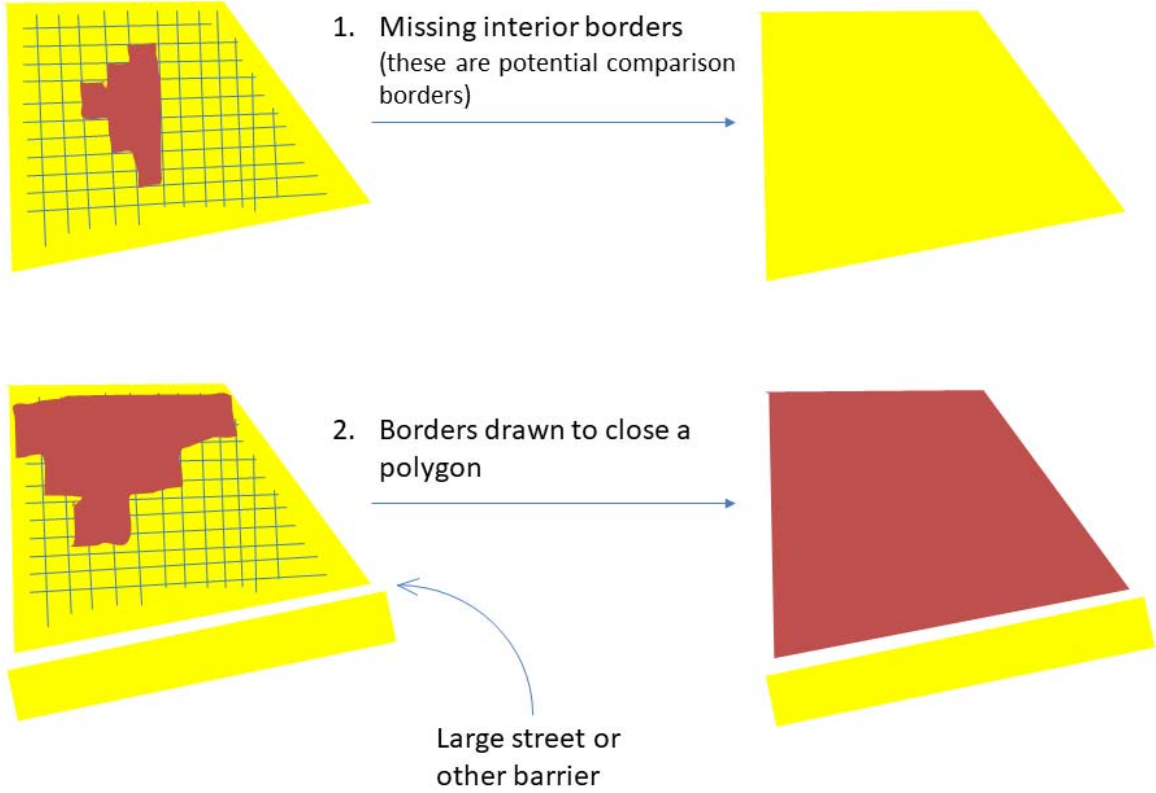


Panel H: Rent, C-B

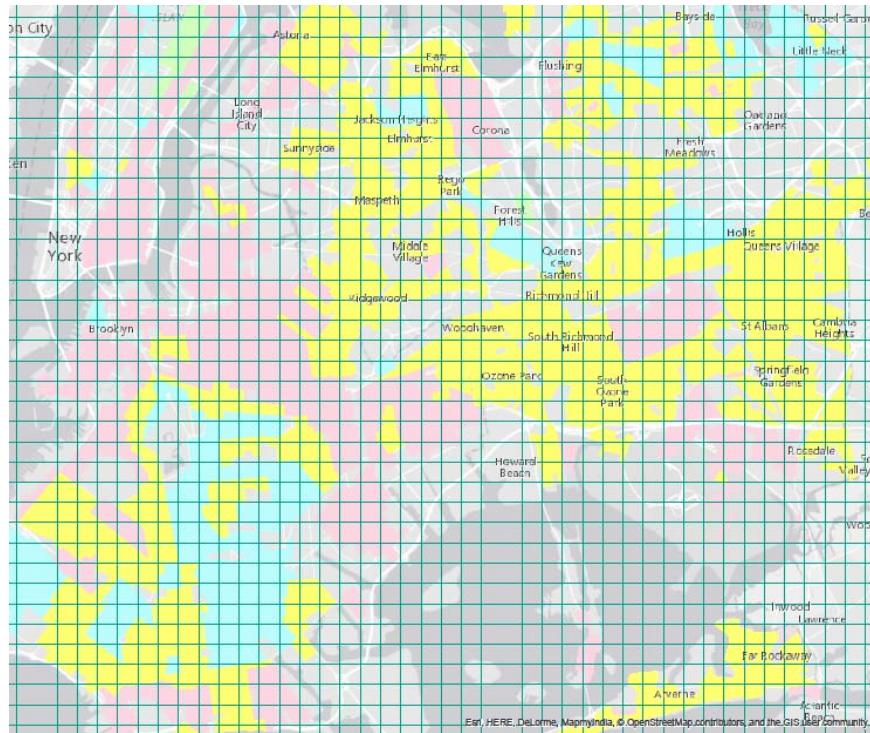


Notes: These plots illustrate the mean outcome at increments of 1/100 of a mile from an HOLC boundary (the vertical red dotted line). Left (right) of the boundary are the higher (lower) graded neighborhood. Each distance plot was constructed using geocoded individual-level data from the full-count 1930 Census and is regression-adjusted to account for border fixed effects.

Appendix Figure A4: Hypothetical Examples of Missing and Misaligned Borders



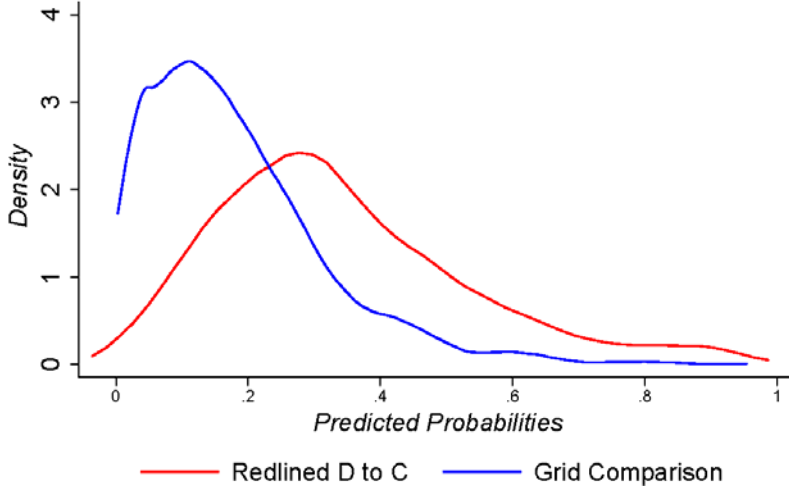
Appendix Figure A5: Example of Grid Placed over New York City



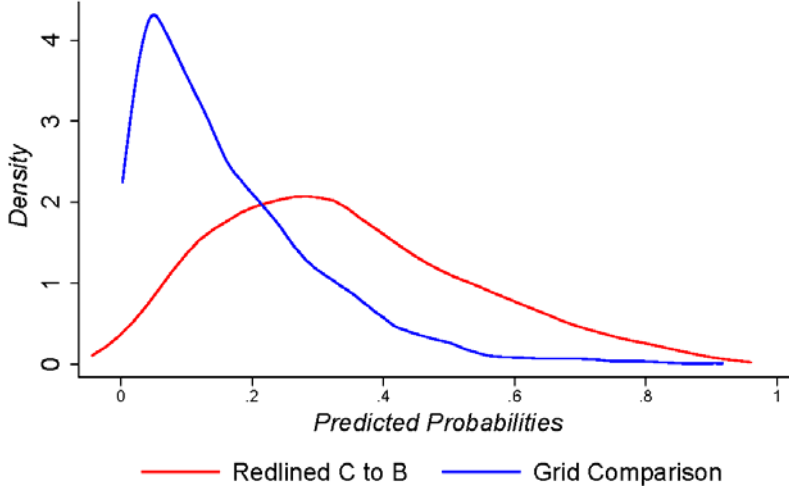
Notes: The above map of NYC depicts the initial step in the construction of a set of non-HOLC “grid” comparison boundaries that are weighted to resemble our treated HOLC boundaries before the maps were drawn. To construct our grid boundaries, we drew 1/2-mile by 1/2-mile grids over HOLC cities. We then constructed 1/4-mile buffer zones around each line segment that did not overlap with an HOLC boundary. See Figure A1 for an illustration of these boundary buffer zones.

Appendix Figure A6: Distribution of Propensity Scores and Effects of Re-weighting

Panel A: Propensity Score Distribution, D-C Boundaries

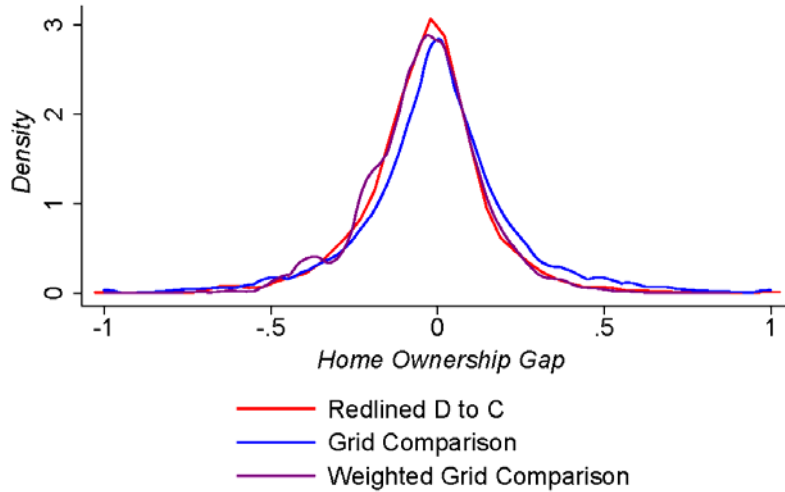


Panel B: Propensity Score Distribution, C-B Boundaries

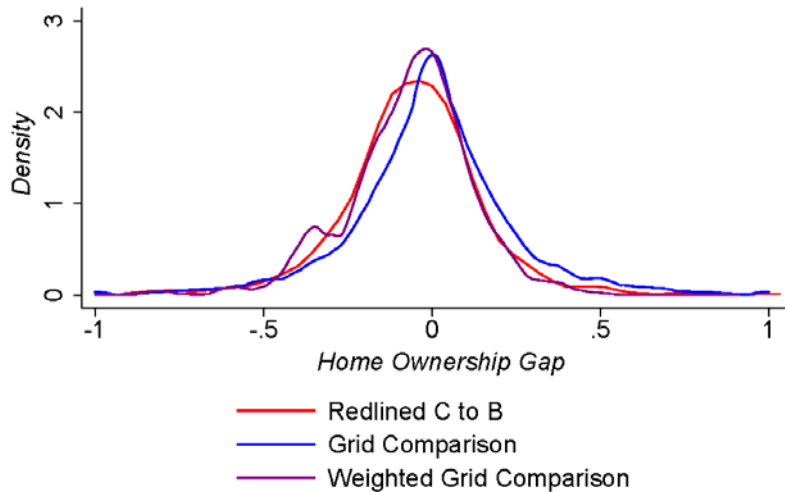


Appendix Figure A6: Distribution of Propensity Scores and Effects of Re-weighting, cont.

Panel C: Distributions of 1930 Home Ownership Gaps, D-C Boundaries



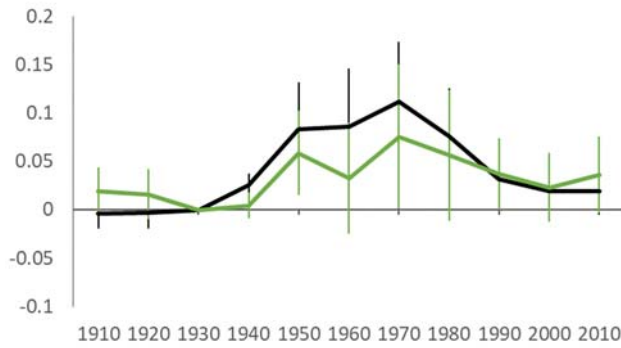
Panel D: Distributions of 1930 Home Ownership Gaps, C-B Boundaries



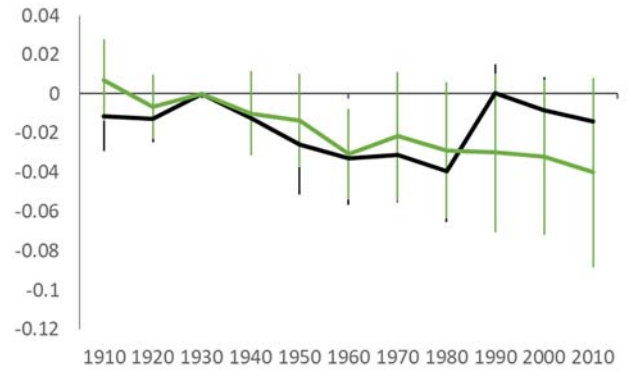
Notes: Panels A and B are kernel density plots of our propensity score distributions for D-C and C-B boundaries, respectively. Panels C and D are kernel density plots of the distribution of the 1930 home ownership gaps across D-C and C-B boundaries. In panels C and D, propensity scores are used to weight the grid comparison boundaries (the purple line) such that they mimic the treated (HOLC) D-C and C-B boundaries. Propensity scores are estimated using full-count Census data from 1910, 1920, and 1930.

Appendix Figure A7: Triple Difference D-C Estimates Using Grid and Same Grade Comparisons

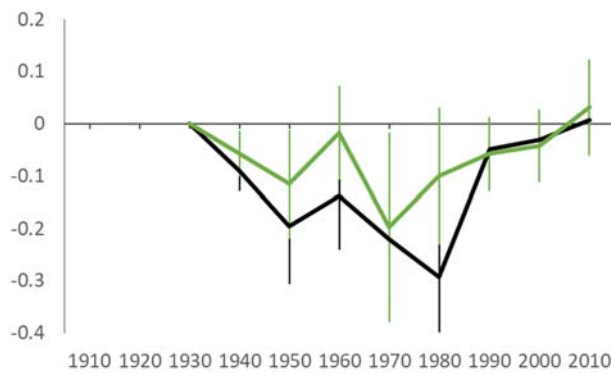
Panel A: Share African American



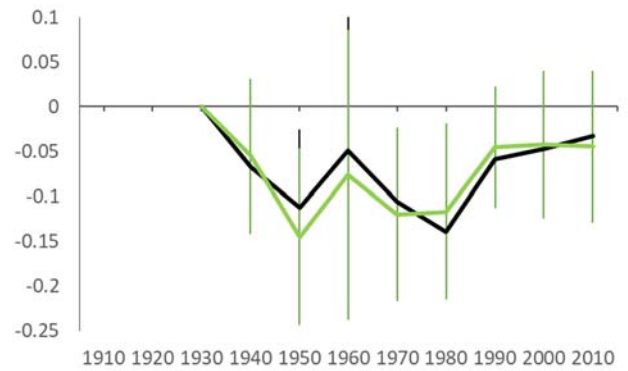
Panel B: Home Ownership



Panel C: Log House Values



Panel D: Log Rent



— Grid — Same Grade

Notes: These figures show triple-difference estimates (treatment minus comparison) using our grid (black) and same-grade (green) comparison borders. The same grade comparisons are based on HOLC boundaries between neighborhoods that received the same grades (D-D, C-C, and B-B). See the text for more detail and the notes to Figure 5. The vertical bands represent 95% confidence intervals.

Appendix Figure A8: Triple Difference C-B Estimates Using Grid and Same Grade Comparisons

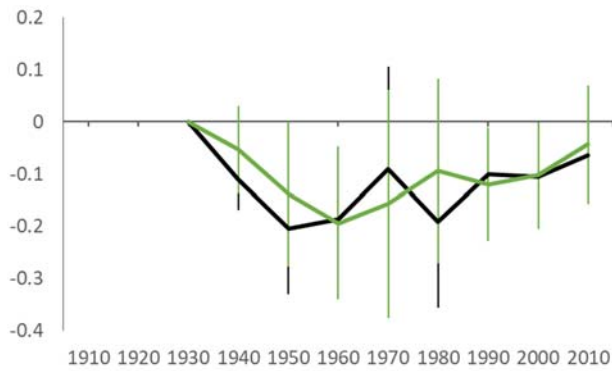
Panel A: Share African American



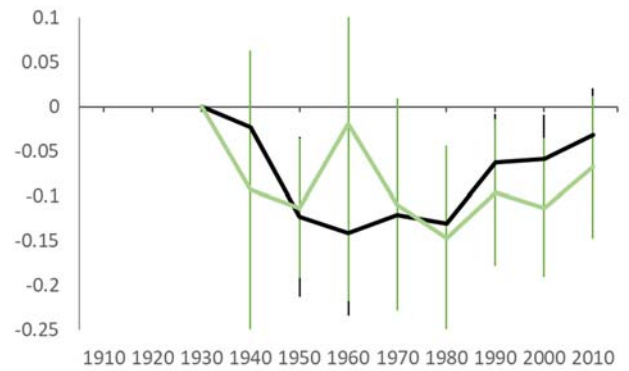
Panel B: Home Ownership



Panel C: Log House Values



Panel D: Log Rent

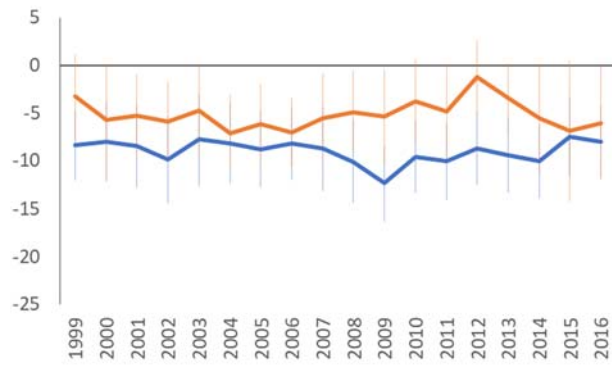


— Grid — Same Grade

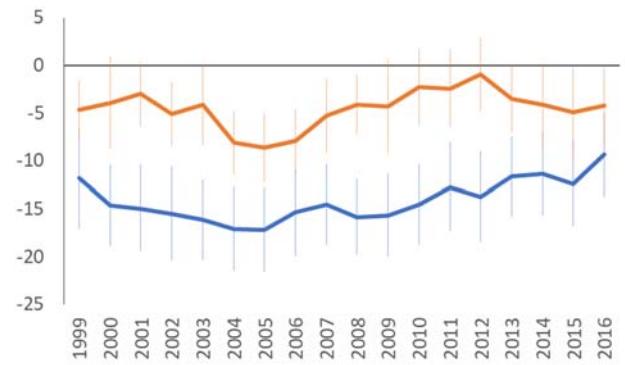
Notes: See notes to Appendix Figure A7.

Appendix Figure 9: Impact on Credit Scores, D-C and C-B Boundaries

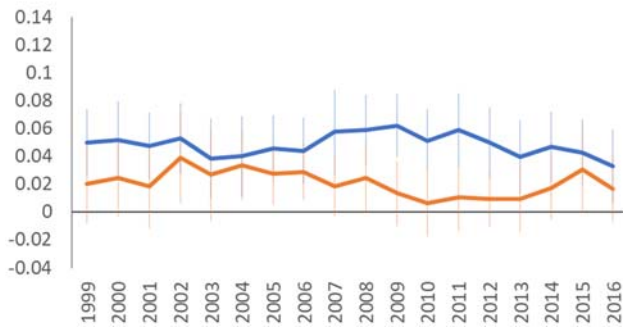
Panel A: D-C Gaps in Credit Scores



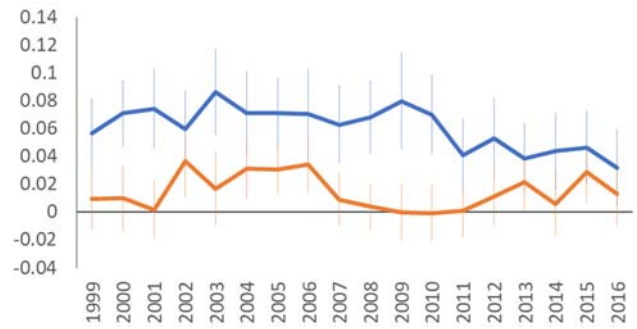
Panel C: C-B Gaps in Credit Scores



Panel B: D-C Gaps in Subprime



Panel D: C-B Gaps in Subprime

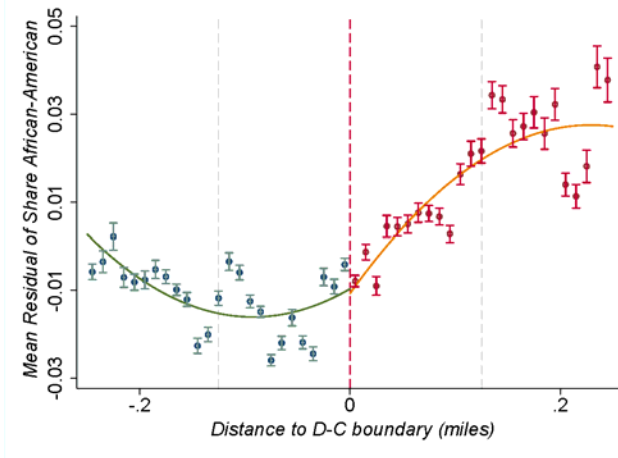


— Treated — Comparison

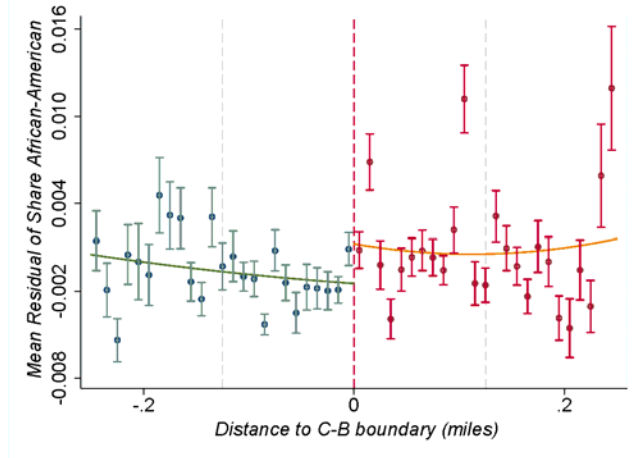
Notes: Credit scores are from the Federal Reserve Bank of NY Consumer Credit Panel. An individual is classified as subprime if her Equifax Risk Score is less than 620. See notes to Figure 5.

Appendix Figure A10: Distance Plots around HOLC Borders Using Low Propensity Treated, 1930

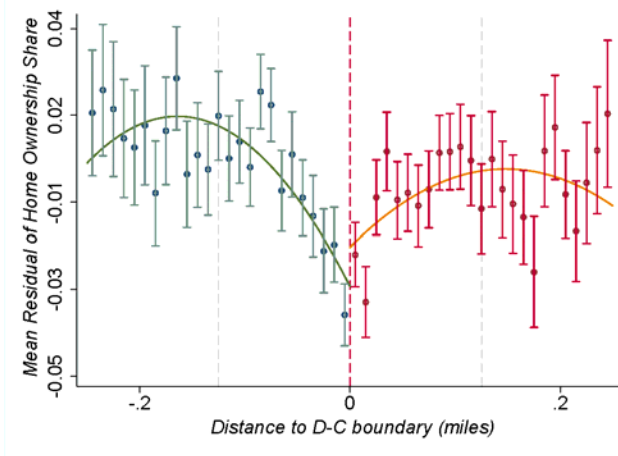
Panel A: African American Share, D-C



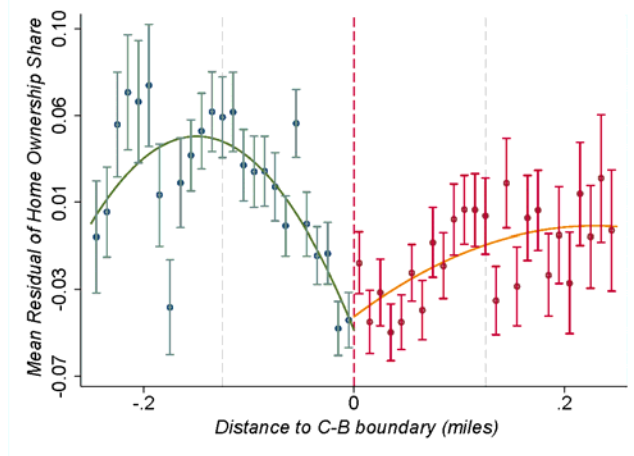
Panel B: African American Share, C-B



Panel C: Home Ownership, D-C

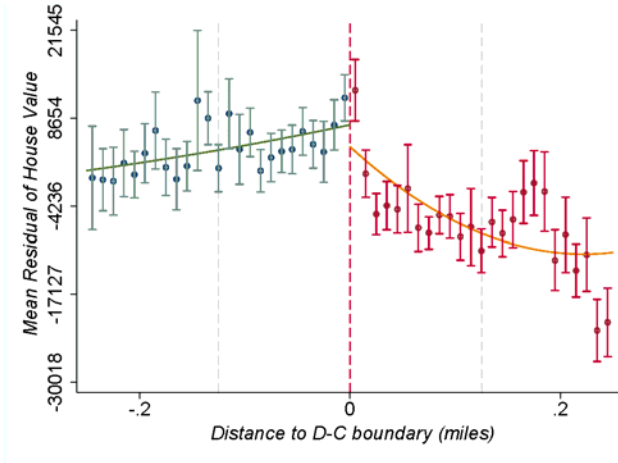


Panel D: Home Ownership, C-B

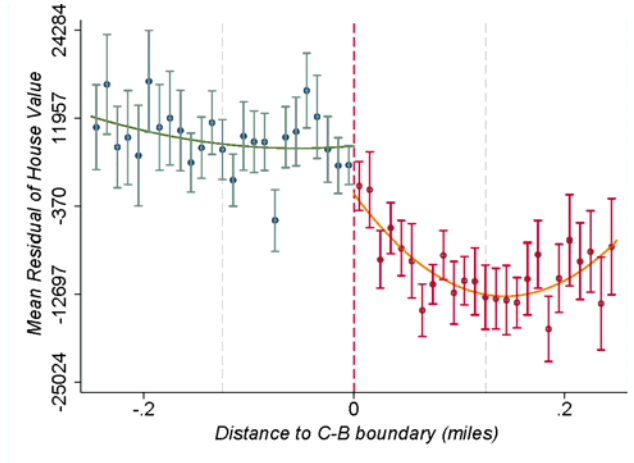


Appendix Figure A10: Distance Plots Around HOLC Borders Using Low Propensity Treated, 1930, continued

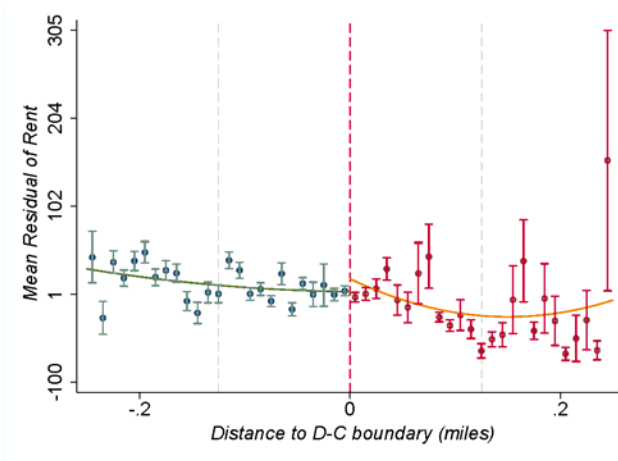
Panel E: House Values, D-C



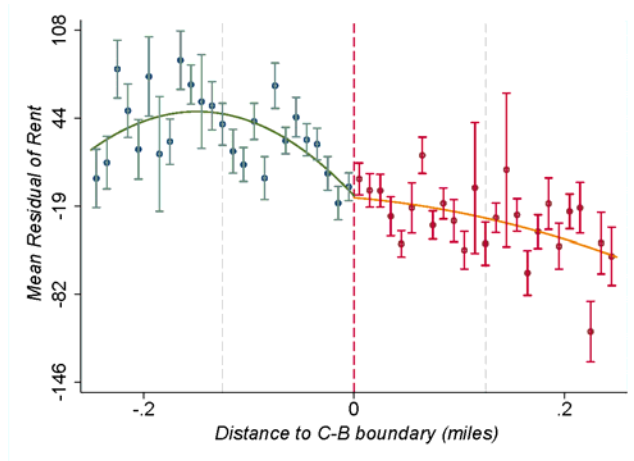
Panel F: House Values, C-B



Panel G: Rent, D-C



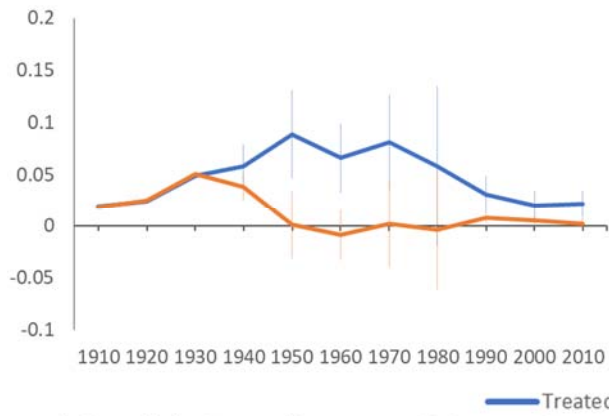
Panel H: Rent, C-B



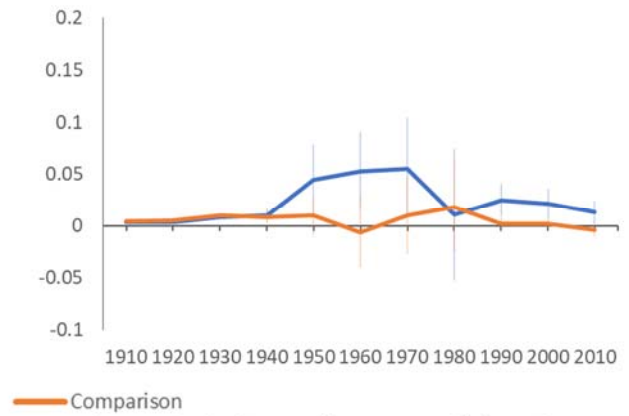
Note: See notes to Appendix Figure A3.

Appendix Figure 11: Additional Robustness Checks, African American Share

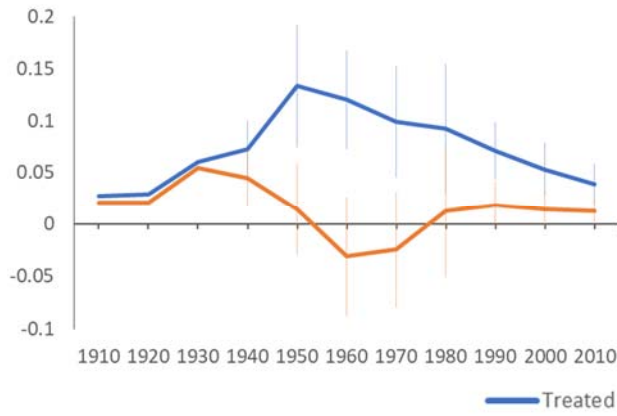
Panel A: 1/8th mile Boundaries, D-C



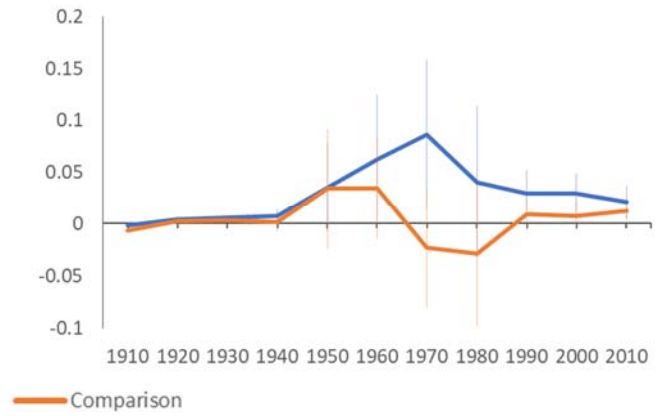
Panel B: 1/8th mile Boundaries, C-B



Panel C: High Geocoding Rate Cities, D-C

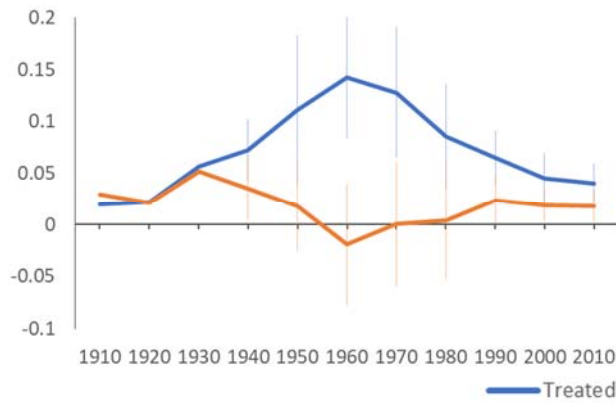


Panel D: High Geocoding Rate Cities, C-B

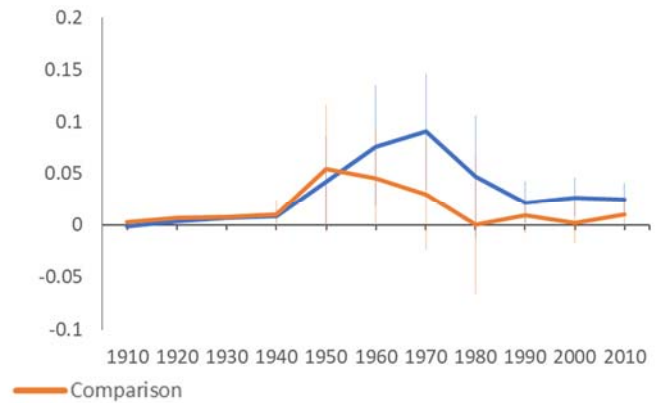


Appendix Figure 11, continued

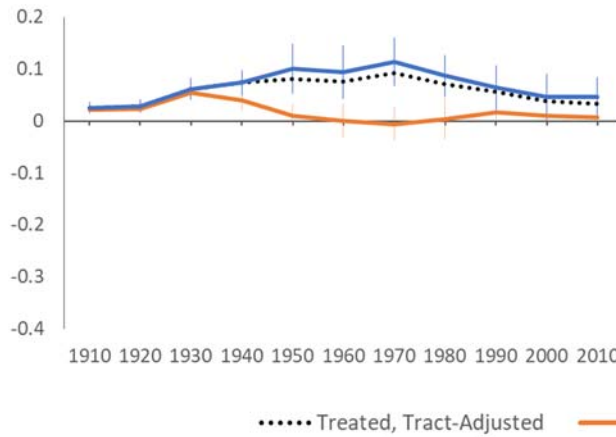
Panel E: Excluding Trains and Rivers, D-C



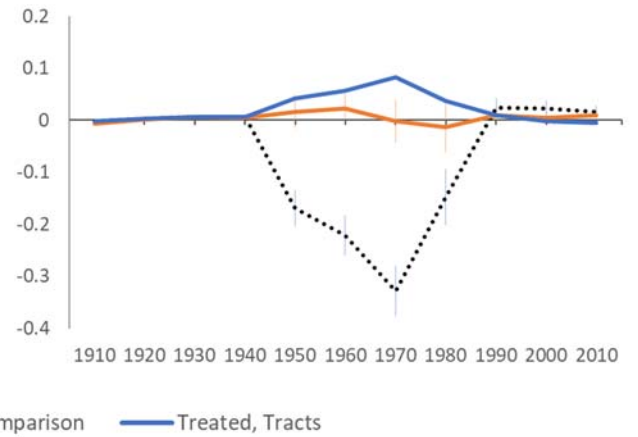
Panel F: Excluding Trains and Rivers, C-B



Panel G: Using Tracts in All Years, D-C



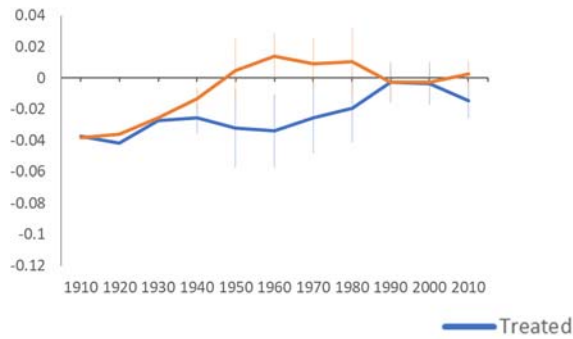
Panel H: Using Tracts in All Years, C-B



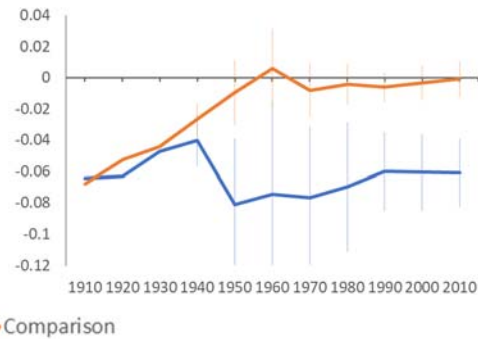
Notes: In Panels A and B, buffer zones are drawn 1/8 (rather than 1/4) mile around boundaries. In Panels C and D, we select the subset of cities that had a geocoding match rate above the median (59.3 percent) in 1920. In Panels E and F, we exclude boundaries that overlap with trains and rivers. Our rivers and trains shapefiles were obtained from Esri, Geospatial at UCLA and Jeremy Atack of Vanderbilt University, respectively. In Panels G and H, we multiply our headline results by the mean block-to-tract ratio in 1990-2010 to generate “tract-adjusted” estimates (the blue line). See text for more detail.

Appendix Figure A12: Additional Robustness Checks, Home Ownership

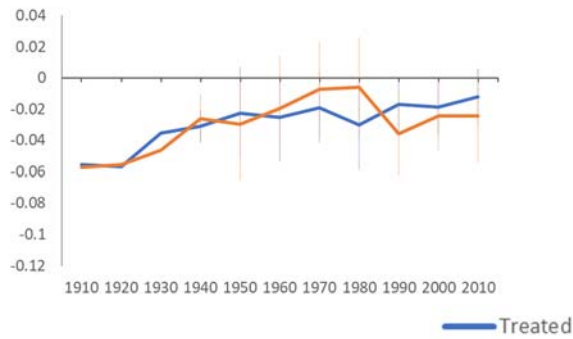
Panel A: 1/8th mile Boundaries, D-C



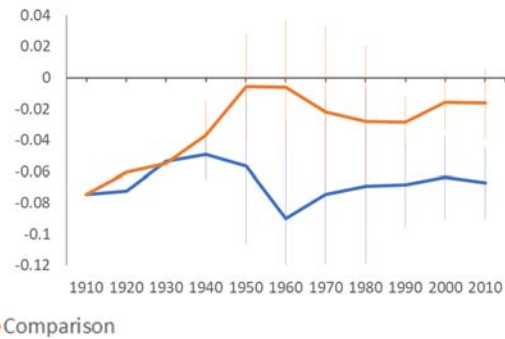
Panel B: 1/8th mile Boundaries, C-B



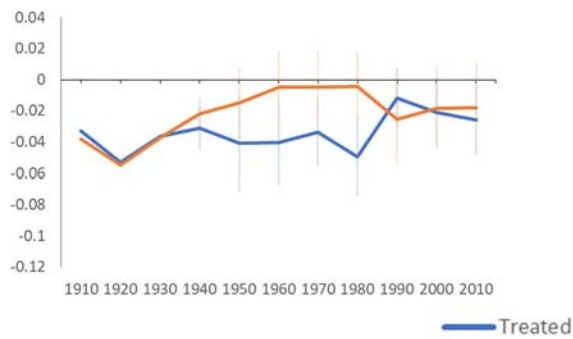
Panel C: High Geocoding Rate Cities, D-C



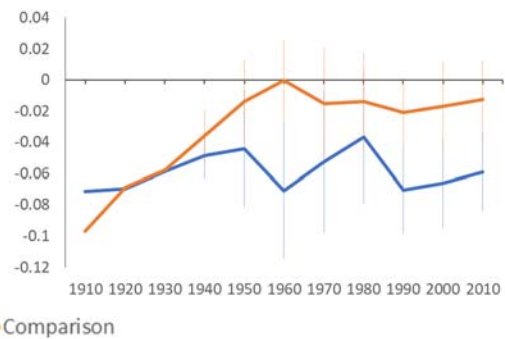
Panel D: High Geocoding Rate Cities, C-B



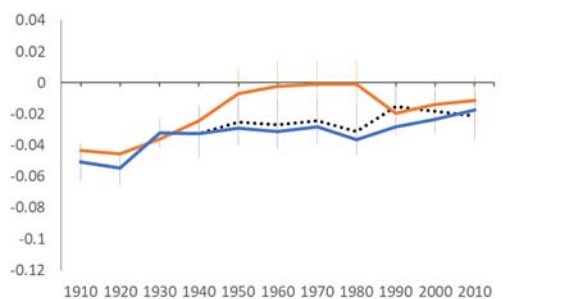
Panel E: Excluding Trains and Rivers, D-C



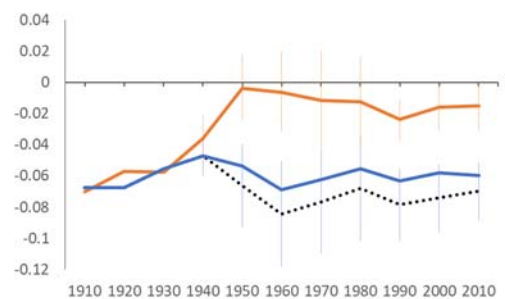
Panel F: Excluding Trains and Rivers, C-B



Panel G: Using Tracts in All Years, D-C



Panel H: Using Tracts in All Years, C-B

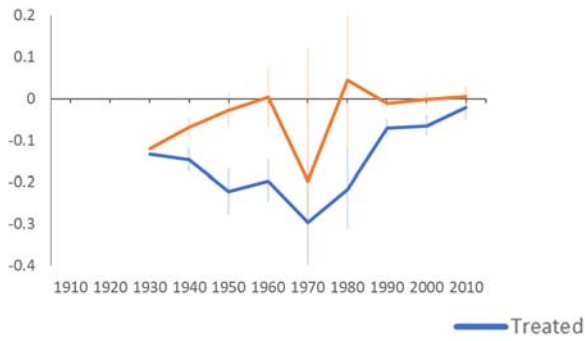


..... Treated, Tract-Adjusted Comparison — Treated, Tracts

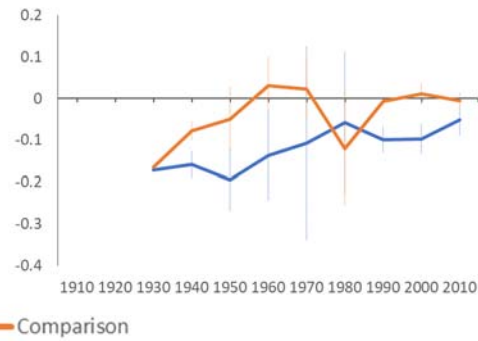
Notes: See notes to Appendix Figure A11.

Appendix Figure A13: Additional Robustness Checks, House Values

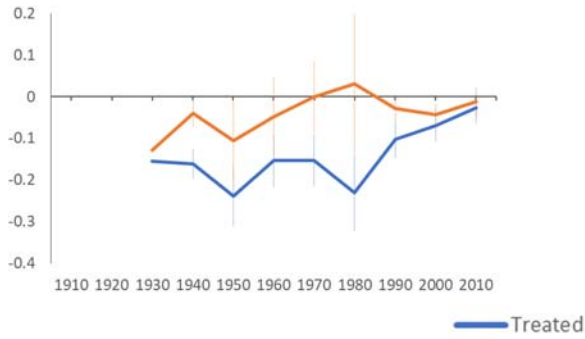
Panel A: 1/8th mile Boundaries, D-C



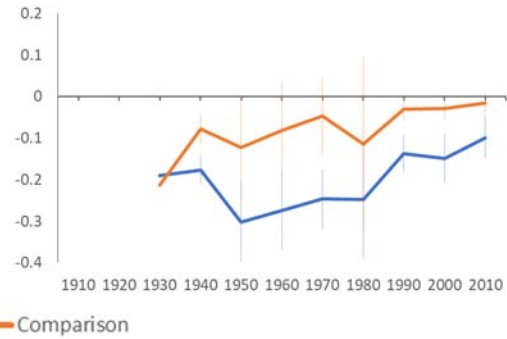
Panel B: 1/8th mile Boundaries, C-B



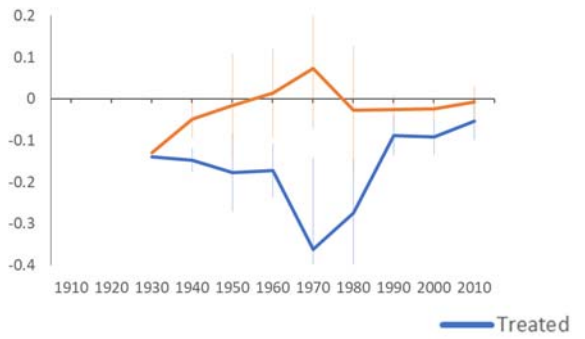
Panel C: High Geocoding Rate Cities, D-C



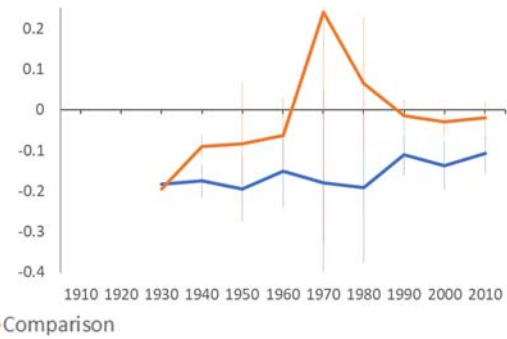
Panel D: High Geocoding Rate Cities, C-B



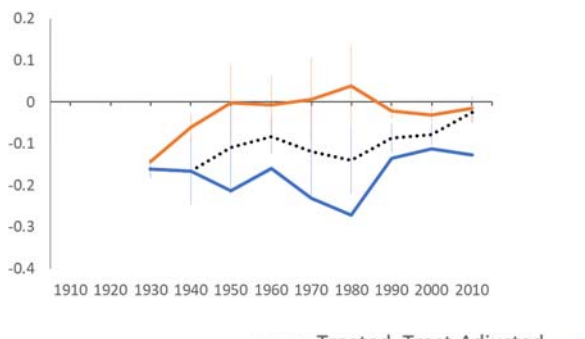
Panel E: Excluding Trains and Rivers, D-C



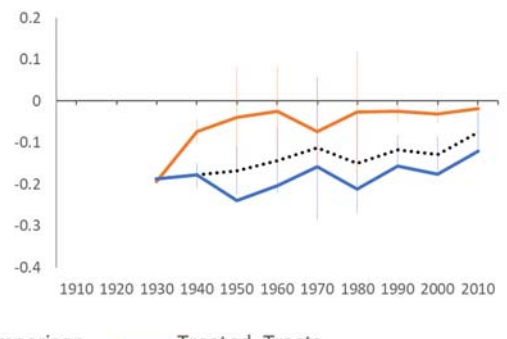
Panel F: Excluding Trains and Rivers, C-B



Panel G: Using Tracts in All Years, D-C



Panel H: Using Tracts in All Years, C-B

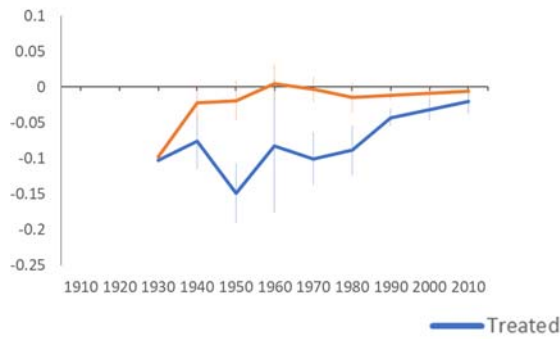


..... Treated, Tract-Adjusted Comparison — Treated, Tracts

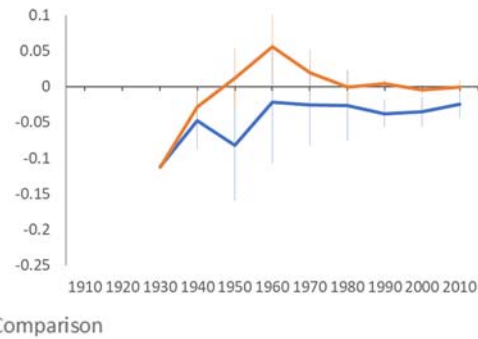
Notes: See notes to Appendix Figure A11.

Appendix Figure A14: Additional Robustness Checks, Rent

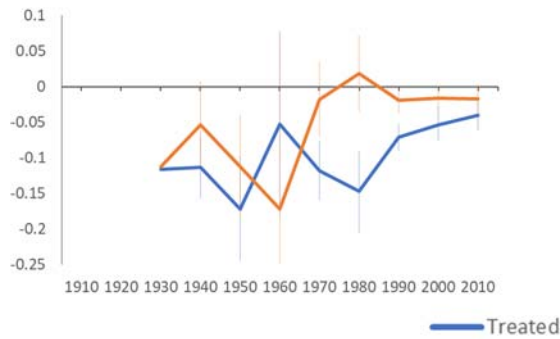
Panel A: 1/8th mile Boundaries, D-C



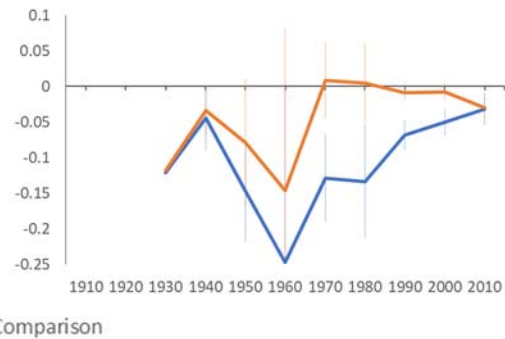
Panel B: 1/8th mile Boundaries, C-B



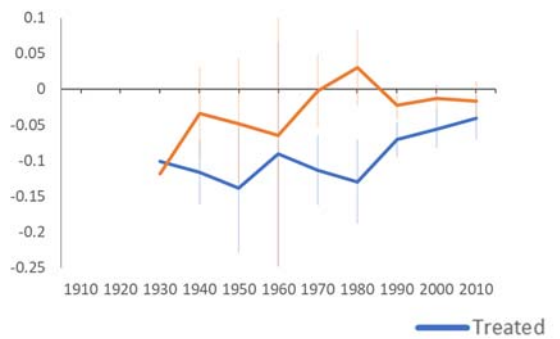
Panel C: High Geocoding Rate Cities, D-C



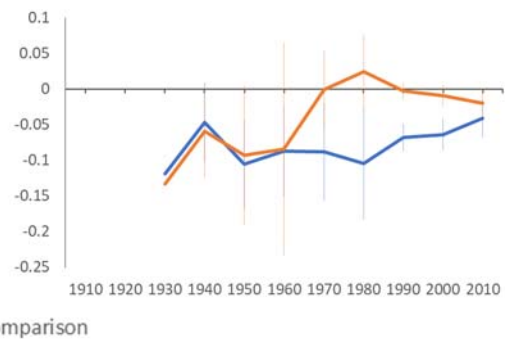
Panel D: High Geocoding Rate Cities, C-B



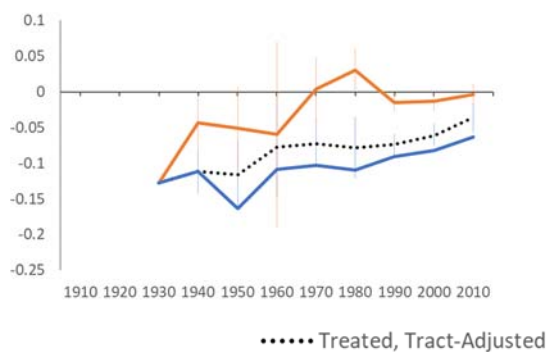
Panel E: Excluding Trains and Rivers, D-C



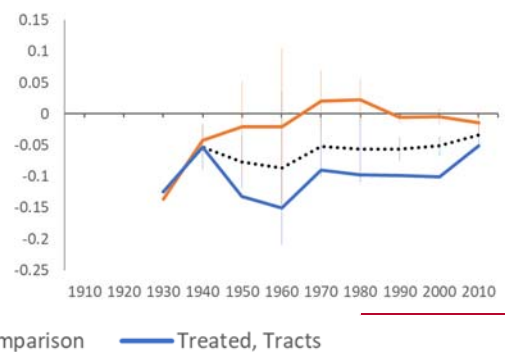
Panel F: Excluding Trains and Rivers, C-B



Panel G: Using Tracts in All Years, D-C



Panel H: Using Tracts in All Years, C-B



..... Treated, Tract-Adjusted Comparison Treated, Tracts

Note: See note to Appendix Figure A11.

Table A1: City Characteristics, 1930

City	1930 Census Variables													
	Pop'n geo'd	Share AA	Home Own	House Values	Share FB	Radio Own	Att. School	Lab F Part.	Rent	Occ. Score	Earn Score	Educ Score	Emp. Rate	Read or Write
Akron, OH	188,793	0.04	0.54	6174	0.13	0.53	0.63	0.60	53	25	51	14	0.82	0.98
Albany, NY	107,893	0.02	0.40	10432	0.14	0.58	0.63	0.60	74	26	55	17	0.84	0.99
Altoona, PA	70,209	0.01	0.61	5449	0.07	0.45	0.61	0.52	54	27	59	14	0.81	0.98
Arlington, MA	31,589	0.00	0.56	9723	0.22	0.74	0.62	0.55	65	28	57	21	0.84	0.99
Asheville, NC	35,807	0.24	0.40	7839	0.02	0.32	0.59	0.61	56	24	46	17	0.80	0.97
Atlanta, GA	161,227	0.27	0.35	6780	0.02	0.31	0.61	0.63	46	24	47	16	0.84	0.97
Atlantic City, NJ	46,508	0.23	0.30	19838	0.16	0.57	0.64	0.63	79	23	43	14	0.81	0.98
Augusta, GA	43,210	0.40	0.29	4983	0.01	0.16	0.57	0.65	39	21	41	12	0.83	0.93
Aurora, IL	39,485	0.02	0.66	6641	0.13	0.71	0.62	0.57	81	26	55	15	0.80	0.98
Baltimore, MD	635,110	0.16	0.56	5421	0.09	0.52	0.56	0.62	53	25	50	14	0.85	0.97
Battle Creek, MI	25,244	0.03	0.60	5845	0.08	0.53	0.63	0.60	72	26	55	15	0.82	0.99
Bay City, MI	36,733	0.00	0.71	2974	0.14	0.49	0.64	0.55	61	26	54	14	0.73	0.97
Belmont, MA	19,988	0.00	0.54	11678	0.22	0.78	0.64	0.55	50	28	56	24	0.88	0.98
Binghamton, NY	61,732	0.01	0.48	7888	0.13	0.50	0.65	0.63	38	25	51	14	0.84	0.97
Birmingham, AL	194,055	0.35	0.39	6109	0.02	0.31	0.57	0.60	47	24	49	15	0.86	0.95
Boston, MA	514,816	0.03	0.29	8504	0.31	0.56	0.66	0.61	69	25	49	15	0.79	0.96
Braintree, MA	12,568	0.00	0.70	5985	0.18	0.77	0.63	0.55	61	27	57	18	0.87	0.99
Bronx, NY	1,072,492	0.01	0.13	13455	0.38	0.65	0.61	0.60	71	26	54	17	0.83	0.96
Brookline, MA	38,951	0.01	0.38	21847	0.27	0.80	0.73	0.57	146	25	47	23	0.83	1.00
Brooklyn, NY	2,191,580	0.03	0.30	11738	0.34	0.59	0.61	0.60	73	26	53	16	0.82	0.95
Buffalo, NY	507,445	0.02	0.47	8354	0.21	0.56	0.62	0.58	50	26	55	15	0.80	0.98
Cambridge, MA	101,103	0.05	0.28	9470	0.29	0.56	0.63	0.61	43	25	50	16	0.80	0.97
Camden, NJ	100,093	0.09	0.51	4903	0.16	0.54	0.60	0.61	67	25	53	12	0.80	0.95
Canton, OH	83,883	0.02	0.56	6348	0.12	0.51	0.61	0.57	44	26	56	15	0.83	0.97
Charleston, WV	31,078	0.11	0.40	10311	0.03	0.46	0.63	0.59	44	26	51	20	0.84	0.98
Charlotte, NC	44,003	0.26	0.35	8803	0.01	0.37	0.53	0.64	51	23	45	15	0.84	0.93
Chattanooga, TN	81,609	0.23	0.36	5638	0.01	0.24	0.54	0.61	31	24	49	14	0.85	0.96
Chelsea, MA	39,184	0.01	0.33	6906	0.38	0.51	0.63	0.58	46	26	52	13	0.79	0.93
Chicago, IL	2,416,387	0.07	0.38	9346	0.26	0.64	0.62	0.61	89	25	53	14	0.80	0.97
Chicopee, MA	40,247	0.00	0.46	5822	0.28	0.44	0.62	0.62	27	25	51	10	0.80	0.95

Table A1: City Characteristics, 1930

City	1930 Census Variables													
	Pop'n geo'd	Share AA	Home Own	House Values	Share FB	Radio Own	Att. School	Lab F Part.	Rent	Occ. Score	Earn Score	Educ Score	Emp. Rate	Read or Write
Cleveland, OH	736,884	0.07	0.42	7305	0.26	0.48	0.65	0.60	46	25	52	13	0.78	0.96
Columbus, GA	34,395	0.28	0.23	6003	0.01	0.17	0.52	0.66	44	22	43	11	0.85	0.93
Columbus, OH	224,650	0.09	0.46	6597	0.05	0.52	0.62	0.59	43	26	54	16	0.82	0.99
Dallas, TX	182,283	0.11	0.42	6224	0.04	0.45	0.55	0.62	51	25	51	18	0.85	0.98
Dayton, OH	143,851	0.08	0.50	6285	0.06	0.58	0.62	0.60	50	26	53	15	0.83	0.99
Decatur, IL	47,825	0.03	0.56	5238	0.04	0.50	0.59	0.57	38	26	54	16	0.82	0.99
Dedham, MA	12,036	0.00	0.67	6588	0.23	0.63	0.64	0.58	60	25	53	16	0.85	0.98
Denver, CO	248,476	0.03	0.48	5421	0.11	0.53	0.63	0.58	41	26	52	19	0.81	0.99
Detroit, MI	1,058,107	0.05	0.49	8977	0.26	0.60	0.61	0.60	73	26	55	13	0.80	0.98
Duluth, MN	69,910	0.00	0.59	6155	0.23	0.53	0.67	0.57	31	26	53	17	0.77	0.99
Durham, NC	30,791	0.27	0.33	6097	0.01	0.22	0.53	0.67	36	24	47	13	0.85	0.95
East Hartford, CT	14,886	0.01	0.50	8098	0.18	0.62	0.61	0.60	33	26	53	14	0.82	0.97
East St. Louis, IL	58,444	0.17	0.45	4350	0.06	0.43	0.58	0.58	41	26	54	13	0.80	0.98
Elmira, NY	39,621	0.01	0.53	6523	0.09	0.47	0.66	0.58	38	26	54	16	0.79	0.98
Erie, PA	99,410	0.01	0.52	7731	0.15	0.51	0.61	0.56	85	26	53	14	0.83	0.97
Essex County, NJ	669,167	0.07	0.42	12616	0.22	0.66	0.63	0.60	51	26	53	17	0.82	0.97
Evansville, IN	75,901	0.06	0.46	4149	0.02	0.34	0.60	0.58	38	25	52	13	0.83	0.99
Everett, MA	43,906	0.02	0.44	6321	0.29	0.65	0.59	0.58	48	26	54	14	0.81	0.97
Flint, MI	102,596	0.02	0.64	5096	0.14	0.55	0.60	0.59	57	26	55	12	0.83	0.99
Fort Wayne, IN	93,848	0.02	0.60	6398	0.05	0.64	0.60	0.59	35	27	56	15	0.83	0.99
Fresno, CA	28,727	0.01	0.50	5075	0.21	0.38	0.67	0.56	37	26	51	19	0.79	0.96
Gary, IN	86,873	0.19	0.44	7264	0.21	0.46	0.62	0.59	62	25	54	12	0.88	0.95
Grand Rapids, MI	117,085	0.02	0.64	5689	0.16	0.50	0.65	0.57	45	26	54	16	0.78	0.98
Greensboro, NC	30,773	0.24	0.47	7648	0.01	0.32	0.56	0.62	36	24	48	17	0.85	0.97
Hamilton, OH	44,014	0.03	0.55	5140	0.04	0.51	0.54	0.57	35	26	55	12	0.84	0.98
Haverhill, MA	42,292	0.01	0.46	5423	0.22	0.51	0.64	0.62	47	25	48	12	0.76	0.97
Holyoke, MA	49,464	0.00	0.27	11802	0.29	0.52	0.68	0.61	34	25	51	13	0.80	0.97
Hudson County, NJ	507,548	0.03	0.29	9256	0.26	0.62	0.61	0.62	84	26	54	14	0.84	0.96
Indianapolis, IN	277,757	0.10	0.44	5881	0.04	0.49	0.59	0.60	63	26	53	16	0.83	0.99
Jacksonville, FL	84,535	0.31	0.35	6927	0.04	0.29	0.58	0.61	31	24	47	16	0.84	0.97

Table A1: City Characteristics, 1930

City	1930 Census Variables													
	Pop'n geo'd	Share AA	Home Own	House Values	Share FB	Radio Own	Att. School	Lab F Part.	Rent	Occ. Score	Earn Score	Educ Score	Emp. Rate	Read or Write
Johnson City, NY	11,678	0.00	0.54	6128	0.07	0.53	0.61	0.66	33	25	49	10	0.83	0.99
Johnstown, PA	52,542	0.02	0.45	6238	0.14	0.40	0.61	0.54	37	25	52	14	0.86	0.96
Joliet, IL	23,480	0.03	0.51	8027	0.16	0.60	0.62	0.57	44	26	55	17	0.82	0.99
Kalamazoo, MI	36,932	0.01	0.66	6181	0.11	0.58	0.66	0.57	45	26	54	18	0.83	1.00
Kansas City, MO	319,031	0.09	0.44	6600	0.07	0.52	0.64	0.61	52	26	52	17	0.85	0.99
Kenosha, WI	45,374	0.00	0.60	7686	0.24	0.63	0.68	0.58	46	25	53	12	0.78	0.96
Knoxville, TN	48,395	0.12	0.42	5279	0.01	0.29	0.56	0.60	42	26	52	16	0.83	0.97
Lexington, KY	35,158	0.27	0.37	6057	0.01	0.31	0.60	0.60	30	23	44	16	0.81	0.96
Lexington, MA	7,490	0.00	0.75	9028	0.20	0.75	0.64	0.55	215	25	50	19	0.87	0.98
Lima, OH	37,340	0.03	0.47	4914	0.04	0.47	0.62	0.58	43	26	55	15	0.84	0.99
Lorain, OH	39,324	0.02	0.62	5137	0.28	0.41	0.62	0.58	46	25	54	11	0.81	0.94
Louisville, KY	241,349	0.13	0.45	5459	0.03	0.37	0.57	0.59	57	25	51	15	0.82	0.98
Lynchburg, VA	31,821	0.23	0.47	5290	0.01	0.24	0.57	0.62	31	24	47	14	0.80	0.95
Macon, GA	18,559	0.34	0.28	4976	0.01	0.18	0.55	0.64	68	23	45	14	0.81	0.95
Madison, WI	51,536	0.00	0.56	8778	0.09	0.65	0.66	0.57	64	27	54	21	0.82	0.99
Malden, MA	53,282	0.01	0.47	6168	0.28	0.66	0.61	0.58	47	26	54	16	0.81	0.98
Manchester, NH	61,731	0.00	0.37	5502	0.29	0.41	0.62	0.64	53	25	49	12	0.79	0.97
Medford, MA	56,087	0.01	0.54	7536	0.23	0.73	0.60	0.57	59	27	56	17	0.84	0.98
Melrose, MA	19,787	0.00	0.67	7033	0.17	0.78	0.65	0.54	65	27	57	22	0.84	1.00
Miami, FL	69,057	0.19	0.35	5993	0.12	0.27	0.58	0.61	60	24	48	17	0.75	0.97
Milton, MA	12,285	0.00	0.69	12359	0.21	0.81	0.68	0.56	50	25	51	21	0.85	1.00
Milwaukee, WI	242,173	0.02	0.46	6719	0.20	0.65	0.66	0.59	52	26	55	14	0.83	0.98
Minneapolis, MN	363,688	0.01	0.51	6070	0.17	0.62	0.67	0.59	53	26	53	18	0.83	0.99
Mobile, AL	47,529	0.33	0.41	4997	0.03	0.22	0.56	0.60	48	23	46	14	0.84	0.94
Montgomery, AL	26,798	0.32	0.33	6288	0.02	0.24	0.57	0.63	29	23	46	16	0.86	0.93
Muncie, IN	34,855	0.06	0.51	4314	0.01	0.47	0.57	0.56	31	26	54	14	0.82	0.99
Muskegon, MI	28,208	0.01	0.61	4640	0.14	0.55	0.66	0.59	43	26	54	15	0.79	0.99
Needham, MA	6,709	0.00	0.73	10936	0.20	0.78	0.66	0.54	63	27	55	22	0.85	0.98
New Britain, CT	61,671	0.01	0.38	9356	0.31	0.41	0.64	0.61	36	26	54	13	0.83	0.92
New Castle, PA	41,741	0.02	0.60	5402	0.16	0.42	0.62	0.53	39	26	54	14	0.78	0.94

Table A1: City Characteristics, 1930

City	1930 Census Variables													
	Pop'n geo'd	Share AA	Home Own	House Values	Share FB	Radio Own	Att. School	Lab F Part.	Rent	Occ. Score	Earn Score	Educ Score	Emp. Rate	Read or Write
New Haven, CT	136,643	0.03	0.35	10769	0.25	0.55	0.64	0.60	45	26	53	16	0.81	0.96
New Orleans, LA	378,493	0.27	0.30	7107	0.04	0.23	0.58	0.60	48	23	47	14	0.81	0.95
New York, NY	1,420,354	0.11	0.04	42199	0.38	0.46	0.62	0.66	88	23	45	15	0.83	0.94
Newport News, VA	25,862	0.34	0.38	4028	0.04	0.33	0.55	0.60	27	26	55	14	0.90	0.96
Newton, MA	16,306	0.01	0.57	12314	0.25	0.69	0.67	0.58	95	25	49	18	0.82	0.98
Niagara Falls, NY	65,818	0.01	0.50	7505	0.33	0.59	0.65	0.59	43	26	55	14	0.84	0.95
Norfolk, VA	76,526	0.29	0.40	5795	0.04	0.38	0.60	0.60	38	25	50	17	0.84	0.96
Oakland, CA	218,891	0.03	0.53	6026	0.19	0.60	0.66	0.57	46	27	55	18	0.80	0.98
Oshkosh, WI	15,475	0.00	0.64	5568	0.12	0.57	0.67	0.55	45	25	51	16	0.79	0.99
Philadelphia, PA	1,623,342	0.11	0.55	6372	0.20	0.57	0.60	0.62	94	25	51	14	0.82	0.97
Pittsburgh, PA	518,768	0.07	0.46	8994	0.16	0.55	0.61	0.58	65	25	50	15	0.80	0.98
Pontiac, MI	47,428	0.04	0.54	6186	0.14	0.53	0.60	0.62	70	25	53	13	0.73	0.98
Portland, OR	42,912	0.01	0.49	5709	0.16	0.58	0.67	0.61	40	26	51	19	0.79	0.99
Portsmouth, OH	32,464	0.04	0.51	5353	0.02	0.40	0.58	0.57	35	26	55	14	0.83	0.98
Poughkeepsie, NY	34,674	0.03	0.39	9636	0.14	0.59	0.61	0.59	46	26	54	16	0.83	0.97
Queens, NY	837,973	0.02	0.51	9986	0.25	0.76	0.60	0.60	84	27	56	17	0.86	0.98
Quincy, MA	65,037	0.00	0.56	6658	0.25	0.72	0.59	0.58	44	27	58	18	0.86	0.98
Racine, WI	58,532	0.01	0.60	7300	0.21	0.69	0.68	0.58	59	26	56	14	0.83	0.98
Revere, MA	32,016	0.00	0.46	5797	0.27	0.64	0.62	0.56	48	26	55	15	0.79	0.95
Richmond, VA	140,735	0.25	0.37	7659	0.02	0.39	0.60	0.61	48	25	50	16	0.84	0.97
Roanoke, VA	42,518	0.19	0.47	5681	0.01	0.28	0.58	0.58	34	24	50	12	0.84	0.97
Rochester, NY	284,366	0.01	0.58	8052	0.23	0.57	0.67	0.60	68	26	54	16	0.80	0.96
Rockford, IL	77,126	0.01	0.53	7600	0.22	0.62	0.61	0.60	92	26	55	14	0.81	0.98
Sacramento, CA	71,415	0.01	0.50	5698	0.16	0.56	0.66	0.59	40	26	53	18	0.80	0.97
Saginaw, MI	47,237	0.03	0.64	4296	0.15	0.56	0.63	0.57	37	26	54	15	0.78	0.98
San Diego, CA	117,541	0.02	0.49	6409	0.15	0.55	0.64	0.53	34	25	51	19	0.74	0.99
San Francisco, CA	485,501	0.01	0.39	8247	0.27	0.51	0.64	0.61	71	26	52	18	0.82	0.98
San Jose, CA	42,403	0.00	0.60	5193	0.18	0.58	0.69	0.53	47	25	51	18	0.74	0.95
Saugus, MA	12,578	0.01	0.75	4866	0.20	0.74	0.60	0.57	47	27	57	15	0.82	0.98
Schenectady, NY	65,710	0.01	0.51	8295	0.20	0.59	0.68	0.58	43	27	58	18	0.84	0.97

Table A1: City Characteristics, 1930

City	1930 Census Variables													
	Pop'n geo'd	Share AA	Home Own	House Values	Share FB	Radio Own	Att. School	Lab F Part.	Rent	Occ. Score	Earn Score	Educ Score	Emp. Rate	Read or Write
Seattle, WA	265,620	0.01	0.53	5422	0.21	0.55	0.67	0.59	47	26	54	18	0.82	0.99
Somerville, MA	93,503	0.00	0.36	7044	0.29	0.64	0.60	0.59	46	26	54	15	0.82	0.97
South Bend, IN	77,632	0.03	0.62	6006	0.14	0.52	0.60	0.60	71	26	53	14	0.76	0.98
Spokane, WA	70,583	0.01	0.62	3768	0.14	0.52	0.65	0.58	33	26	53	18	0.80	0.99
Springfield, IL	57,261	0.04	0.57	5425	0.09	0.50	0.62	0.60	45	25	52	15	0.78	0.98
Springfield, MO	41,132	0.02	0.52	4162	0.02	0.28	0.61	0.54	24	26	54	17	0.81	0.99
Springfield, OH	55,778	0.11	0.48	5413	0.03	0.56	0.62	0.58	50	26	54	14	0.81	0.99
St. Joseph, MO	61,335	0.05	0.43	4172	0.05	0.49	0.62	0.58	30	25	51	15	0.83	0.99
St. Louis, MO	665,880	0.08	0.36	7254	0.10	0.53	0.59	0.60	58	25	52	15	0.83	0.98
St. Petersburg, FL	30,831	0.17	0.49	6194	0.06	0.25	0.64	0.51	26	24	48	18	0.67	0.98
Stamford, CT	36,991	0.03	0.43	11729	0.27	0.62	0.60	0.60	62	25	52	14	0.84	0.95
Staten Island ,NY	132,112	0.02	0.56	8327	0.25	0.67	0.64	0.59	56	27	57	17	0.84	0.97
Stockton, CA	34,605	0.01	0.46	5334	0.17	0.53	0.67	0.59	35	26	52	18	0.79	0.98
Syracuse, NY	173,151	0.01	0.49	10068	0.17	0.57	0.66	0.59	49	27	55	17	0.80	0.97
Tacoma, WA	70,786	0.01	0.63	3500	0.19	0.52	0.64	0.57	61	26	53	16	0.81	0.99
Tampa, FL	66,802	0.16	0.40	4046	0.16	0.16	0.58	0.62	25	24	47	13	0.79	0.96
Terre Haute, IN	52,646	0.05	0.49	4345	0.05	0.44	0.67	0.56	39	26	53	16	0.75	0.99
Toledo, OH	250,820	0.04	0.53	6688	0.12	0.62	0.63	0.59	49	26	55	14	0.80	0.98
Troy, NY	58,090	0.01	0.40	6558	0.14	0.53	0.65	0.61	83	26	53	15	0.82	0.98
Utica, NY	82,770	0.00	0.48	7994	0.21	0.48	0.66	0.60	43	26	52	14	0.79	0.94
Waltham, MA	31,475	0.00	0.42	7830	0.27	0.65	0.62	0.60	53	26	53	14	0.83	0.98
Warren, OH	29,274	0.05	0.57	6080	0.16	0.48	0.63	0.57	49	26	56	14	0.83	0.97
Watertown, MA	31,759	0.00	0.46	9267	0.28	0.67	0.61	0.59	50	27	55	17	0.83	0.98
Wheeling, WV	45,311	0.03	0.46	7169	0.08	0.50	0.58	0.57	36	25	52	16	0.81	0.98
Wichita, KS	62,996	0.03	0.48	4726	0.02	0.40	0.65	0.57	38	26	53	18	0.83	0.99
Winchester, MA	11,489	0.02	0.69	11351	0.19	0.76	0.67	0.54	80	25	50	20	0.84	0.98
Winston-Salem, NC	44,493	0.31	0.38	8166	0.01	0.22	0.53	0.67	25	24	48	13	0.84	0.94
Winthrop, MA	14,977	0.00	0.55	8466	0.21	0.76	0.67	0.55	78	28	58	23	0.84	0.99
Youngstown, OH	136,985	0.07	0.57	6055	0.20	0.46	0.65	0.56	47	26	55	14	0.78	0.96

Table A2: Rates of Geocode Matching

	1910	1920	1930	1940
Share of population with a non-missing address	73%	72%	99%	82%
Share of population successfully geocoded	49%	50%	79%	62%
Share of non-missing addresses successfully geocoded	63%	68%	79%	74%

Table A3: Effects of D versus C Grade, Home Ownership

Sample Type	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	HOLC Neighborhoods		1/4 Mile D-C Boundaries				
Year	D-C	D-C	D-C	D-C	Grid C.F's	Triple Diff	Low PS D-C
1910	-0.124 (0.012)	-0.118 (0.01)	-0.052 (0.006)	-0.051 (0.006)	-0.043 (0.007)	-0.011 (0.009)	-0.007 (0.008)
1920	-0.137 (0.011)	-0.128 (0.007)	-0.055 (0.006)	-0.055 (0.006)	-0.046 (0.006)	-0.013 (0.006)	-0.022 (0.007)
1930	-0.110 (0.012)	-0.101 (0.007)	-0.033 (0.005)	-0.032 (0.005)	-0.036 (0.006)	-- --	-0.010 (0.005)
1940	-0.105 (0.011)	-0.097 (0.007)	-0.034 (0.005)	-0.032 (0.005)	-0.024 (0.005)	-0.012 (0.005)	-0.015 (0.006)
1950	-0.136 (0.023)	-0.117 (0.009)	-0.039 (0.011)	-0.029 (0.01)	-0.007 (0.008)	-0.026 (0.013)	-0.029 (0.01)
1960	-0.141 (0.021)	-0.115 (0.009)	-0.041 (0.009)	-0.031 (0.008)	-0.002 (0.008)	-0.033 (0.012)	-0.034 (0.01)
1970	-0.120 (0.017)	-0.096 (0.009)	-0.035 (0.01)	-0.028 (0.008)	-0.001 (0.008)	-0.031 (0.012)	-0.028 (0.009)
1980	-0.112 (0.019)	-0.086 (0.009)	-0.050 (0.011)	-0.036 (0.008)	-0.001 (0.008)	-0.040 (0.013)	-0.034 (0.009)
1990	-0.076 (0.01)	-0.067 (0.006)	-0.016 (0.007)	-0.015 (0.007)	-0.020 (0.007)	0.000 (0.008)	-0.008 (0.008)
2000	-0.073 (0.01)	-0.065 (0.007)	-0.017 (0.007)	-0.018 (0.007)	-0.014 (0.006)	-0.008 (0.009)	-0.012 (0.009)
2010	-0.072 (0.009)	-0.063 (0.007)	-0.020 (0.007)	-0.021 (0.008)	-0.011 (0.008)	-0.014 (0.008)	-0.019 (0.011)
<i>Cities</i>	<i>148</i>	<i>148</i>	<i>115</i>	<i>115</i>	<i>115</i>	<i>115</i>	<i>97</i>
<i>Neighborhoods</i>	<i>3,522</i>	<i>3,554</i>	--	--	--	--	--
<i>Boundaries</i>	--	--	--	<i>1,133</i>	<i>4,214</i>	<i>5,347</i>	<i>567</i>
<i>N</i>	<i>27,786</i>	<i>27,786</i>	<i>16,663</i>	<i>16,663</i>	<i>61,305</i>	<i>77,968</i>	<i>8,510</i>
<i>R2</i>	<i>0.071</i>	<i>0.285</i>	<i>0.287</i>	<i>0.616</i>	<i>0.598</i>	<i>0.602</i>	<i>0.64</i>
<i>F.E.</i>	<i>None</i>	<i>City</i>	<i>City</i>	<i>Bound.</i>	<i>Bound.</i>	<i>Bound.</i>	<i>Bound.</i>

Notes: Table entries are from regressions that estimate the gaps between D and C rated neighborhoods in Home Ownership. See notes to Table 2.

Table A4: Effect of D versus C grade, Log House Values

Sample Type	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	HOLC Neighborhoods		1/4 Mile D-C Boundaries				
Year	D-C	D-C	D-C	D-C	Grid C.F's	Triple Diff	Low PS D-C
1910							
1920							
1930	-0.307 (0.051)	-0.283 (0.032)	-0.159 (0.011)	-0.161 (0.012)	-0.144 (0.019)	-- --	-0.054 (0.016)
1940	-0.355 (0.039)	-0.327 (0.026)	-0.166 (0.012)	-0.166 (0.013)	-0.060 (0.017)	-0.089 (0.02)	-0.095 (0.014)
1950	-0.341 (0.044)	-0.303 (0.031)	-0.202 (0.03)	-0.213 (0.028)	-0.001 (0.045)	-0.195 (0.057)	-0.151 (0.037)
1960	-0.239 (0.054)	-0.238 (0.028)	-0.156 (0.024)	-0.161 (0.022)	-0.006 (0.036)	-0.137 (0.052)	-0.108 (0.031)
1970	-0.394 (0.08)	-0.399 (0.117)	-0.230 (0.054)	-0.231 (0.057)	0.007 (0.05)	-0.220 (0.081)	-0.248 (0.089)
1980	-0.293 (0.033)	-0.293 (0.034)	-0.257 (0.042)	-0.272 (0.04)	0.038 (0.049)	-0.293 (0.081)	-0.220 (0.067)
1990	-0.191 (0.055)	-0.174 (0.025)	-0.088 (0.017)	-0.087 (0.017)	-0.022 (0.009)	-0.048 (0.025)	-0.065 (0.019)
2000	-0.169 (0.048)	-0.151 (0.021)	-0.083 (0.012)	-0.079 (0.013)	-0.031 (0.01)	-0.032 (0.022)	-0.040 (0.02)
2010	-0.112 (0.058)	-0.099 (0.026)	-0.024 (0.014)	-0.026 (0.013)	-0.016 (0.015)	0.007 (0.031)	0.003 (0.015)
<i>Cities</i>	<i>148</i>	<i>148</i>	<i>115</i>	<i>115</i>	<i>115</i>	<i>115</i>	<i>97</i>
<i>Neighborhoods</i>	<i>2,798</i>	<i>3,542</i>	--	--	--	--	--
<i>Boundaries</i>	--	--	--	<i>1,133</i>	<i>4,214</i>	<i>5,347</i>	<i>567</i>
<i>N</i>	<i>22,152</i>	<i>22,152</i>	<i>11,620</i>	<i>11,620</i>	<i>41,645</i>	<i>53,265</i>	<i>6,005</i>
<i>R2</i>	<i>0.195</i>	<i>0.564</i>	<i>0.505</i>	<i>0.625</i>	<i>0.622</i>	<i>0.623</i>	<i>0.614</i>
<i>F.E.</i>	<i>None</i>	<i>City</i>	<i>City</i>	<i>Bound.</i>	<i>Bound.</i>	<i>Bound.</i>	<i>Bound.</i>

Notes: Table entries are from regressions that estimate the gaps between D and C rated neighborhoods in Log House Values. See notes to Table 2.

Table A5: Effect of D versus C Grade, Log Monthly Contract Rents

Sample Type	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	HOLC Neighborhoods		1/4 Mile D-C Boundaries				
Year	D-C	D-C	D-C	D-C	Grid C.F's	Triple Diff	Low PS D-C
1910							
1920							
1930	-0.315 (0.03)	-0.286 (0.025)	-0.126 (0.01)	-0.128 (0.01)	-0.127 (0.019)	-- --	-0.050 (0.013)
1940	-0.285 (0.036)	-0.254 (0.028)	-0.110 (0.016)	-0.111 (0.016)	-0.044 (0.018)	-0.067 (0.022)	-0.040 (0.019)
1950	-0.291 (0.026)	-0.259 (0.028)	-0.170 (0.025)	-0.164 (0.024)	-0.051 (0.03)	-0.113 (0.044)	-0.132 (0.022)
1960	-0.284 (0.066)	-0.256 (0.052)	-0.112 (0.036)	-0.109 (0.036)	-0.060 (0.066)	-0.049 (0.096)	-0.095 (0.057)
1970	-0.228 (0.024)	-0.206 (0.02)	-0.107 (0.019)	-0.103 (0.017)	0.003 (0.024)	-0.106 (0.034)	-0.086 (0.017)
1980	-0.218 (0.031)	-0.201 (0.02)	-0.109 (0.022)	-0.110 (0.022)	0.030 (0.015)	-0.140 (0.033)	-0.064 (0.019)
1990	-0.180 (0.025)	-0.155 (0.011)	-0.072 (0.009)	-0.074 (0.008)	-0.015 (0.007)	-0.059 (0.02)	-0.054 (0.009)
2000	-0.140 (0.025)	-0.116 (0.011)	-0.060 (0.007)	-0.061 (0.008)	-0.013 (0.007)	-0.048 (0.019)	-0.055 (0.011)
2010	-0.090 (0.029)	-0.066 (0.013)	-0.034 (0.011)	-0.036 (0.011)	-0.003 (0.007)	-0.033 (0.023)	-0.032 (0.016)
<i>Cities</i>	148	148	115	115	115	115	97
<i>Neighborhoods</i>	667	3,542	--	--	--	--	--
<i>Boundaries</i>	--	--	--	1,133	4,214	5,347	567
<i>N</i>	22,291	22,291	12,098	12,098	44,281	56,379	6,235
<i>R2</i>	0.188	0.424	0.425	0.53	0.54	0.538	0.533
<i>F.E.</i>	None	City	City	Bound.	Bound.	Bound.	Bound.

Notes: Table entries are from regressions that estimate the gaps between D and C rated neighborhoods in Log Rents. See notes to Table 2.

Table A6: Summary Statistics of Cities Around the 40,000 Population Cutoff

Non-Redlined Cities

City	Mean Characteristics								
	1930 Pop'n	1930				1980			
		Share AA	Home Own	Log Rent	Log H Value	Share AA	Home Own	Log Rent	Log H Value
Baton Rouge, LA	30,729	0.35	0.38	5.54	10.83	0.36	0.54	6.33	11.90
Bellingham, WA	30,823	0.00	0.65	5.54	10.55	0.00	0.54	6.38	11.94
Hagerstown, MD	30,861	0.05	0.37	5.72	11.06	0.06	0.43	6.04	11.50
Fort Smith, AR	31,429	0.11	0.44	5.43	10.55	0.07	0.61	6.07	11.42
Pensacola, FL	31,579	0.31	0.36	5.02	10.55	0.34	0.66	6.10	11.53
Meridian, MS	31,954	0.37	0.40	4.84	10.40	0.37	0.60	5.72	11.36
Muskogee, OK	32,026	0.21	0.45	5.54	10.36	0.18	0.67	5.92	11.26
Watertown, NY	32,205	0.00	0.49	5.87	11.06	0.00	0.51	6.04	11.31
Moline, IL	32,236	0.01	0.53	5.76	11.06	0.01	0.65	6.38	11.83
Wilmington, NC	32,270	0.41	0.40	5.02	10.55	0.39	0.47	5.93	11.20
Tucson, AZ	32,506	0.03	0.40	5.94	10.95	0.04	0.60	6.39	11.85
Laredo, TX	32,618	0.00	0.45	4.33	9.45	0.00	0.60	5.84	11.27
Colorado Springs, CO	33,237	0.03	0.54	5.54	10.70	0.06	0.59	6.33	11.99
Sioux Falls, SD	33,362	0.00	0.47	5.94	10.95	0.00	0.60	6.31	11.80
Joplin, MO	33,454	0.01	0.55	5.31	10.14	0.02	0.64	5.93	11.17
Mansfield, OH	33,525	0.03	0.54	5.94	11.24	0.16	0.61	6.05	11.39
Paducah, KY	33,541	0.20	0.38	5.18	10.14	0.19	0.59	5.79	11.25
Santa Barbara, CA	33,613	0.02	0.44	6.01	11.24	0.02	0.42	6.70	12.81
Lewiston, ME	34,948	0.00	0.34	5.63	11.15	0.00	0.47	6.13	11.58
Zanesville, OH	36,440	0.05	0.56	5.54	10.70	0.10	0.59	5.93	11.17
Hazleton, PA	36,765	0.00	0.44	5.94	11.06	0.00	0.61	5.96	11.16
San Bernardino, CA	37,481	0.01	0.53	5.76	10.83	0.15	0.59	6.30	11.89
Rock Island, IL	37,953	0.02	0.52	5.87	11.00	0.15	0.63	6.19	11.73
Quincy, IL	39,241	0.03	0.52	5.54	10.83	0.04	0.65	5.96	11.49
Butte, MT	39,532	0.00	0.40	5.76	10.14				
La Crosse, WI	39,614	0.00	0.55	5.63	10.78	0.00	0.55	6.23	11.72
<i>Mean</i>		0.09	0.46	5.54	10.70	0.11	0.58	6.12	11.58

Table A6: Summary Statistics of Cities Around the 40,000 Population Cutoff, cont.

Redlined Cities

City	Mean Characteristics								
	1930 Pop'n	1930				1980			
		Share AA	Home Own	Log Rent	Log H Value	Share AA	Home Own	Log Rent	Log H Value
Oshkosh, WI	40,108	0.00	0.68	5.76	10.83	0.01	0.61	6.15	11.60
Poughkeepsie, NY	40,288	0.03	0.37	5.94	11.59	0.26	0.38	6.22	11.63
St. Petersburg, FL	40,425	0.18	0.50	5.54	11.06	0.17	0.65	6.23	11.51
Lynchburg, VA	40,661	0.24	0.45	5.25	10.70	0.24	0.62	6.06	11.55
Warren, OH	41,062	0.06	0.54	6.10	11.15	0.18	0.62	6.09	11.50
Muskegon, MI	41,390	0.01	0.61	5.76	10.78	0.21	0.59	6.07	10.92
Lima, OH	42,287	0.03	0.46	5.63	10.83	0.20	0.62	6.04	11.33
Portsmouth, OH	42,560	0.04	0.46	5.63	11.06	0.05	0.60	5.84	11.23
Joliet, IL	42,993	0.03	0.53	5.94	11.32	0.20	0.61	6.24	11.75
Columbus, GA	43,131	0.33	0.24	5.02	10.83	0.34	0.57	5.90	11.36
Perth Amboy, NJ	43,516	0.02	0.41	5.87	11.39	0.08	0.44	6.37	11.66
Battle Creek, MI	43,573	0.04	0.58	5.94	11.06	0.23	0.59	6.15	10.96
Chicopee, MA	43,930	0.00	0.43	5.68	11.06	0.01	0.58	6.08	11.47
Lorain, OH	44,512	0.02	0.58	5.87	11.06	0.12	0.65	6.19	11.70
Jamestown, NY	45,155	0.01	0.54	5.76	11.24	0.03	0.55	5.97	11.26
Lexington, KY	45,736	0.29	0.36	5.54	10.95	0.13	0.53	6.34	11.87
Chelsea, MA	45,816	0.01	0.28	5.94	11.24	0.03	0.27	6.11	11.50
Stamford, CT	46,346	0.05	0.37	6.10	11.75	0.15	0.55	6.69	12.63
Muncie, IN	46,548	0.06	0.51	5.72	10.83	0.10	0.62	6.07	11.20
Aurora, IL	46,589	0.02	0.64	6.10	11.24	0.10	0.62	6.41	11.83
Bay City, MI	47,355	0.00	0.70	5.43	10.36	0.01	0.73	6.19	11.27
Elmira, NY	47,397	0.01	0.51	5.76	11.24	0.10	0.50	6.09	11.28
Brookline, MA	47,490	0.01	0.32	6.63	12.16	0.02	0.33	6.84	12.50
Stockton, CA	47,963	0.01	0.45	5.76	10.83	0.11	0.52	6.26	11.95
Everett, MA	48,424	0.02	0.40	6.01	11.24	0.02	0.41	6.21	11.84
Haverhill, MA	48,710	0.01	0.45	5.80	11.06	0.01	0.51	6.27	11.65
New Castle, PA	48,764	0.03	0.57	5.76	11.06	0.07	0.65	5.91	11.18
<i>Mean</i>		0.06	0.48	5.79	11.11	0.12	0.55	6.18	11.56

Table A7: Assessing HOLC Grading Criteria

Coefficients	(1) (2)		(3)	(4)	(5)	(6)	(7)	(8)				
	Ordered Logit								Probit			
	ABCD	ABCD							DC	DC	CB	CB
Share AA	2.824 (1.233)	1.510 (1.521)	2.742 (0.870)	2.093 (1.125)	-2.857 (1.146)	-3.531 (1.398)	-5.514 (1.262)	-10.147 (2.283)				
Share Home Own	-6.600 (0.594)	-7.590 (0.737)	-3.353 (0.428)	-4.523 (0.529)	-3.966 (0.485)	-4.818 (0.593)	-3.786 (0.565)	-3.857 (0.753)				
Log House Value	-3.057 (0.225)	-3.319 (0.268)	-1.570 (0.239)	-1.936 (0.218)	-1.474 (0.178)	-2.005 (0.189)	-1.598 (0.195)	-1.676 (0.281)				
Log Rent	-0.154 (0.080)	-0.163 (0.091)	-0.095 (0.060)	-0.071 (0.072)	-0.118 (0.061)	-0.145 (0.075)	0.064 (0.073)	0.035 (0.092)				
Occscore	-4.318 (1.166)	-6.012 (1.246)	-0.514 (1.091)	-2.231 (1.177)	-1.593 (0.968)	-3.875 (1.215)	-3.004 (1.055)	-2.971 (1.258)				
Employment	-0.139 (0.031)	-0.148 (0.038)	-0.143 (0.041)	-0.203 (0.049)	-0.132 (0.022)	-0.170 (0.037)	0.030 (0.023)	0.051 (0.030)				
Radio	-6.665 (0.753)	-7.163 (0.910)	-3.812 (0.530)	-2.894 (0.576)	-3.809 (0.622)	-4.260 (0.765)	-1.336 (0.766)	-2.214 (0.930)				
Literacy	-7.825 (2.349)	-10.676 (2.698)	-7.803 (1.802)	-10.726 (2.331)	-0.649 (3.618)	-0.888 (3.596)	-4.699 (3.834)	-4.003 (6.512)				
School Attendance	4.198 (0.811)	6.099 (1.192)	1.059 (0.729)	1.329 (0.947)	2.210 (0.661)	4.537 (1.014)	1.783 (0.721)	2.645 (1.202)				
Share Foreign Born	-0.332 (1.373)	-1.194 (1.757)	-2.548 (0.824)	-3.139 (0.968)	0.466 (1.023)	0.172 (1.139)	0.681 (1.298)	0.609 (1.832)				
Includes changes*	--	X	--	X	--	X	--	X				
Cities	147	146	138	137	144	142	120	102				
N	4,717	3,928	3,146	2,704	3,045	2,506	1,479	1,088				
Pseudo R ²	0.482	0.511	0.498	0.538	0.442	0.502	0.348	0.399				

Note: This table reports estimates of the relationship between HOLC map grades and 1930 neighborhood characteristics and 1920 to 1930 trends in characteristics. Each observation represents an HOLC neighborhood. In the ordered logit specification, the dependent variable is coded such that the neighborhood graded as riskiest has the highest value (e.g. the dependent variable is coded as D=4, C=3, B=2, and D=1). All specifications include city fixed effects and are weighted by the log of the population of the HOLC neighborhood in 1930. City-clustered standard errors are shown in parentheses.

Table A8: Counts of Boundaries, by City

City	C-B	D-C
Akron, OH	62	28
Albany, NY	6	3
Altoona, PA	14	7
Arlington, MA	6	4
Asheville, NC	11	18
Atlanta, GA	13	1
Augusta, GA	1	4
Aurora, IL	12	13
Baltimore, MD	19	15
Battle Creek, MI	6	14
Bay City, MI	1	19
Belmont, MA	1	0
Binghamton, NY	11	2
Birmingham, AL	19	71
Boston, MA	6	22
Braintree, MA	3	0
Bronx, NY	8	17
Brookline, MA	4	0
Brooklyn, NY	44	73
Buffalo, NY	18	6
Cambridge, MA	4	8
Camden, NJ	8	3
Canton, OH	15	9
Charleston, WV	5	3
Charlotte, NC	1	3
Chattanooga, TN	8	14
Chelsea, MA		5
Chicago, IL	118	117
Chicopee, MA	2	0
Cleveland, OH	42	62
Columbus, GA	1	7
Columbus, OH	58	41
Dallas, TX	14	4
Dayton, OH	17	17
Decatur, IL	18	16
Dedham, MA	4	2
Denver, CO	33	24
Detroit, MI	41	109
Duluth, MN	16	3
Durham, NC	5	6
East Hartford, CT	2	2

Table A8: Counts of Boundaries, by City, cont.

City	C-B	D-C
Muncie, IN	1	6
Muskegon, MI	4	8
Needham, MA	3	0
New Britain, CT	6	0
New Castle, PA	8	4
New Haven, CT	4	11
New Orleans, LA	24	53
New York, NY	10	5
Newton, MA	3	3
Niagara Falls, NY	11	5
Norfolk, VA	6	5
Oakland, CA	23	23
Oshkosh, WI		11
Philadelphia, PA	58	53
Pittsburgh, PA	25	28
Pontiac, MI	5	3
Portland, OR	71	39
Portsmouth, OH	2	7
Poughkeepsie, NY	1	3
Queens, NY	35	27
Quincy, MA	5	0
Racine, WI	9	8
Revere, MA	0	3
Richmond, VA	5	5
Roanoke, VA	0	5
Rochester, NY	25	21
Rockford, IL	10	20
Sacramento, CA	12	0
Saginaw, MI	9	11
San Diego, CA	30	15
San Francisco, CA	13	25
San Jose, CA	15	13
Saugus, MA	3	5
Schenectady, NY	9	5
Seattle, WA	68	26
Somerville, MA	4	6
South Bend, IN	11	9
Spokane, WA	29	37
Springfield, IL	24	28
St. Joseph, MO	4	6
St. Louis, MO	51	31

Table A8: Counts of Boundaries, by City, cont.

City	C-B	D-C
St. Petersburg, FL	12	20
Stamford, CT	0	2
Staten Island ,NY	17	20
Stockton, CA	4	1
Syracuse, NY	18	8
Tacoma, WA	22	28
Tampa, FL	10	6
Terre Haute, IN	6	25
Toledo, OH	31	21
Troy, NY	9	8
Utica, NY	7	9
Waltham, MA	3	2
Warren, OH	9	4
Watertown, MA	4	0
Wheeling, WV	1	2
Wichita, KS	7	22
Winchester, MA	1	0
Winston-Salem, NC	3	4
Winthrop, MA	2	0
Youngstown, OH	25	31
<i>Total</i>	<i>1965</i>	<i>2111</i>

Table A9: City Level Average Estimates, 1950 to 1980

City	African American Share		Home Ownership Share		Log House Value		Log Rent	
	D-C	C-B	D-C	C-B	D-C	C-B	D-C	C-B
Akron, OH	0.22	0.56	-0.08	-0.02	-0.20	0.01	0.09	-0.20
Arlington, MA		0.01		0.14		-1.11		-0.92
Baltimore, MD	0.13		-0.13		-0.24		-0.13	
Bay City, MI	0.03		-0.30		0.06		0.03	
Binghamton, NY		0.01		-0.35		-0.31		-0.12
Birmingham, AL	0.43	-0.49	-0.16	0.20	0.97	0.52	-0.41	-0.08
Boston, MA	0.14		-0.03		-0.18		-0.08	
Bronx, NY	0.12	0.02	0.00	0.04	-0.30	-0.43	-0.17	-0.08
Brooklyn, NY	0.04	0.06	-0.01	-0.06	-0.22	-0.16	-0.06	-0.08
Buffalo, NY		0.14		-0.07		-0.47		-0.37
Cambridge, MA	0.16		0.03		-0.35		-0.36	
Chicago, IL	0.03	0.01	-0.03	-0.09	-0.13	-0.20	-0.09	-0.08
Cleveland, OH	0.07	0.01	0.01	-0.28	-0.16	0.23	-0.08	-0.05
Columbus, OH	0.45	0.05	-0.17	-0.02	-0.19	-0.18	-0.22	-0.33
Dayton, OH	-0.05	0.03	-0.19	-0.27	-0.06	-0.22	-0.11	0.04
Decatur, IL	0.25		-0.09		-0.06		-0.48	
Denver, CO		0.00		-0.12		-0.72		-2.57
Detroit, MI	0.21		0.01		0.02		-0.03	
Duluth, MN		0.01		-0.30		0.03		-0.41
East St. Louis, IL	-0.04		-0.25		-1.04		-0.42	
Elmira, NY		0.02		-0.18		0.70		-0.28
Erie, PA	0.43	0.12	-0.07	-0.08	-0.09	-0.23	-0.02	-0.27
Evansville, IN	0.51		-0.18		-0.05		-0.48	
Fort Wayne, IN		0.02		-0.05		0.49		0.02
Grand Rapids, MI	0.07		-0.01		-0.33			
Hudson County, NJ	0.19	-0.06	-0.07	-0.04	-0.27	-0.14	-0.10	0.02
Indianapolis, IN	0.08	0.19	0.03	-0.16	-0.20	-0.20	-0.03	0.08
Kansas City, MO	-0.04		-0.06		-0.14		-0.11	
Lexington, KY	0.45		-0.04		0.59		-0.66	
Louisville, KY	-0.17		0.10		-0.39		0.02	
Malden, MA	0.01		-0.03		-0.46		-0.91	
Minneapolis, MN	0.01	-0.02	-0.08	-0.03	-0.14	-0.13	-0.19	-0.07
Mobile, AL	0.64		0.07		0.02		-0.39	
New Britain, CT		0.03		-0.46		-0.18		-0.20
New Haven, CT	0.22		-0.03		-0.89		-0.41	
New Orleans, LA	0.23	-0.12	-0.03	-0.07	-0.27	0.00	-0.20	-0.74
New York, NY	0.22	0.16	-0.01	-0.01	-0.52	-0.08	-0.25	-0.21
Niagara Falls, NY		0.00		0.18		0.88		-0.03
Oakland, CA	0.03	-0.02	0.08	-0.04	-0.11	-0.39	-0.06	-0.28
Philadelphia, PA	0.18	0.11	0.00	-0.15	-0.32	-0.25	-0.25	-0.08
Pittsburgh, PA	0.05	0.01	0.03	-0.16	-0.24	-0.36	-0.12	-0.05

Table A9: City Level Average Estimates, 1950 to 1980, cont.

City	African American Share		Home Ownership Share		Log House Value		Log Rent	
	<i>D-C</i>	<i>C-B</i>	<i>D-C</i>	<i>C-B</i>	<i>D-C</i>	<i>C-B</i>	<i>D-C</i>	<i>C-B</i>
Rochester, NY	0.08	0.03	-0.07	-0.07	-0.28	-0.14	-0.08	-0.02
Rockford, IL	0.12		-0.22		0.77		-0.08	
San Diego, CA		0.03		-0.24		-0.06		0.01
San Francisco, CA	0.30		-0.01		0.02		0.09	
Somerville, MA	0.00		-0.10		0.06		-0.04	
Spokane, WA		0.01		-0.04		-0.28		-0.17
St. Louis, MO	0.09	0.19	-0.05	0.05	-0.24	-0.29	-0.24	-0.25
Staten Island ,NY	0.08	0.07	-0.03	-0.18	-0.28	-0.61	-0.19	-0.44
Syracuse, NY		0.06		0.00		-0.17		-0.14
Toledo, OH	0.45		0.02		-0.06		-0.03	

Table A10: City Level Average Estimates, 1990 to 2010

City	African American Share		Home Ownership		Log House Value		Log Rent	
	D-C	C-B	D-C	C-B	D-C	C-B	D-C	C-B
Akron, OH	0.17	0.07	0.07	0.11	-0.10	-0.05	-0.06	-0.04
Altoona, PA	0.00	0.01	-0.10	-0.04	0.03	-0.11	0.03	-0.11
Arlington, MA		0.01		-0.04		-0.12		-0.07
Aurora, IL	0.00	0.03	0.06	-0.14	-0.04	-0.07	-0.04	-0.05
Baltimore, MD	0.02	-0.02	-0.04	0.04	-0.10	0.18	-0.11	-0.01
Battle Creek, MI	0.10		0.01		0.06		0.00	
Bay City, MI	0.01		0.01		-0.04		-0.09	
Binghamton, NY		-0.01		-0.09		0.09		-0.02
Birmingham, AL	0.09	0.09	-0.10	-0.12	-0.07	-0.17	-0.11	-0.12
Boston, MA	0.00	0.01	-0.07	-0.15	0.06	-0.02	-0.16	-0.16
Bronx, NY	0.04	0.04	0.03	0.07	-0.21	0.23	-0.10	0.02
Brooklyn, NY	0.03	0.01	-0.01	-0.07	-0.09	-0.13	-0.06	-0.02
Buffalo, NY	0.14	0.02	-0.14	0.05	-0.22	-0.38	-0.09	-0.08
Cambridge, MA	0.06		-0.03		-0.15		-0.24	
Camden, NJ		-0.16		-0.14		-0.25		-0.06
Chelsea, MA	-0.01		-0.08		0.00		-0.08	
Chicago, IL	-0.01	-0.02	0.02	-0.13	-0.04	-0.08	-0.02	-0.04
Cleveland, OH	0.01	0.03	-0.03	-0.20	-0.05	-0.34	-0.01	0.07
Columbus, OH	0.06	0.03	0.02	-0.08	-0.15	0.02	-0.03	-0.08
Dayton, OH	0.02	-0.06	-0.06	-0.20	-0.10	-0.07	-0.15	0.12
Decatur, IL	0.13	0.08	-0.02	-0.09	-0.05	-0.10	0.00	0.03
Denver, CO	0.00	0.00	-0.12	-0.13	-0.08	-0.10	-0.08	-0.07
Detroit, MI	0.03		-0.04		-0.23		-0.11	
Duluth, MN		0.01		-0.05		-0.10		-0.01
East St. Louis, IL	-0.03		0.00		0.08		-0.16	
Elmira, NY	-0.03	0.02	0.16	-0.05	0.10	-0.18	-0.07	-0.06
Erie, PA	0.11	0.07	0.06	-0.06	-0.01	-0.15	-0.02	-0.09
Evansville, IN	0.12		0.00		-0.02		-0.12	
Everett, MA	0.02		0.04		-0.02		-0.02	
Fort Wayne, IN	0.15	0.01	-0.13	-0.15	-0.33	-0.10	-0.19	0.00
Grand Rapids, MI	0.17		0.05		-0.39		-0.01	
Hamilton, OH		0.00		-0.13		-0.10		-0.05
Hudson County, NJ	0.04	0.02	-0.04	-0.05	-0.14	-0.11	-0.11	-0.06
Indianapolis, IN	0.02	0.06	-0.01	-0.01	-0.10	-0.27	-0.03	-0.13
Jacksonville, FL	0.10		0.17		-0.02		-0.04	
Joliet, IL		0.01		-0.01		-0.05		-0.03
Kansas City, MO	-0.03		-0.01		-0.06		-0.04	
Knoxville, TN	0.05		-0.11		-0.15		-0.01	
Lexington, KY	-0.01	-0.01	0.01	0.01	0.03	-0.10	0.01	0.02
Lima, OH	0.04		-0.06		0.00		-0.01	
Louisville, KY	-0.02	0.03	-0.01	0.00	-0.14	-0.03	-0.02	-0.01

Table A10: City Level Average Estimates, 1990 to 2010, cont.

City	African American Share		Home Ownership		Log House Value		Log Rent	
	D-C	C-B	D-C	C-B	D-C	C-B	D-C	C-B
Malden, MA	0.01		-0.06		0.00		-0.01	
Manchester, NH	0.01		-0.03		-0.09		0.00	
Melrose, MA		0.01		-0.15		-0.08		-0.17
Minneapolis, MN	0.01	0.04	0.05	-0.08	0.03	-0.07	-0.05	-0.03
Mobile, AL	0.05		-0.16		0.02		-0.15	
Muncie, IN	0.11		-0.26		-0.06		-0.27	
New Britain, CT		0.02		-0.09		-0.07		-0.08
New Haven, CT	0.13		-0.01		-0.11		-0.23	
New Orleans, LA	0.22	0.33	-0.07	-0.14	-0.27	-0.50	-0.13	-0.25
New York, NY	0.08	0.09	-0.02	-0.05	-0.14	-0.13	-0.04	-0.25
Niagara Falls, NY		-0.05		0.00		-0.03		-0.14
Oakland, CA	0.05	0.05	-0.01	-0.12	-0.04	-0.16	-0.07	-0.12
Oshkosh, WI	0.00		-0.08		-0.08		-0.04	
Philadelphia, PA	0.07	0.01	0.00	-0.02	-0.14	-0.17	-0.07	-0.05
Pittsburgh, PA	0.08	0.04	-0.01	-0.03	-0.15	-0.21	-0.04	-0.06
Portland, OR	-0.03		0.00		0.05		0.00	
Quincy, MA		0.01		-0.06		0.05		0.03
Roanoke, VA	-0.03		-0.03		-0.10		-0.02	
Rochester, NY	0.04	0.07	0.01	-0.15	-0.07	-0.15	-0.04	-0.04
Rockford, IL	0.02	0.03	-0.05	-0.05	0.03	-0.07	-0.05	-0.03
Saginaw, MI	-0.09		0.09		-0.08		-0.04	
San Diego, CA		0.02		-0.09		-0.05		-0.06
San Francisco, CA	0.02	0.04	-0.02	-0.20	-0.01	-0.27	-0.02	-0.07
San Jose, CA	0.01		-0.06		-0.07		-0.09	
Schenectady, NY		0.03		-0.10		-0.09		-0.05
Seattle, WA		0.03		-0.20		-0.27		-0.20
Somerville, MA	0.03		-0.03		-0.11		-0.06	
Spokane, WA		0.00		-0.17		0.06		-0.05
Springfield, IL	0.10	0.07	-0.04	-0.13	-0.02	-0.03	-0.02	-0.02
St. Joseph, MO	-0.01		0.02		0.00		0.00	
St. Louis, MO	0.01	0.03	0.00	0.03	-0.06	-0.24	-0.03	-0.07
Staten Island ,NY	-0.02	0.02	-0.13	-0.10	-0.05	-0.19	0.01	0.00
Syracuse, NY	0.09	0.05	-0.08	-0.05	0.05	-0.07	-0.08	-0.03
Tacoma, WA	-0.03	0.00	0.02	-0.01	0.06	-0.04	0.01	-0.06
Terre Haute, IN	0.08		0.00		-0.04		-0.01	
Toledo, OH	0.22	-0.08	0.01	-0.06	0.01	-0.04	-0.10	-0.01
Troy, NY	0.08	0.03	0.01	-0.21	-0.23	-0.08	0.00	-0.02
Wichita, KS	0.01		-0.06		-0.10		-0.03	
Youngstown, OH	-0.05	0.13	-0.04	0.09	-0.10	-0.08	-0.08	-0.26

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Deloitte.



Striving for balance,
advocating for change

THE DELOITTE GLOBAL 2022 GEN Z & MILLENNIAL SURVEY

Reconciling desire for change with the challenges and complexities of everyday life



Marking its 11th annual edition, Deloitte's 2022 Gen Z and Millennial Survey connected with respondents around the globe to gauge their views about work and the world around them. The survey, fielded between November 2021 and January 2022, and the subsequent qualitative interviews, held in April 2022, found Gen Zs and millennials navigating a very uncertain time.

When Deloitte fielded last year's survey, the world was in the midst of the second year of the COVID-19 pandemic, just as vaccines were starting to roll out. It had been a difficult year, but the survey revealed that Gen Zs and millennials were determined to create a better post-pandemic world. Fast forward to 2022 and, unfortunately, economic conditions and quality of life have deteriorated in many parts of the world. Now in the third year of the pandemic, we're also facing alarming geopolitical conflicts, extreme climate events, inequality, and a steep rise in inflation. Rather than being a temporary condition, disruption seems to have become part of the new normal.

This year's survey found that Gen Zs and millennials are deeply worried about the state of the world and are fighting to reconcile their desire for change with the demands and constraints of everyday life. They are struggling with financial anxiety, while trying to invest in environmentally sustainable choices.

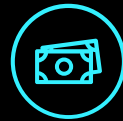
They feel burned out, but many are taking on second jobs, while pushing for more purposeful—and more flexible—work. They press their employers to tackle climate change, particularly when it comes to efforts they can get directly involved in, but businesses may still be missing opportunities to drive deeper and broader climate action. They have inspired organizations to take action to address workplace mental health, but they are not always comfortable talking about these issues or taking advantage of the resources available.

The unprecedented circumstances of the past few years have prompted many people around the world to rethink their priorities, leading to the Great Resignation. This time of historic voluntary turnover presents significant opportunities for millennials and Gen Zs. As this year's survey results indicate, the sustained workplace changes they've been asking for—including higher compensation, more flexibility, better work/life balance, increased learning and development opportunities, better mental health and wellness support, and a greater commitment from businesses to make a positive societal impact—are also the strategies that will help employers attract and retain talent.



Executive summary

Deloitte's Gen Z and Millennial Survey connected with 14,808 Gen Zs and 8,412 millennials across 46 countries. Their responses present a picture of vivid contrasts, as these generations strive to balance their desire to drive change with the challenges of their everyday lives.



Struggling with the cost of living and financial concerns

Gen Zs (29%) and millennials (36%) selected cost of living (e.g., housing, transport, bills, etc.) as their greatest concern. Of note, 12% of Gen Zs and 11% of millennials selected political instability, war, and conflicts between countries as their greatest concern, percentages that likely would have been much higher if the survey had been fielded just a few months later, as Russia invaded Ukraine.

Concerns about cost of living may be a symptom of the times, given high levels of inflation, but they also speak to issues that these generations have been expressing for years: they don't feel financially secure personally, and at a broader societal level, they are deeply concerned about wealth inequality.

- Almost half of Gen Zs (46%) and millennials (47%) live paycheck to paycheck and worry they won't be able to cover their expenses.
- More than a quarter of Gen Zs (26%) and millennials (31%) are not confident they will be able to retire comfortably.
- Around three-quarters of Gen Zs (72%) and millennials (77%) agree that the gap between the richest and poorest people in their country is widening.

Amid this financial unease, many Gen Zs and millennials are redefining their working patterns. As many as 43% of Gen Zs and 33% of millennials have a second part- or full-time paying job in addition to their primary job. A small, but growing, percentage are also moving to less expensive cities with remote jobs.



Executive summary

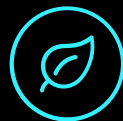


The Great Resignation signals a breaking point, and an opportunity to reassess how we work

The Great Resignation may continue for some time. While job loyalty is up slightly from last year, four in 10 Gen Zs and nearly a quarter of millennials would like to leave their jobs within two years, and roughly a third would do so without another job lined up, signaling significant dissatisfaction levels. But businesses can learn from this period and implement workplace changes that will help to attract and retain talent.

- Pay is the No. 1 reason why Gen Zs and millennials left a role in the last two years. However, good work/life balance and learning/development opportunities were the top priorities when choosing an employer.
- Aligning with Gen Zs' and millennials' values is also key. Nearly two in five say they have rejected a job or assignment because it did not align with their values. Meanwhile, those who are satisfied with their employers' societal and environmental impact, and their efforts to create a diverse and inclusive culture, are more likely to want to stay with their employer for more than five years.

There is also clear demand for more flexible working: currently 49% of Gen Zs and 45% of millennials work remotely at least some of the time, while three-quarters say this would be their preferred mode of working. Saving money, freeing up time to do other things they care about, and spending more time with family are the top reasons Gen Zs and millennials like to have the option to work remotely.



Prioritizing sustainable choices and environmental action by employers

Protecting the environment remains a top priority for Gen Zs and millennials. About three-quarters of respondents believe the world is at a tipping point in responding to climate change, but less than half are optimistic that efforts to protect the planet will be successful.



Executive summary

The vast majority of Gen Zs and millennials (90%) are making at least some effort to reduce their own impact on the environment.

- Many are willing to pay more to make sustainable choices. 64% of Gen Zs would pay more to purchase an environmentally sustainable product, versus 36% who would choose a cheaper product that is not as sustainable.

They want businesses, and their own employers, to do more. Only 18% of Gen Zs and 16% of millennials believe their employers are strongly committed to fighting climate change. Gen Zs and millennials want to see employers prioritize visible climate actions that enable employees to get directly involved, such as banning single-use plastics and providing training to help people make better environmental decisions.



Workplace mental health continues to be a challenge

Gen Zs are regularly stressed and anxious. Nearly half say that they feel stressed all or most of the time. Millennial stress levels are also high but are down slightly from last year. Long-term financial futures and day-to-day finances continue to be top stress drivers for both generations.

Meanwhile, burnout is very high among both generations, and signals a major retention issue for employers:

- 46% of Gen Zs and 45% of millennials feel burned out due to the intensity/demands of their working environments.
- 44% of Gen Zs and 43% of millennials say many people have recently left their organization due to workload pressure.

Employers do seem to be making progress when it comes to prioritizing mental health and well-being in the workplace. More than half agree that workplace well-being and mental health has become more of a focus for their employers since the start of the pandemic. However, there are mixed reviews on whether the increased focus is actually having a positive impact.



Part 1: Struggling with the cost of living and financial anxiety

The cost of living is the top concern among both Gen Zs and millennials

As Gen Zs and millennials learn to adapt to the pandemic, personal financial challenges—followed by climate change—are top-of-mind.



In the third year of the pandemic, Gen Zs and millennials are adapting. **Health care/disease prevention, a predominant concern last year, is now slightly less pressing** as vaccines and therapeutics to fight COVID-19 have become more widely available and adopted.

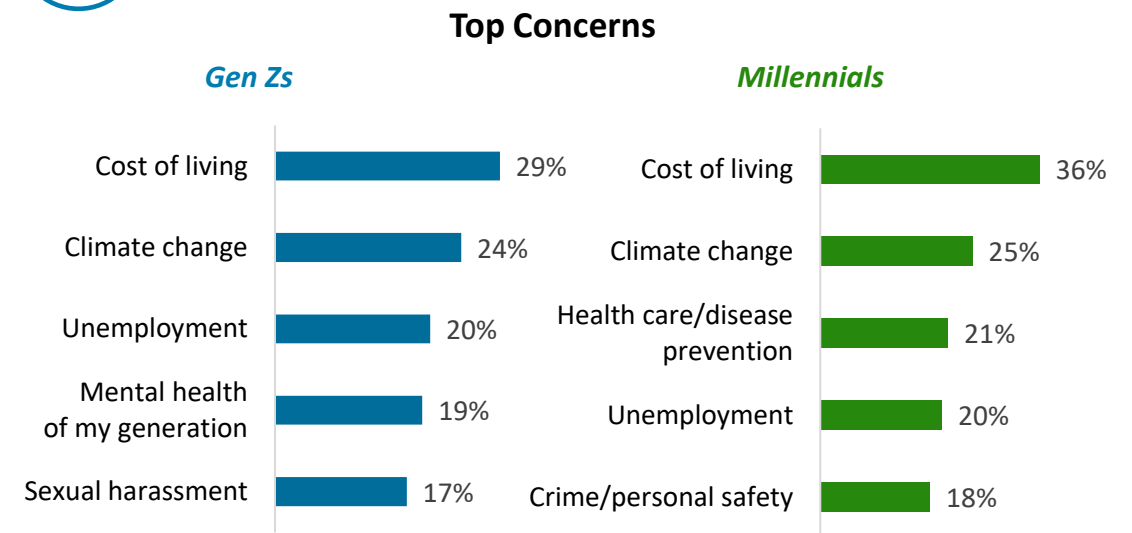


Gen Zs and millennials also continue to be very concerned about wealth inequality, and trust in business is declining.

- 72% of Gen Zs and 77% of millennials **agree that the gap between the richest and poorest people in their country is widening.**
- Only 28% of Gen Zs and millennials **expect the economic situation in their country to improve over the next 12 months**, consistent with last year’s findings.
- **Less than half of Gen Zs (45%) and millennials (44%) agree business is having a positive impact on society**, marking the fifth consecutive year this percentage has dropped.



The cost of living is the top concern among Gen Zs and millennials, followed closely by climate change.



To address financial concerns, Gen Zs and millennials are actively exploring new working models to widen their income

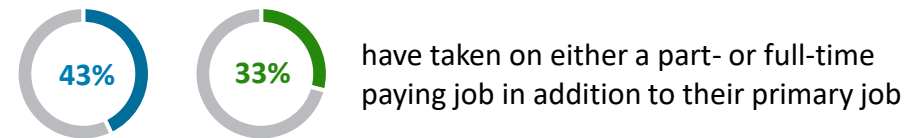
Financial anxiety is widespread among Gen Zs and millennials. They are worried about their day-to-day finances, and fear that they won't be able to retire comfortably.

Gen Zs *Millennials*



Perhaps as a way to alleviate financial concerns, many are taking on side jobs.

Gen Zs *Millennials*



However, side jobs may also be about more than money. For example, they can enable Gen Zs and millennials to hone new skills and tap into their entrepreneurial spirits. The top side jobs held by respondents include selling products or services through online platforms, consulting, running their own business, and social media influencing.

The financial benefits of hybrid working

Saving money—on expenses like commuting, clothes, dry cleaning, and more—is one of the **top reasons that many Gen Zs and millennials prefer hybrid or remote work.** A smaller percentage are taking advantage of remote work to relocate to less expensive cities. This appears to be a growing trend, roughly 15% of Gen Zs and millennials say they've done so this year, up from the 9% of respondents in last year's survey who said they'd temporarily or permanently moved out of a major city.

Gen Zs *Millennials*
33% **39%**

who currently work remotely say doing so has helped them save money

Gen Zs *Millennials*
15% **13%**

indicated that remote work has allowed them to relocate further away from their place of work



What Gen Zs and millennials are saying about their top concerns

“My biggest concern is the amount of turmoil that exists in the world, which is seemingly getting worse. We have one large existential crisis after another, and I think the challenge is everyone is exhausted with having to be resilient...we're not truly able to solve the issues we're faced with. Instead, we put a plaster on it and inevitably the problem comes back bigger. This unrest and turmoil then plays out in the financial markets, in the economy, in politics and this coupled with the climate crisis is making everyone more stressed than ever before.”

– Matt, 29, UK, One Young World ambassador

“The Ukraine situation is extremely distressing. It's just another existential worry to add to a growing list. I want to believe that, on average, we as people are making progress towards more peaceful co-existence. But what is happening in Ukraine certainly hurts that narrative.”

– C, 32, US

“I've been extremely concerned about COVID-19 since it showed up more than two years ago. This has been less of a central concern over the past year, but I still think it's a problem. I'm also concerned about the rising mental health problems in the US and around the world and an increased sense of nihilism and hopelessness everywhere. I'm very concerned about the rising cost of living and especially cost of housing and rent. I'm concerned about conflict in Russia and Ukraine, the humanitarian crisis in Afghanistan, and other global conflicts. All of these things prompt me to have at least a low level of stress basically at all times.”

– Rebecca, 25, US

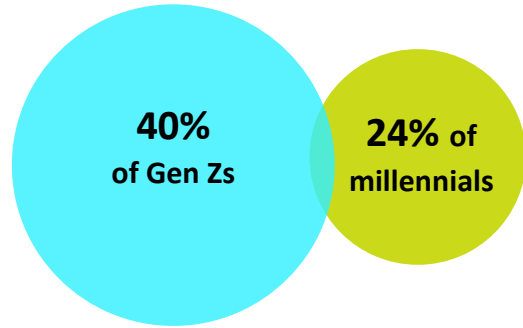
“I do think our generation struggles with high cost of living and financial concerns. I think the housing market at the moment is just crazy and is nothing like what our parents' generations faced...I currently have three jobs. I have to do this in order to make enough money to live my life as a full-time student.”

– Julia, 21, Australia

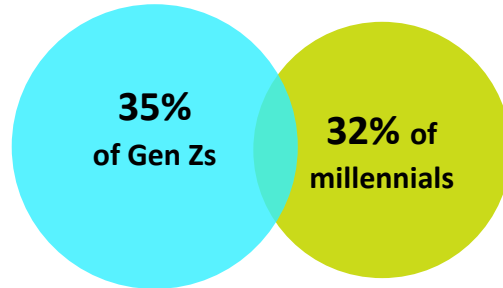


Part 2: Reassessing the way we work

The Great Resignation may be with us for a while



would like to leave
their jobs within
two years



would leave even
without another job
lined up



Voluntary job turnover in the past year has been historically high— but interestingly, employee loyalty may now be on the rise

Loyalty levels are on the rise among millennials and Gen Zs, but consumer-facing industries are still facing major challenges as the pandemic drags on.






Last year’s survey revealed that nearly **one in four millennial respondents planned to leave their jobs within the year**, effectively anticipating the Great Resignation.

This year’s survey connected with millennials and Gen Zs amid this period of high voluntary job turnover. It found an **increase in loyalty across both groups, potentially because many people changed jobs over the last year**. This year millennials are more likely to say they expect to stay beyond five years rather than leave within the next two.

	Gen Zs		Millennials	
	2021	2022	2021	2022
Stay beyond 5 years	21%	23% ↑	34%	38% ↑
Leave within 2 years	53%	40% ↓	36%	24% ↓

But the Great Resignation may be with us for a while. Four in 10 Gen Zs and nearly a quarter of millennials would like to leave their jobs within two years, and roughly a third would do so without another job lined up, signaling significant dissatisfaction levels.

Respondents are particularly eager to leave some public-facing industries within two years, many of which are already facing labor shortages.

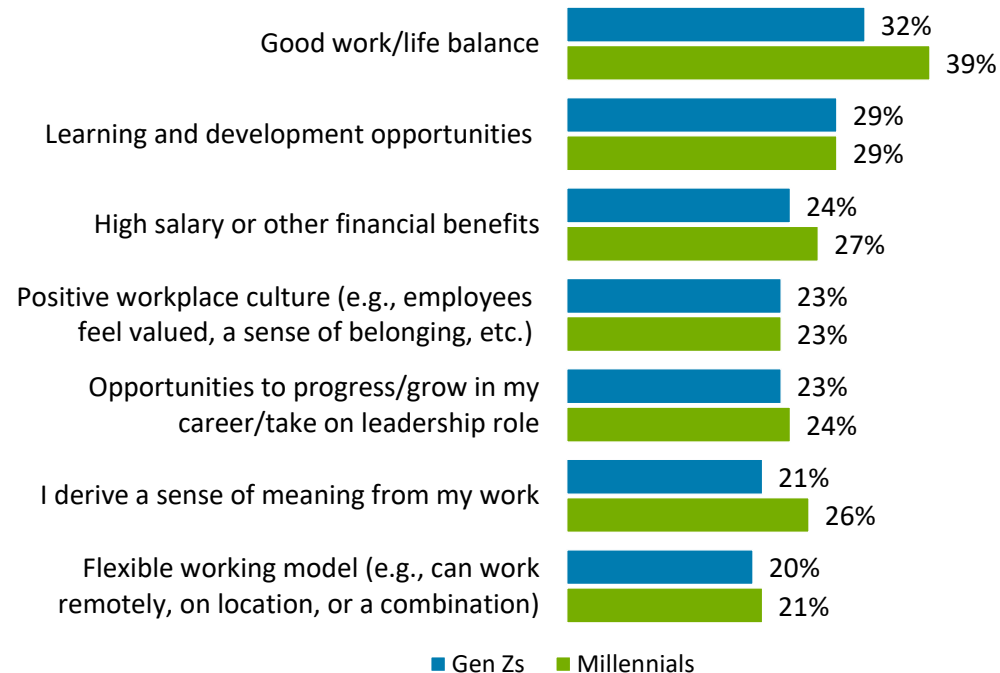
	Gen Zs	Millennials
 consumer	49%	25%
 retail	48%	25%
 energy/mining	46%	34%
 education	42%	27%
 health care/ life science	41%	29%

So what can employers do to attract and retain talent?

When it comes to attracting Gen Zs and millennials, getting the basics right comes first, but businesses' impact on society and the planet cannot be discounted.

Pay, feeling the workplace was detrimental to their mental health, and burnout are the top reasons millennials and Gen Zs left their employers over the last two years. But when it comes to what makes them choose an organization to work for, good work/life balance and learning and development opportunities are their top priorities.

Top reasons respondents chose to work for their current organization:



The focus on learning and development is perhaps not surprising given evolving work demands and skills requirements. Gen Zs (37%) and millennials (38%) predict that the most notable workplace shift within the next 10 years will be artificial intelligence (AI) and other technologies being used to fully automate many jobs or job functions. So, employers who can help professionals adapt to this changing workplace are likely more appealing.

Purpose is also critical. Gen Zs and millennials are willing to turn down jobs and assignments which don't align with their values. This is particularly true among Gen Zs and millennials in leadership positions.



Nearly two in five (37% of Gen Zs and 36% of millennials) say they have rejected a job and/or assignment based on their personal ethics



Nearly half (46%) of Gen Zs and millennials in **senior positions** have rejected a job and/or assignment based on their personal ethics

While societal and environmental impact, along with a diverse and inclusive culture, are not always at the top of the priority list when choosing a job, these continue to be critical issues in terms of retention. Those who are satisfied with their employers' societal and environmental impact, and their efforts to create a diverse and inclusive environment are more likely to want to stay with their employer for more than five years.

Level of satisfaction with commitment to societal impact, diversity and inclusion, and sustainability have a direct impact on job loyalty

Gen Zs' satisfaction on the following efforts of their organization and its impact on their loyalty

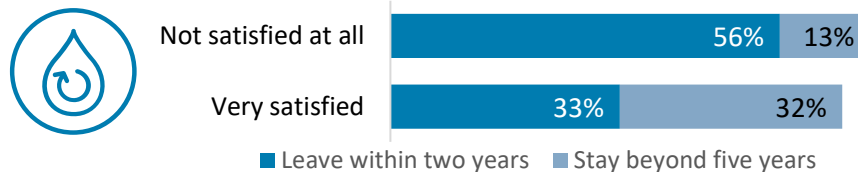
Societal impact



Progress in creating a diverse and inclusive environment

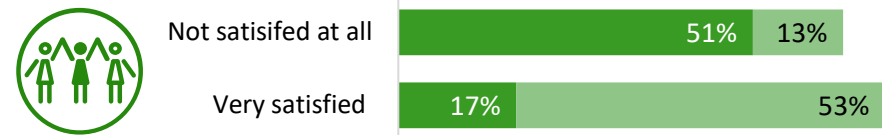


Commitment to sustainability

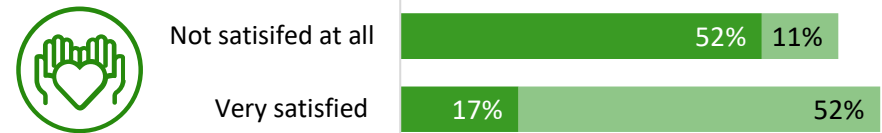


Millennials' satisfaction on the following efforts of their organization and its impact on their loyalty

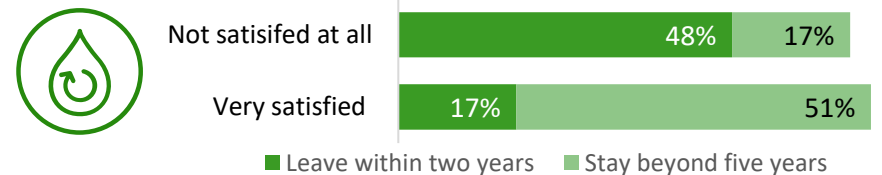
Societal impact



Progress in creating a diverse and inclusive environment



Commitment to sustainability



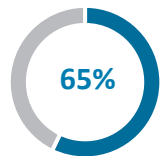
Empowering people to drive change within their organizations is key to fostering a sense of belonging and driving loyalty

Gen Zs and millennials aren't afraid to speak up to ask for change, but it's critical for employers to listen to their people, across all levels, and implement their feedback. While just over half of respondents feel their organization does a good job on this front, roughly a third don't feel empowered to drive change.

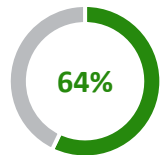


32% of Gen Zs and 33% of millennials say decisions are made from the top down within their organizations and employee feedback is not often acted upon

Gen Zs and millennials in senior leadership positions are more likely to say their organization seeks input from employees at all levels and incorporates their feedback.



65% of Gen Zs in senior positions agree with this statement versus **43% in junior positions**



64% of millennials in senior positions agree with this statement versus **37% in junior positions**

This suggests that organizations have work to do to ensure that all professionals feel empowered to speak up and drive change within their workplaces. Gen Zs want workplaces with less rigid hierarchies, where they feel they can speak openly with their employers, and where they can be part of shaping their workplace's culture.

Empowering people across an organization helps foster a more inclusive environment.

Of the 52% of Gen Zs and millennials who feel empowered to drive change within their organizations, **89% of Gen Zs and 90% of millennials** say they feel a sense of belonging.

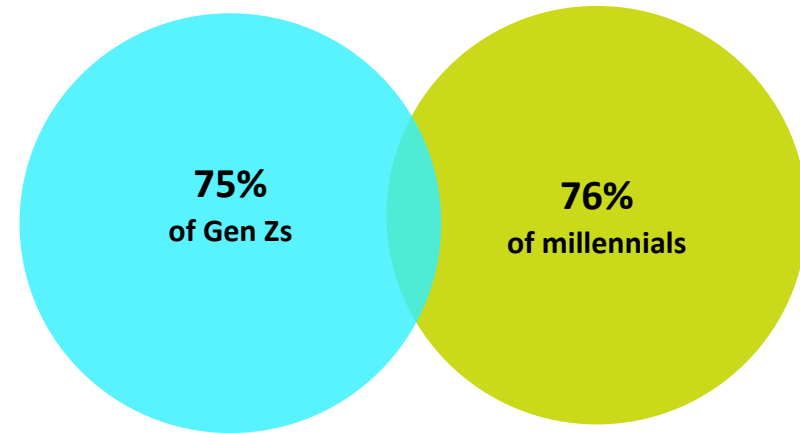
When people feel their voices are heard, they tend to feel more connected and loyal to their organizations.

Among Gen Zs and millennials who feel empowered

Stay beyond 5 years	66%	65%
Leave within a year	38%	33%

Among Gen Zs and millennials who don't feel heard

Stay beyond 5 years	24%	25%
Leave within a year	47%	54%



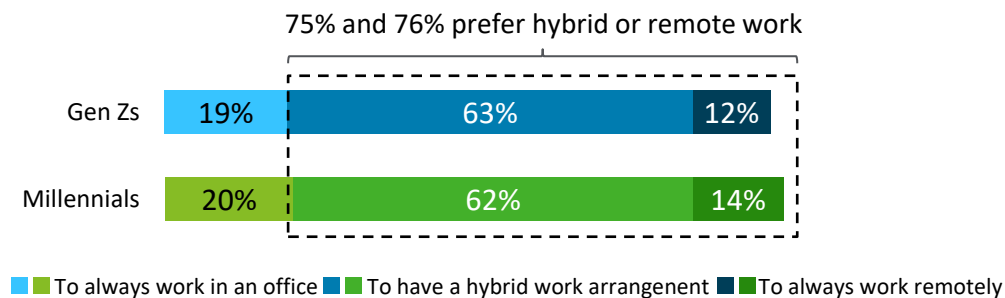
would prefer a hybrid or remote working pattern

There's huge demand for more hybrid ways of working, but businesses have work to do to get it right

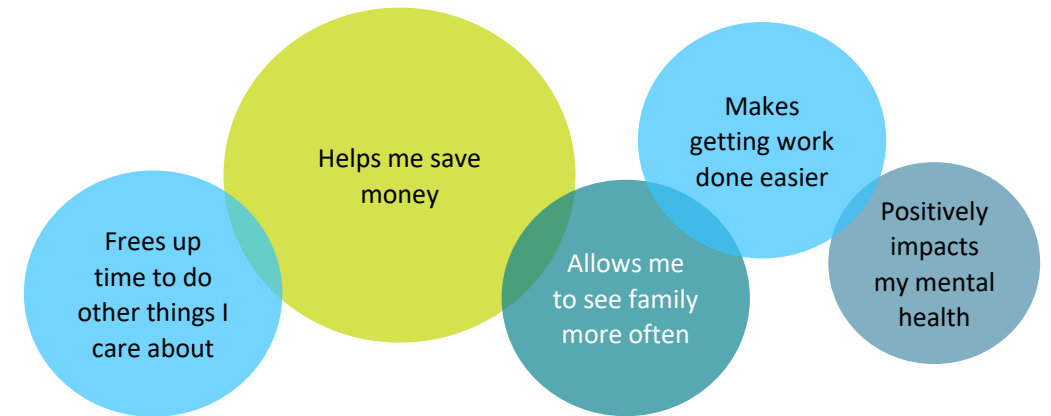
The pandemic has accelerated remote work and many would prefer not to go back to the office, at least not full time. The vast majority of Gen Zs (75%) and millennials (76%) would prefer working patterns where they either split their time between remote and on-site work or work entirely from home. This is, however, significantly higher than the proportion currently able to do so—only 49% of Gen Zs and 45% of millennials say they currently have the option to work remotely at least some of the time.

In addition to where they work, Gen Zs and millennials want flexibility in how and when they work. They'd like their organizations to offer flexible working hours and potentially reduced work weeks. They see flexible work as an important strategy to enable better work/life balance.

Preferred working patterns:



Those who have been able to work remotely cite benefits such as:



While the survey shows a clear case for enabling flexible and hybrid working, it also highlights the challenges that it can bring if not effectively implemented. One in five Gen Zs and millennials who have worked remotely say it has made forming connections with colleagues more difficult, and just under 14% say it made opportunities for mentorship or sponsorship harder to find.



Hybrid work and equality

At a global level, this survey did not find significant differences between genders when it comes to work pattern preferences. But, a number of other studies¹ have shown that women² and minorities are more likely to prefer remote work, compared to their white male colleagues. As a result, there are concerns that hybrid work could deepen inequalities³, as in-office workers have more contact with managers and leaders, potentially leading to more opportunities to progress in their careers.

However, many in-person workplaces aren't equitable⁴ either. The gender pay gap, along with the relatively small proportion of women and minorities in leadership roles, underscores that.

Hybrid work is not a cure-all for inequality in the workplace. But giving people the flexibility to work where and when they want is a critical starting point to address inequities in the workplace and enable better work/life balance.

Businesses have a responsibility to make hybrid work arrangements work for everyone. A big part of that will be fostering more diverse and inclusive work environments, which account for different working patterns and preferences.



What Gen Zs and millennials are saying about the Great Resignation, the future of work, and their ideal jobs

“The pandemic forced me to reassess what is important in life. I started to pay more attention to my health, my family, and my personal life, and I redistributed my focus and time spent for work and for life after COVID-19 lockdowns. I think this sentiment has contributed to the Great Resignation, and that it may lead to improved work/life balance, because large companies will need to start paying more attention to employees’ well-being.”

– Moly, 29, Japan, One Young World Ambassador

“Life is too short to be doing something you don’t enjoy. I want to be doing work that is making a difference to people's lives, not just admin or theoretical work... I'd like to think that the Great Resignation might lead to more serious commitments from senior leaders to adapt to the way Gen Zs and millennials work, and provide real support, not just lip service...I'd like to see my employer give younger professionals a seat at the table through things like reverse mentoring, shadow boards etc. Other generations need to be listened to and given a proper voice. Flexible benefits that support our modern lifestyles are also important such as subsidies for exercise or taking new courses to better ourselves (education shouldn't be linear)...If I were to stay within a large company a 4-day work week is also something I'd like to see happen - I tried this and took a pay cut to allow for it, but my KPIs weren't cut and it made it untenable.”

– Matt, 29, UK, One Young World Ambassador

“The Great Resignation has made lasting changes in the business world already. More jobs are implementing permanent work from home options, which I think is the greatest improvement. Restoring the option to stay home and work gives people their lives back.”

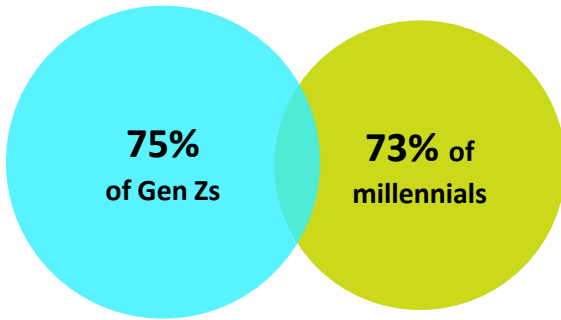
– Serraya, 25, US

“I think that before the Great Resignation, companies expected you to be already experienced in what they wanted you to do. Now, I think that at least some companies have realized that it's not possible to find people that are exactly as you want them when you hire them. You have to put effort into them in order for them to not only do well, but to stay.”

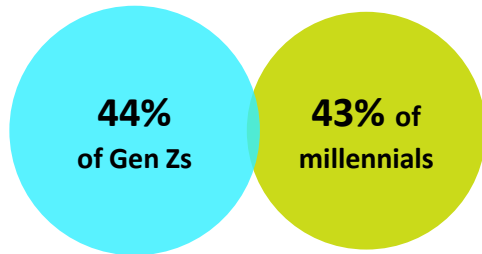
– Melissa, 24, US



Part 3: Advocating for climate change



agree that the world is at a tipping point in responding to climate change and the future can go either way



are optimistic that efforts to protect and sustain the health of the planet will be effective



The future of the environment is uncertain, but Gen Zs and millennials are putting in the work to drive change and willing to pay a premium for sustainability

About three-quarters of Gen Zs and millennials agree that the world is at a tipping point when responding to climate change. And roughly two-thirds of Gen Zs (68%) and millennials (66%) have already been personally impacted by severe weather events, which emphasizes the urgent need to address the climate emergency.

Gen Zs and millennials are doing their part—nine in 10 make an effort to protect the environment. In the near-term they are focused on small everyday actions like buying second-hand clothes or sourcing locally or organically produced food. In the longer term they see themselves increasing their civic engagement and bringing sustainability into their large purchases. Financial constraints may make it challenging for them to invest in more expensive items like solar panels and electric vehicles. Still, half of respondents say they plan on making these purchases in the future.



Top actions they are already taking

Using recyclable or recycled plastics/paper

Using reusable mugs and utensils

Buying second-hand (e.g., clothes and furniture)

Buying food that is locally or organically produced



Top actions they plan on taking in the future

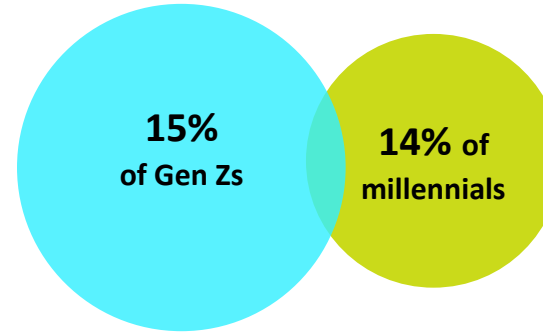
Purchase an electric or hybrid vehicle

Improve their homes to make them more sustainable (e.g., add solar panels, geothermal, etc.)

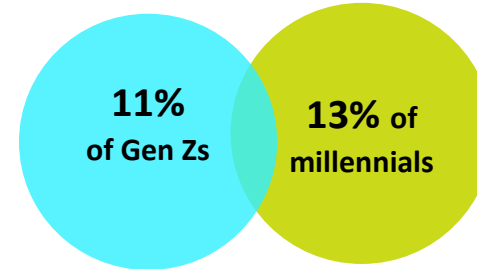
Increase civic engagement

The takeaway

Gen Zs and millennials are willing to spend money in the short term for sustainability, but currently some are hesitant to make large, long-term financial investments, likely due to financial constraints.



strongly agree that large companies are taking substantive actions to combat climate change



agree that their country's government is highly committed to tackling climate change



Gen Zs and millennials are pushing for climate action within their own organizations

They believe businesses and governments need to do more to fight climate change. Only 15% of Gen Zs and 14% of millennials strongly agree that businesses are taking substantive actions, marginally more than the 11% of Gen Zs and 13% of millennials who think their governments are highly committed to addressing the climate emergency.

They are slightly more optimistic about their own employer's efforts, with 18% of Gen Zs and 16% of millennials agreeing that their employer is strongly committed to fighting climate change. But there is clearly room for improvement. **Almost half of Gen Zs (48%) and millennials (43%) say they have put some pressure on their employer to take action.** Those who are the most vocal on this issue, and feel their employers are listening and incorporating their feedback, are also more loyal. This suggests there is mutual long-term benefit for employers to listen and act. We know that many business leaders are indeed listening: [Deloitte's 2022 CxO Sustainability Report⁵](#) found that two-thirds (65%) of leaders are feeling pressure from their employees to act.

Gen Zs and millennials want to see their employers invest in visible, everyday environmental actions where they have an opportunity to be directly involved

When asked to rank the environmental actions they'd like to see their employers invest in, Gen Zs and millennials prioritized highly visible actions that enable employees themselves to take part, such as banning single-use plastic products and training people to make better environmental choices in their everyday lives. Lower on Gen Zs' and millennials' priority list are some of the broader and deeper climate actions businesses can take to drive change outside of their own four walls and effect policy change, potentially because these areas are less visible to them, and less easy to get involved in directly. **This suggests that businesses should identify the hierarchy of climate actions they want to pursue to drive change and communicate their strategy in such a way that their people understand the relative impact and have an opportunity to engage.**

Ranking of where Gen Zs and millennials feel their organizations should invest more resources to help combat climate change:

Top priorities



Banning single-use plastic products at work/office locations



Offering sustainability-oriented employee benefits (e.g., electric car subsidies, incentive to use public transport, cycle-to-work schemes)



Providing training for employees on how they can make a positive impact on the environment in everyday activities



Providing employees incentives to make better environmental choices (e.g., encouraging them to track their footprints and compare with colleagues, etc.)

Lower priorities



Committing to achieving net-zero greenhouse gas emissions within the next decade



Engaging in public policy engagement to better align the company's walk with its talk



Using social impact pension providers or retirement funds focused on sustainable investments



What Gen Zs and millennials are saying about climate change

“Personally, I have made a lot of lifestyle substitutions to protect the environment, such as, not buying meat, sourcing locally, cycling, buying an EV car. These aren't huge but they are conscious efforts and I try to encourage my friends and family to do the same.... I think governments need to mandate more policies to address wealth inequality and empower people to take steps to fight climate change. People can't fight climate change if their basic needs aren't even being met, so addressing wealth inequality is key here.”

– Matt, 29, UK, One Young World ambassador

“I try to take steps at my level like switching off the lights when not in use, using a metal straw, reusable cloth bags, etc. I feel like even though it may not matter on an individual level, if everyone makes green choices it will have a great impact as a whole. I also think that business and governments are taking steps to fight climate change, but it is not enough.”

– Rajwee, 18, India

“I always opt for sustainable products even though they are more expensive. In the future, I will also buy an electric car and solar panels for my house to help combat climate change. Even though it's expensive now I believe in the future it will be more accessible and cheaper.”

– Julia, 22, Australia

“When it comes to what employers could do to fight climate change, I'd like to see them use ethical and sustainable materials, reduce energy waste where possible, and incentivize their employees to take action. Another option would be to have a zero-tolerance policy when it comes to producing, manufacturing, or just interacting with other businesses or suppliers who are harming the environment.”

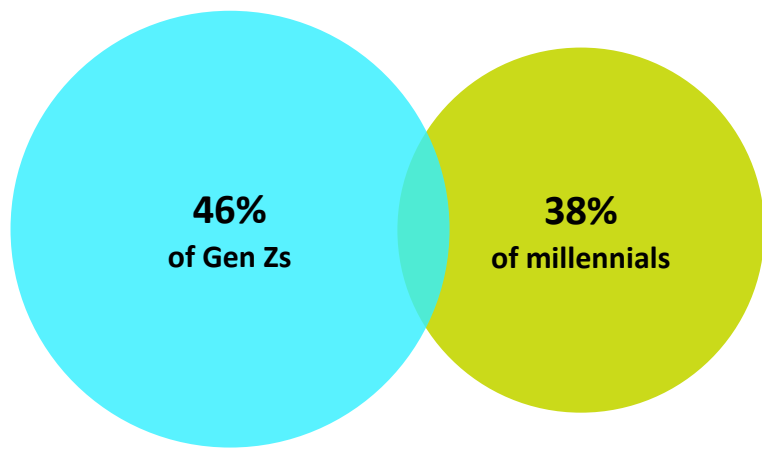
– Serraya, 25, US

“I do not think businesses and governments are doing enough to drive change. They need to take actions to reduce our global emissions by 2024. It is an issue that requires immediate attention.”

– Alex, 29, US



Part 4: Addressing the workplace mental health crisis



say they are stressed all or most of the time

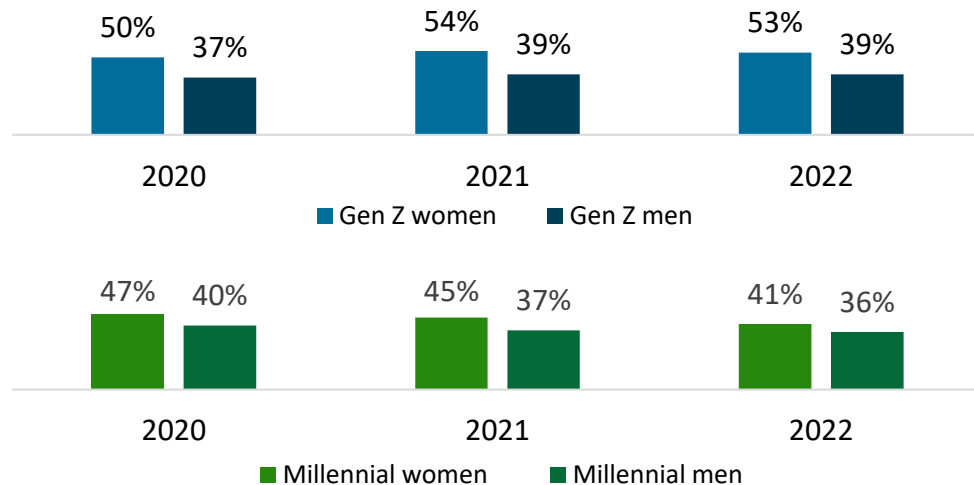


High stress levels are becoming more common for Gen Zs, particularly among women, compared to their millennial counterparts

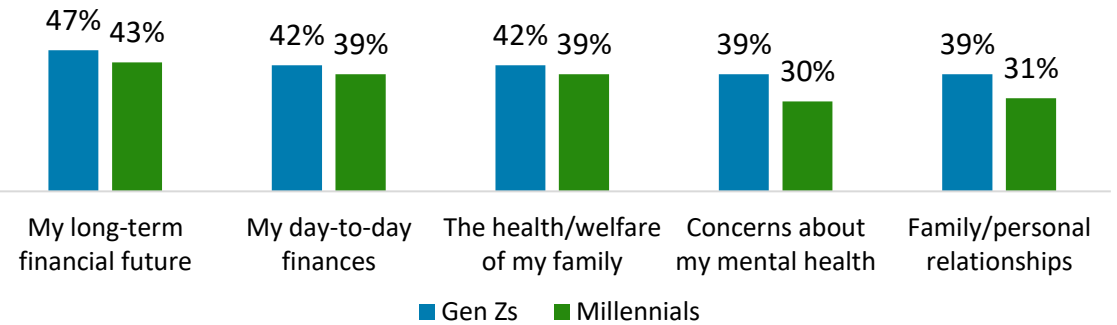
While stress and anxiety levels are significant in both generations, they are higher among Gen Zs. **46% of Gen Zs say they are stressed or anxious all or most of the time**, roughly consistent with survey results from the past two years. This compares to **38% of millennials**, whose stress levels have been slowly declining from 44% in 2020.

Stress levels are more pronounced among women, particularly among Gen Zs. This is a continuation of last year's survey findings and is also echoed in Deloitte's recent [Women @ Work 2022: A Global Outlook](#), in which 53% of women reported feeling more stressed than they were a year ago.

The gender gap among those who regularly feel stressed or anxious:



Top factors contributing to feelings of stress



When looking at the key factors driving stress levels in Gen Zs and millennials, concerns around financial security rank high. Of those who say they feel regularly stressed or anxious, **47% of Gen Zs and 43% of millennials** cite their long-term financial future as the main reason—similar to last year. In addition, 42% of Gen Zs now consider day-to-day finances to be a top contributor, a rise from 38% last year, and now on par with the health and welfare of their families.

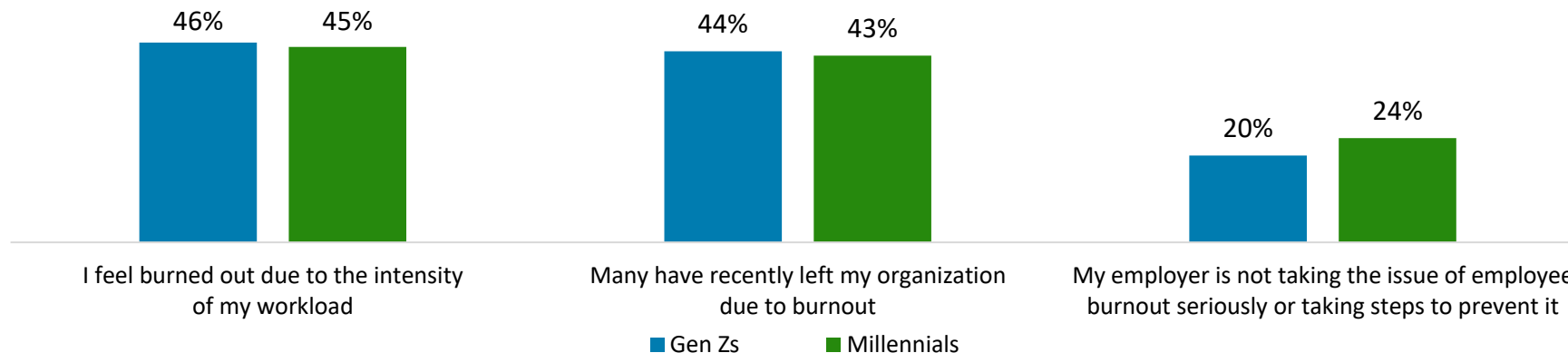
A number of workplace factors are also driving stress, especially when it comes to Gen Zs. A third of those who feel regularly stressed say their workload (34%) and a poor work/life balance (32%) contributes significantly to their stress and anxiety, while one in four have selected their inability to be themselves at work as a significant issue.

Burnout levels signal retention issues for employers

Almost three years into the pandemic, levels of burnout, categorized by the World Health Organization as an occupational phenomenon resulting from chronic workplace stress, are very high in both millennials and Gen Zs. **More than four in 10 Gen Zs (46%)** and **millennials (45%)** surveyed said they feel burned out due to the intensity and demands of their work environments. This signals a significant retention issue for employers. In fact, **44% of Gen Zs** and **43% of millennials** say that many people have recently left their organizations due to the pressure of their workloads, and Gen Zs and millennials who have changed organizations in the last two years cited burnout as one of the top three reasons for leaving their previous employer.

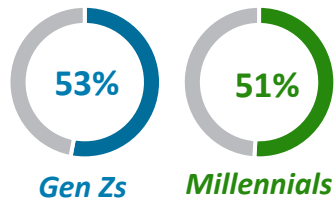
Despite this, **one in four millennials** and **one in five Gen Zs** do not believe that their employer takes burnout seriously or is taking steps to address it, indicating that many employers have yet to fully understand—or address—the impact that burnout is having on their business.

% who agree with the following statements:



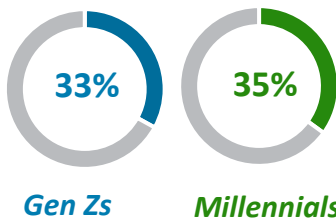
Gen Zs and millennials say their organizations are now more focused on mental health, but it's not necessarily translating to tangible positive change

More than half of Gen Zs (57%) and millennials (53%) agree that workplace well-being and mental health has become more of a focus for their employers since the start of the pandemic. However, there are mixed reviews on the impact.



agree that their organization talks more about mental health now, but this has not resulted in any meaningful impact on employees

It's clear that there is still discomfort around speaking openly about stress, anxiety, or other mental health challenges in the workplace.



said they would not feel comfortable speaking openly with their direct manager about feeling stressed or anxious or about other mental health challenges

And among the 38% of Gen Zs and 33% of millennials who have taken time off work due to feelings of anxiety or stress, nearly half didn't feel comfortable admitting the reason to their employer.

Reason provided to employer for time off work:

Gen Zs



Millennials





What Gen Zs and millennials are saying about stress and mental health

“I think the biggest problem with the mental health of my generation is that we've had so many life changing events happen in a really short space of time...from 9/11, to various tsunamis around the world, to terror attacks, to the climate crisis, to the COVID-19 pandemic...I think everyone has gotten to a point where they are just exhausted, and there's not an awful lot of support being given. In addition to houses being more expensive, we don't really have a solution to the climate challenge, jobs are harder to find for people who weren't able to get education during the pandemic as easily, and inequality is rising. I think everyone is just seeing things running out of control, and we don't seem to have strong leadership to solve this. So, I think that really plays into everyone's mental health and stress.”

– Matt, 29, UK, One Young World ambassador

“Sometimes I worry about the mental health of my generation. But I also think that people my age are doing something that hasn't really been done before – seeking therapy, being honest with ourselves, and our loved ones, about how we're feeling and opting out of doing things, even for a day, like going to work or school, because we're not having a good mental health day. I think we're realizing that physically showing up isn't always enough. You have to mentally be there too. So, I think that when we take the space for ourselves, that's how we take care of each other.”

– Natalie, 21, US

“I think social media is going to continue to have a huge negative effect on people's mental health, as well as the impact of the pandemic. Everyone has obviously been affected, but I think our generation is probably most affected in terms of our futures, our careers and everything.”

– Julia, 22, Australia

“Right now, the ongoing war between Russia and Ukraine has become one of my biggest concerns for the world. While things like climate change and global warming have been a concern for a long time now. Even a few months back, COVID was a big concern but not so much now. These concerns do affect my stress levels, although sometimes not as much as they really should. It's all so overwhelming, it just feels paralyzing sometimes, like there's nothing I can do. I think it would be really helpful if employers understood that some days people just need a break, and it's okay to take a leave when things get overwhelming. And it's really important to invest in their employees' mental health and provide resources to support them.”

– Rajwee, 18, India

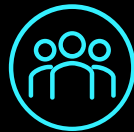


Key takeaways for business leaders



Support people struggling with economic uncertainty and financial stress

One of the most direct actions organizations can take to address wealth inequality is to focus on supporting their own people. By understanding employees' priorities, organizations can align benefits and compensation accordingly. Competitive salaries are important, as are benefits like paid time off, health care, and retirement savings. But there is more organizations can do: they can offer financial education and resources, given finances are such a significant source of stress for young people. They can offer learning and development opportunities that help employees to advance professionally. And they can offer flexible work models that enable people to take the time they need for personal responsibilities. Another key factor is focusing on closing the pay gap, which will include working to ensure that women and minorities are represented at all levels, and that they have equal opportunities to grow.



Empower people to lead and drive change

Gen Zs and millennials want to make their voices heard and to drive change. The Great Resignation has made this even more critical for employers to pay attention to. Gen Zs and millennials are demanding workplace changes that they've long been asking for, and if these changes don't happen, many are willing to leave. Beyond better compensation, work/life balance, learning and development, and flexibility, they want to derive a sense of meaning from their work, and to work for organizations that are having a positive societal impact. To attract and retain talent, business leaders need to listen to their people and empower them to drive change. They can do so through initiatives like reverse mentoring, and by providing opportunities for upskilling and stretch projects, which give people opportunities to grow and explore their potential.



Key takeaways for business leaders



Implement hybrid work strategies

The last few years have shown many organizations that remote, or hybrid work is possible for a wide range of roles, and many people prefer these arrangements. They value the flexibility, and the potential for better work/life balance that it brings. With this in mind, businesses should develop hybrid work strategies that enable employees to choose where and when they work. The key to creating an effective hybrid work strategy is offering flexibility, while fostering an inclusive workplace culture, where everyone has equal opportunities to form connections, learn, grow, and advance in their careers. There are a number of strategies that organizations can leverage to ensure that those who choose to spend less time in the physical office are not penalized for it. Steps in this direction include, unconscious bias training for leaders to prevent and overcome proximity bias, tracking promotion rates to ensure that remote workers are promoted at the same rate, and managers scheduling equal one-on-one time with their reports, regardless of where they work.



Prioritize climate action, and empower people to help

Gen Zs and millennials believe that urgent action is needed to address climate change. They are doing their part to reduce their personal environmental impact, and they want businesses and governments to do more. Businesses have a need and an opportunity to provide more sustainable products and services. And as employers, they should set climate strategies and look for ways to consistently engage and inspire their people to take part. This includes everyday actions like banning single-use plastics. It should also include longer-term strategies to achieve net-zero greenhouse gas emissions, which will require efforts such as, educating people about how to make sustainable choices, offsetting current carbon emissions, reducing business travel, and greening office locations, fleets, and supply chains. Gen Zs and millennials care about these issues, and they want to be directly involved. By empowering their people to help fight climate change, businesses will be better positioned to drive change at scale.



Key takeaways for business leaders



Support better workplace mental health

Stress and anxiety levels are high among Gen Zs and millennials and are unlikely to ease as global threats continue to affect their daily lives and shape their long-term view of the world. In this context, business leaders have a crucial role to play in supporting mental health at work, and in mitigating the causes of stress and burnout. Providing better mental health resources is a critical first step—from supportive leaders, to educational resources, to company-sponsored counseling or therapy. To ensure that people feel comfortable accessing these resources, business leaders must make a consistent and vocal commitment to designing stigma-free work environments that value well-being, where workers feel able to speak up about their needs without fear of judgement. The trust needed for people to open up and seek help rests on the everyday behaviors and accessibility of their managers, which is why business leaders must act on building empathetic leadership skills, and helping managers learn how to recognize and help with mental health challenges. Organizations should also take a broad view of their employees' well-being. Disruption is here to stay, which means it's important for employers not only to try to help reduce stress and anxiety levels, but also to help address their root causes. This includes showing people how to set boundaries to protect their work/life balance and supporting them in doing so. It also means having a clear purpose and giving employees the opportunity to address societal problems through their work.

Mood Monitor

The 2019 Millennial Survey began gauging respondents' mood using an index intended to provide an annual snapshot of Gen Zs' and millennials' optimism that the world and their places in it will improve.

Index scores are based on responses to five questions:



Economy

Do you expect the overall economic situation to improve, worsen, or stay the same over the next 12 months?



Social/political

Do you expect the overall social/political situation to improve, worsen, or stay the same over the next 12 months?



Personal finances

How do you expect your personal financial situation to change over the next 12 months?



Environment

Are you generally optimistic or pessimistic that efforts to protect and sustain the health of the planet will be effective?



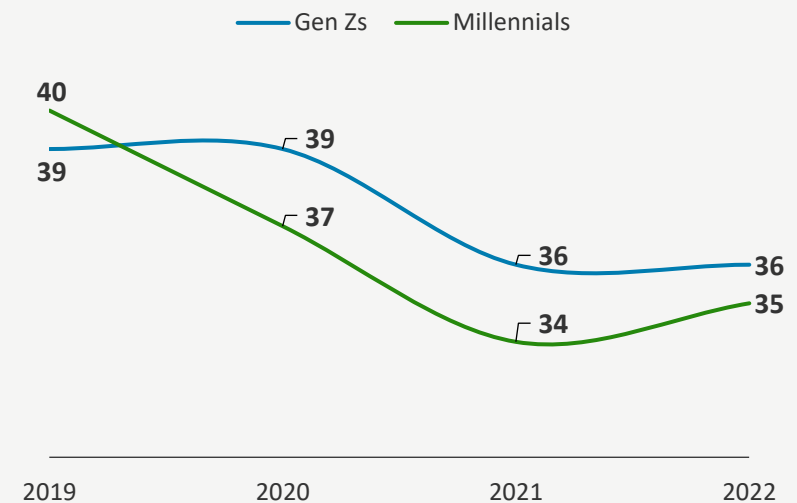
Business

What impact do you think businesses are having on the wider society in which they operate?

Composite scores are calculated and expressed on a scale ranging from zero (absolute pessimism) to 100 (complete optimism).

In its fourth year, the Mood Monitor reflects flat levels of optimism compared to last year, and slowly declining levels since 2019.

Total Mood Monitor scores:



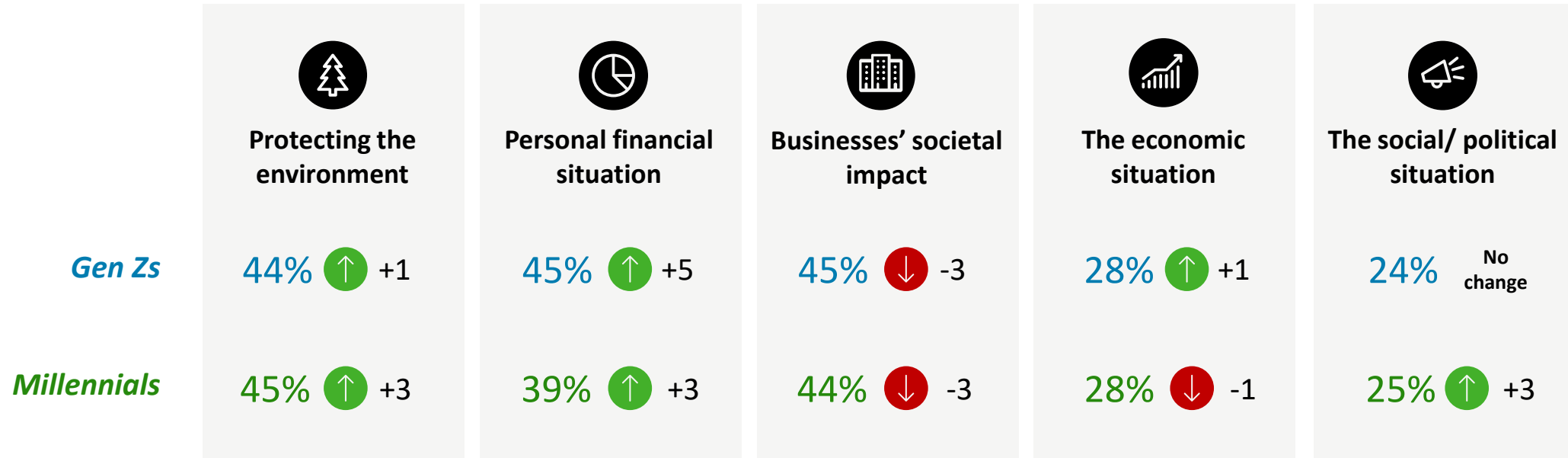
* Results were aggregated using the percentages of respondents expressing positive outlooks regarding each of the five questions. That number was divided by the maximum possible total of 500, yielding a percentage that is stated as a whole number (i.e., 0.4 gives a composite score of 40).

**The primary 2020 Millennial and Gen Z Survey was fielded before the onset of the COVID-19 pandemic. A smaller "pulse" survey of 9,100 respondents across 13 countries was fielded between April and May 2020 to gauge the effect of the pandemic on Gen Zs' and millennials' views. The Mood Monitor score based on that pulse survey was 32 for both generations. While optimism has bounced back slightly, scores have not returned to pre-pandemic levels.

*Global scores don't include China.

Mood Monitor Drivers

This year, scores were boosted by slightly higher levels of optimism that personal financial situations would improve, and that efforts to protect the environment would be effective. While those who feel this way are still in the minority, the findings suggest that, despite financial anxieties, some are hopeful that the cost-of-living crisis will soon improve. However, views on business' societal impact counteracted these gains, dropping three points compared to last year and continuing the steady decline that has been occurring for over five years. Meanwhile, optimism about economic and sociopolitical situations remains low.



Research Methodology

Deloitte's 2022 Gen Z and Millennial Survey reflects the responses of **14,808 Generation Zs** and **8,412 millennials** (23,220 respondents in total), **from 46 countries** across North America, Latin America, Western Europe, Eastern Europe, the Middle East, Africa, and Asia-Pacific. The survey was conducted using an online, self-complete-style interview. **Fieldwork was completed between 24 November 2021 and 4 January 2022.**

In addition to the survey, in **April 2022, a virtual qualitative assessment was conducted** with 15 Gen Zs and millennials from Australia, India, Japan, the UK, and US. The participants shared their personal thoughts on questions related to their societal concerns, finances, the future of work, climate change, and mental health. Their quotes are included throughout the report, attributed to them by first name, age, and location. Two respondents are [One Young World ambassadors](#). To ensure that the initial survey results and report content did not influence their responses, the participants were not given an advance copy of this report to review. Their views are their own and do not necessarily represent Deloitte's views.

The report represents a broad range of respondents, from those with executive positions in large organizations to others who are participating in the gig economy, doing unpaid work or are unemployed. Additionally, the Gen Z group includes students who have completed or are pursuing degrees, those who have completed or plan to complete vocational studies, and others who are in secondary school and may or may not pursue higher education.

*As defined in the study, **Gen Z respondents** were born between January 1995 and December 2003, and **millennial respondents** were born between January 1983 and December 1994.*





Endnotes

1. The Future Forum, [A new era of workplace inclusion: moving from retrofit to redesign](#), 11 March 2021.
2. Axios, [The gender divide in remote work](#), 13 May 2021.
3. Axios, [Women, people of color happier working from home](#), 22 February 2022.
4. Harvard Business School, [The old boys' club: Schmoozing and the gender gap](#), June 2021.
5. Deloitte Global, [CxO Sustainability Survey](#), January 2022.
6. Deloitte Global, [Women @ Work: A global outlook](#), 26 April 2022.



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Advancing **all** women. It's just good business.

Deloitte.



**WELCOME TO
GENERATION Z**

INTRODUCTION

Heard the words “lit”, “bruh” and “major key” before? They’re just a few examples¹ of what you’ll be hearing from the mouths of Gen Zers as they use “lit” to describe something cool, call a close friend “bruh” and refer to something essential as “major key.” This reworking of the English language is the beginning of Gen Z’s influence.

A new generation has arrived. Gen Z will soon surpass Millennials as the most populous generation on earth, with more than one-third of the world’s population counting themselves Gen Zers. In the US, Gen Z constitutes more than a quarter of the population and by 2020 will be the most diverse generation in the nation’s history².

Its members are about to step onto the world stage, entering the workforce and spending money on the products, services and solutions that you produce, provide and create.

The impact of their entry will be swift and profound, its effects rippling through the workplace, retail consumption and technology, as well as in politics and culture. Radically different than Millennials, this generation has an entirely unique perspective on careers and how to define success in life and in the workforce.

In late 2018, in partnership with Deloitte, NEW surveyed more than 6,000 individuals across several demographics including generation, race, gender, income, education and location. Of the total respondents, 1,531 were considered Generation Z, 1,541 were considered Millennials, 1,560 were considered Generation X and 1,595 were considered Baby Boomers. Women represented 3,151 of the total respondents with 1,590 respondents classified as minority women. For the purposes of this report, Black, Hispanic and Asian women data and insights are grouped as minority women.

In this report, we look at the factors that have gone into shaping Gen Z, demographic shifts taking place in the US that will affect Gen Z's entry into the workforce, Gen Z behaviors and attitudes and their view toward work, the future of work and what it means to organizations and employers seeking to entice and integrate Gen Z into the workplace.

Entire industries and businesses will rise and fall in the wake of the Gen Zers. Yet few industries or organizations seem to be ready for it.

Are YOU?



talkin' bout this

GENERATION

Born between 1995 and 2012, making up 24.3% of the U.S. population³ and on track to be the most diverse generation in US history by 2020⁴, Gen Z is about to make its presence known in the workplace in a major way — and it's important to understand the differences that set them apart.

Gen Z cannot remember a time before the September 11 attacks and the War on Terror. Its members were born after the collapse of communism and witnessed the meteoric rise of China in the global economy. It came of age in a world where content and information is increasingly free and shared, where the body of human knowledge has expanded with mapping of the human genome and where one-click online purchasing is taken for granted.

8 THINGS FROM THE '90S, ZERS DON'T QUITE GET...⁵

1. Listening to music on cassette players.
2. Drawing a picture on an Etch a Sketch—the forerunner of creative drawing tablets.
3. Making a pay phone call.
4. Transistor radios: Invented in 1947, it was revolutionary for its time. Today it's a rare sight.
5. Myspace, the first social networking site of choice.
6. Paper maps: With step-by-step directions on Google Maps, paper maps are a thing of the past.
7. Fax machines, the original email.
8. Typing a letter on a typewriter.

GEN Z FIRSTS...

- The first generation that has never known a world without the worldwide web.
- The first generation that has never used a phone with a cord.
- The first generation that has no idea what floppy disks are.





Gen Z is the most ethnically and racially diverse generation in history: One in four is Hispanic, 14% are African-American and 6% are Asian, according to studies led by the Pew Research Center⁶. And their views on gender and identity are unprecedented and untraditional: Gen Z refuses to turn ethnicity and race into checkboxes on a survey form⁷.

Gen Z is entering the workforce at a key inflection point in the evolution of work⁸. Historically, a first job was viewed as a rite of passage: It meant starting at the bottom of the ladder, learning how the business world really worked and doing boring but necessary work as a way to learn more valuable professional skills. But all of this has changed—technology and automation have eliminated many of the more manual and repetitive tasks.

With jobs undergoing change AND with the workforce shrinking, competition for talent will be fierce. Companies need to think—and prepare—differently to win in the talent market. Employers should consider redesigning these jobs in a way that can both attract and engage Gen Z and ensure that jobs continue to generate a pipeline of future talent.

GEN Z STEREOTYPES

Gen Z has arrived replete with a set of stereotypes and generalizations: Gen Zers are tech-dependent; they want to experience new adventures, not just buy things; and they're less loyal to brands.

As the first digitally native generation, it's touted they prefer digital communication to avoid face-to-face interaction, they're harder to reach because of their short, "eight second" attention span and they're focused on authenticity in a brand.

Yet companies and organizations would be wise not to fall for the myths and stereotypes: Whether you're talking about gender and ethnicity or modes of learning,

Gen Z refuses to fit into neat little boxes.

To better understand the challenges facing this rising workforce and their impact on employers and the workplace, the Network of Executive Women (NEW) and Deloitte surveyed Gen Zers to understand the key events that helped shape their lives; to explore individual behaviors, attitudes and preferences; and to separate the myths and stereotypes from reality.

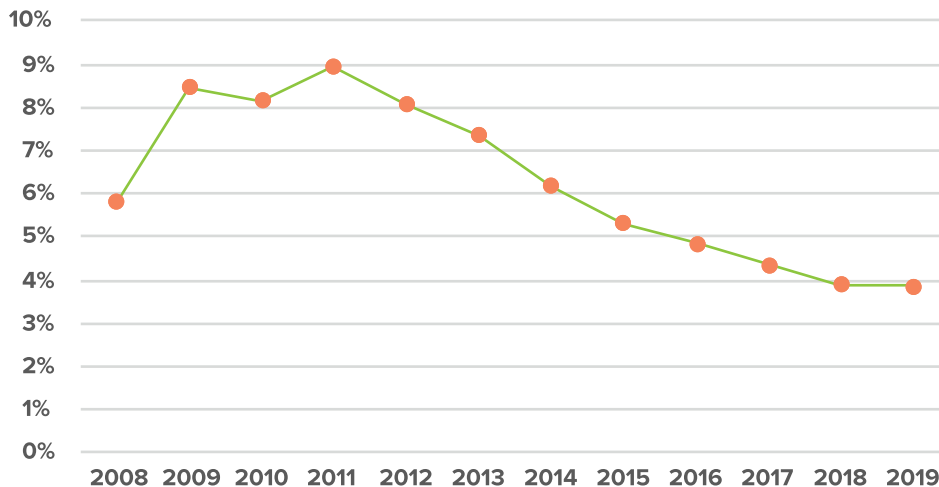
Gen Z is not a completely different “species” than previous generations that entered the workforce. But its members do approach the workplace in a very different way than did earlier cohorts. To appeal to them will require organizations to truly personalize career experiences (the way we think about personalizing offers we make to customers). Not only will this personalization help to attract this generation and compel them to spend some part of their career in our companies, applying their diverse skills sets to drive customer solutions, but it can also benefit workers across generations, helping to attract and retain talent more broadly.



KEY DEMOGRAPHIC *SHIFTS*

Demography is said to be destiny. While there are currently more than 44 million Baby Boomers who are still working, 10,000 Boomers retire each day⁹. This shift in demographics is transforming the workforce. From 2017 to 2027, the US will face a shortage of 8.2 million workers—the most substantial shortfall on a percentage basis in 50 years, according to Thomas Lee, head of research at Fundstrat Global Advisors¹⁰.

US unemployment: before and after the Great Recession¹¹



In addition to demographic changes, there are structural shifts afoot. US labor force participation has shrunk, from 65.9 percent in 2007 to 62.8 percent this year, the lowest rate since the late 1970s¹². The supply of workers has fallen steadily since the last recession.

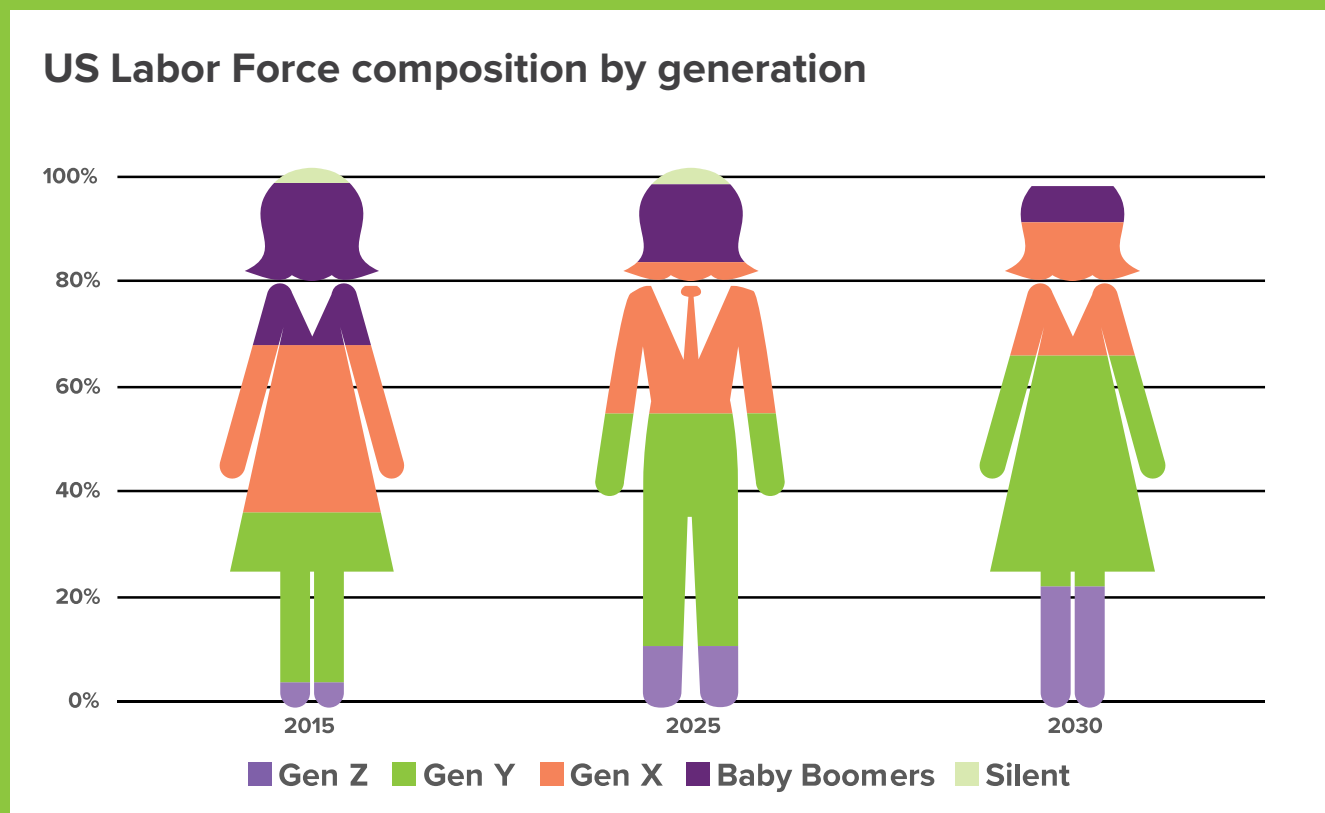
These demographic and structural trends are reshaping the labor market. As more Boomers enter retirement, Gen Z will be replacing them, bringing with them an entirely different worldview and perspective on their careers and how to succeed in the workplace. Understanding the forces that shaped their views, career aspirations and working styles is essential for companies looking to attract them.

What led us to explore this new generation

The entry of any new generation into the workforce is usually accompanied by comparisons to earlier generations, along with expectations, anticipation and generalizations of how the generation may disrupt the workforce. Much anticipation arose when the Millennials were entering the workforce, with the conversation in the marketplace and the media focusing on the impact that smartphones, technology, social media and connectivity has had on this generation.

We wanted to look beyond the surface and explore what will happen as the following forces have an impact on companies, business and the economy:

- Gen Z makes up more than a quarter of the U.S. population and will contribute \$44 billion to the national economy¹³.
- The workforce has dropped from 67% in 2000 to 63% in 2018¹⁴.
- Companies' experience with the entry of Millennials into the workplace may not have prepared them to win with Gen Z.



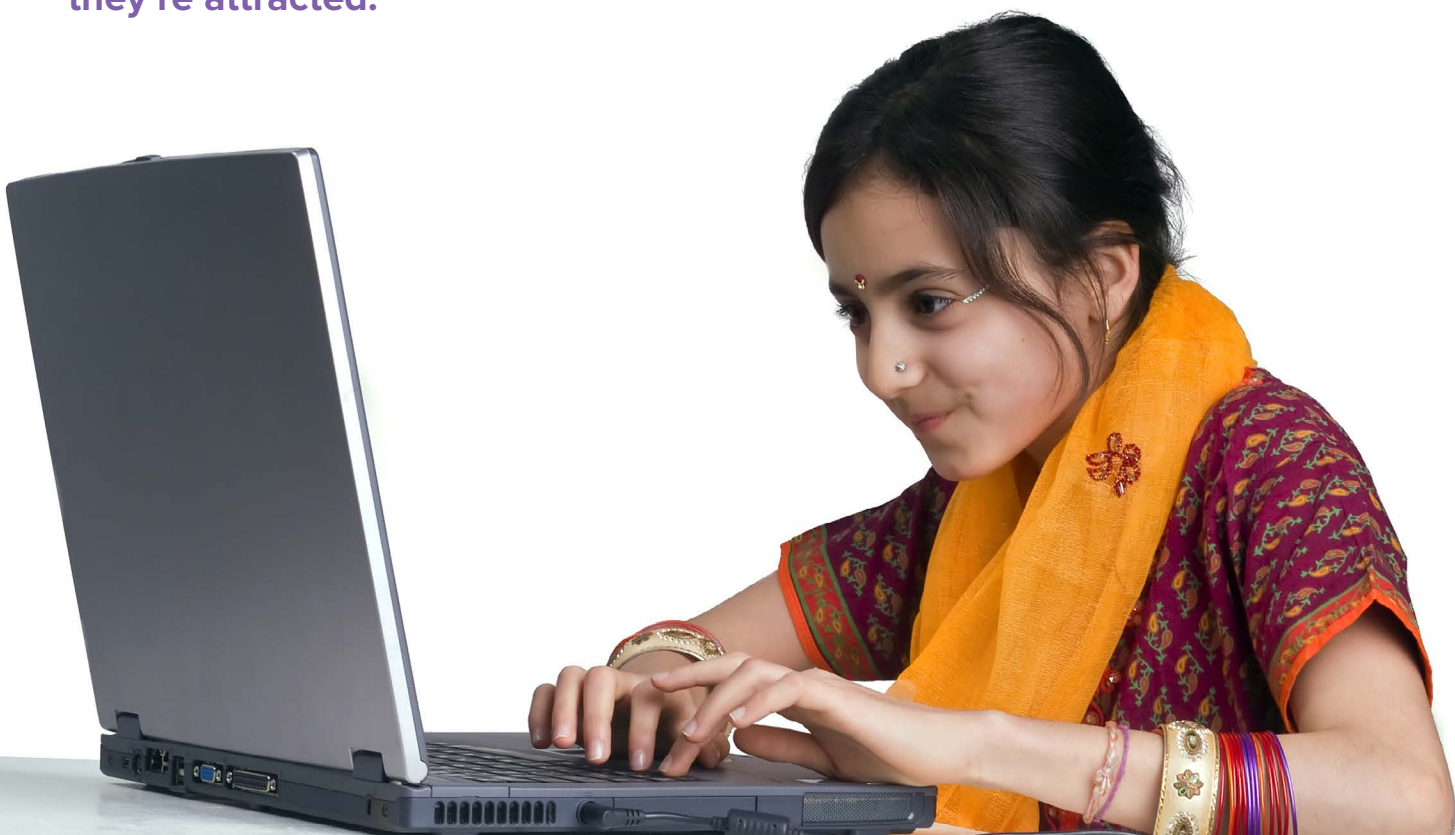
Source: US Dept of Labor.

GEN Z: Key factors that shaped their worldview

To truly understand this new generational cohort and what their entry into the workplace will mean, employers first need to appreciate the environment in which they came of age and forces that shaped their outlook:

- The Great Recession and the slow, decade-long recovery that followed in its wake: watching parents lose jobs; seeing older Millennial siblings having to move back home.
- The growing wealth gap between income groups: from 2007-2016, the high-income group saw its income increase 1,425% more than the low-income group and four times the middle-income cohort — and the gap is widening¹⁵.
- Rising non-discretionary expenses, such as housing, transportation, food and healthcare.
- A dramatic rise in higher education tuition and student debt will make this generation the most educated and indebted generation to date¹⁶.

These key factors have shaped Gen Z behaviors and their view of work, the future and those organizations and industries to which they're attracted.



INDIVIDUAL BEHAVIORS & TRENDS OF GEN Z

So who is Gen Z, what are their behaviors and what sort of impact will they have on the workplace, business and the economy?

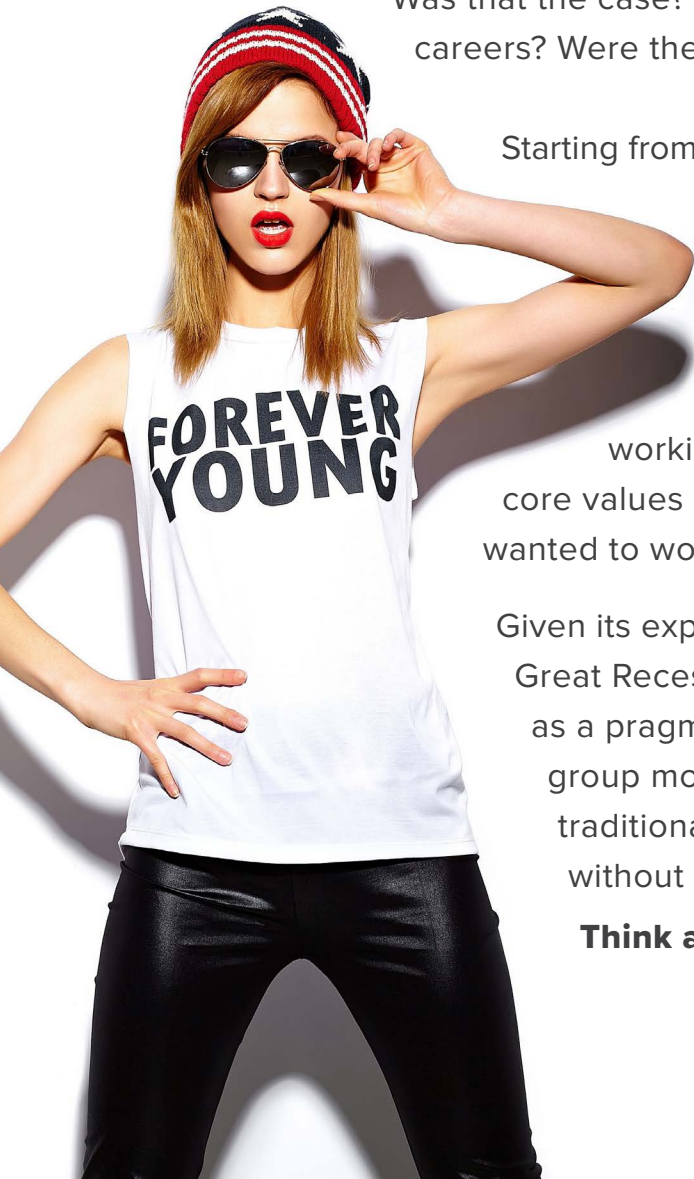
To explore those issues, we surveyed 1,531 Gen Zers, looking to resolve assumptions and premises about this generation that often pass as conventional wisdom in the media. For example, Gen Z is typically portrayed as prioritizing financial security over “personal fulfillment.”

Was that the case? What were their aspirations in terms of careers? Were they risk-averse or more entrepreneurial?

Starting from nine hypotheses, we sought to understand their career aspirations and development and which industries and sectors they were drawn to. We wanted to understand their working styles: Are they more comfortable as team players versus working individually? We looked at how their core values determine the kinds of companies they wanted to work (and would avoid working) for.

Given its experience growing up in the aftermath of the Great Recession, one might think Gen Z has emerged as a pragmatic, risk averse, non-entrepreneurial group motivated by job security, uninterested in traditional higher education and ready to work without argument at the whim of employers, right?

Think again.



SURVEY HYPOTHESES

1. ✓ Career Aspirations
Gen Z prefers to work in industries that they interact with in their personal lives opposed to industries they aren't frequent consumers of.

2. ✓ Career Development
Gen Z desires diverse and entrepreneurial opportunities with the safety of stable employment and will remain loyal to a company if they can offer this.

3. ✓ Working Styles
Gen Z prefers individual tasks over team-based activities however they will value physical connection. They prefer independence but not isolation.

4. ✓ Core Value
Gen Z no longer forms opinions of a company solely based on the quality of their products/services but now on their ethics, practices and social impact.

5. ✓ Core Values
Gen Z will prioritize financial security over "personal fulfillment".

6. ✓ Education/Learning
Gen Z is reevaluating the cost/benefit analysis of traditional education given the dramatic rise in education expenses and the impact of student loan debts.

7. ✓ Education/ Learning
Gen Z proactively seeks out learning opportunities to enhance skills and prefers to learn independently via online platforms, such as online tutorials.

8. ✓ Behavior & Character
Gen Z's attachment to social media will pose implications to how they interact and want to be perceived.

9. ✓ Diversity
Gen Z defines diversity along different lines than generations before them.

 Hypothesis confirmed

Instead, a more nuanced picture emerged as we explored their career aspirations, career development, working styles, core values, behavior and character, education and stance on diversity.

Much has been made in the media and in earlier surveys of Gen Z's emphasis on money and salary. However, we found that of the respondents, when it comes to salary and compensation, the reality is much more nuanced. Yes, money and salary matters the most to Gen Z. But because of the environment in which this generation came of age, other things matter too, such as work-life balance, flexible hours, perks and benefits. More importantly, Gen Z feels itself in a position to get those perks from employers, in addition to salary. And while salary is the most important factor in deciding on a job, Gen Z values salary less than every other generation: if given the choice of accepting a better-paying but boring job versus work that was more interesting but didn't pay as well, Gen Z was fairly evenly split over the choice.

The core values of the generation are reflected in their prioritizing social activism more than previous generations and in the importance they place on working at organizations whose values align with their own, with 77% of respondents saying that it's important. Gen Z no longer forms opinions of a company solely based on the quality of their products/services but also now on their ethics, practices and social impact. To win the hearts of Gen Z, companies and employers will need to highlight their efforts to be good global citizens. While focusing on the quality of the goods/services you provide is still important, a company's ethics are more important than ever. Moreover, actions speak more loudly than words: Companies must demonstrate their commitment to a broader set of societal challenges, such as sustainability, climate change and hunger. Not only must companies have strong ethics, they have to demonstrate they take action consistent with their ethics and values, and this action must be front and center of their brand for prospective Gen Z buyers and employees to see.



RECRUITING MORE GEN Z WOMEN TO THE TECH INDUSTRY

At the moment, women only make up 28% of STEM jobs in America and, according to a study by the National Association of Manufacturing and Deloitte, more than 3.5 million STEM jobs will be needed by 2025¹⁷. Despite the many initiatives aimed at girls and young women, women appear not to be drawn to the STEM fields. To meet the goal of greater gender diversity, companies will have to change and figure out ways to attract more women to technology, particularly as every industry faces a workforce crunch.

Gen Z is an independent, entrepreneurial generation yet it differs from Millennials, whose career development paths seemed to be directed toward startups and early-stage companies. Gen Z's preferred career development is to have diverse and entrepreneurial opportunities with the safety of stable employment, and they may offer more loyalty to companies that can offer this.

Gen Z digital natives are drawn toward working in the tech industry: 51% of those surveyed rate technology as a top industry in which to work. At the same time, they also are drawn to work that supports the greater good, such as education (41%) and healthcare (37%). But there are gender differences: Gen Z females seek roles in technology at a much lower rate (34%) than their male counterparts (73%). This continuing gap between the sexes will likely have implications, particularly for tech companies seeking to create greater diversity and inclusivity at their organizations.



Diversity is the watchword for Gen Z: Diversity matters to them through many dimensions, not just isolated to race and gender, but also related to identity and orientation. Gen Z prioritizes diversity — across race, gender, and orientation — more than any other generation and companies should as well. Gen Z is also the most likely generation to have individuals that identify as non-binary/third gender. As a result, companies need to represent the full spectrum of humans in marketing: Many Gen Z minorities feel their race isn't well represented in marketing. Companies that can better represent the spectrum of differences in their external branding/marketing are much more likely to diversify their talent pipelines.

Finally, we found that contrary to popular belief, Gen Z is not reevaluating the value of a college education. In fact, Gen Z considers a traditional four-year college education more important than ever before. Gen Z is quickly becoming the most educated and debt-laden generation in history. So organizations that focus on investment in learning and skill/capability development become more attractive to this education-oriented cohort.



THE FUTURE OF WORK

As we draw insights from the preferences and behaviors of our newest generation entering the workforce, we need to also take a look at how “work” itself is changing and evolving. We define the future of work as a result of the many forces that are effecting change in three deeply connected areas of an organization: work (the what), the workforce (the who), and the workplace (the where)¹⁸.

The new realities produced by these forces of change present us with complex questions to consider — including the ethics around human-machine collaboration, how to plan for 50-60 year careers and how we unleash organizations through a continuum of talent sources. As Pulitzer Prize-winning author Thomas Friedman has pointed out: “What’s going on is that work is being disconnected from jobs, and jobs and work are being disconnected from companies, which are increasingly becoming platforms.”

Deloitte’s Point of View on the Future of Work

2. WORKFORCE

Who can do the work?

With new talent platforms and contracts, who can do the work? How do we leverage the continuum of talent from full-time, to managed services, to freelancers, gig workers, and crowds?

1. WORK

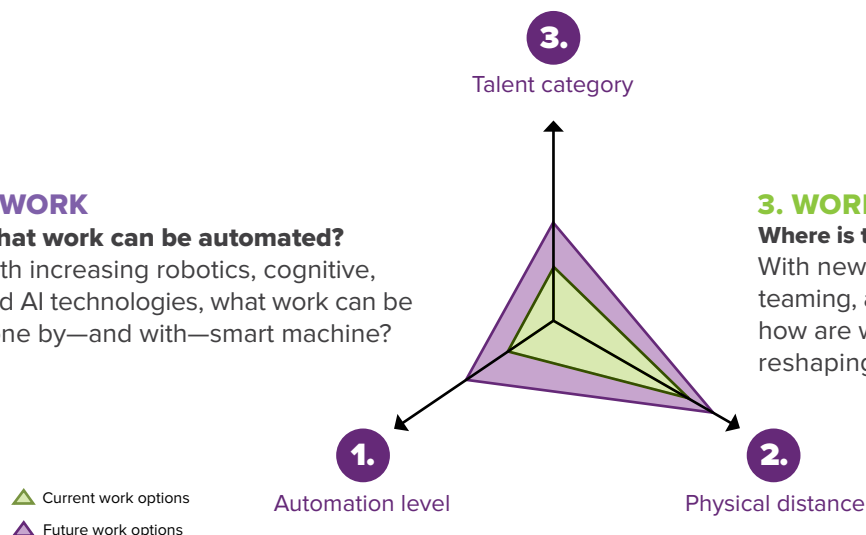
What work can be automated?

With increasing robotics, cognitive, and AI technologies, what work can be done by—and with—smart machine?

3. WORKPLACE

Where is the work done?

With new combination of collaborative, teaming, and digital reality technologies, how are workplaces and work practices reshaping where and when work is done.



Work skills in the past were often separated and distinct and siloed. The future of work, by contrast, draws on skill sets from diverging fields. For example, marketing will increasingly require a combination of creative thinking with analytics and analysis, necessitating that marketing managers be designers and analysts rolled into one. In computer science, the opposite has taken place: Once considered highly technical work, software developers require communications skills, problem-solving skills, creative and research skills, and skills in teamwork and collaboration.

The future of work will call for a return of the Renaissance figure: A person with many talents, interest and areas of knowledge. It will require a fusion of four key work skills:

Digital tools and technology skills: Along with a familiarity and comfort with digital tools, work will be defined by the ability to learn new systems, and to configure and customize these tools.

Comfort with analytics and data: Data analytics — including interpretation, visualization and communication — is one of the most important. Every one of these high-paying jobs (customer service manager, health care advisor, sales professional) requires facility with analytics and data.

Business and management skills: Work increasingly requires business and leadership skills, irrespective of the position: engineers as well as accountants must have the necessary business management skills.

Design and creative skills: Design skills in the broadest sense are an essential part of the future of work, playing a growing role in areas that span from business analysis to finance to manufacturing.

WHAT DOES THIS **MEAN** FOR EMPLOYERS?

To succeed, organizations should consider “zooming out” and imagining the possibilities so they can compose the work, the workforce and the workplace in a way that increases value and meaning.

What we have learned about Gen Z preferences reinforces Deloitte’s research around the redefinition of work. Our findings further suggest Gen Z has the opportunity to shift the “balance of power” between the employer and the employee to a model where instead of workers trying to fit into a box called a “job”, organizations will need to tailor work around the curated skillset of a worker. That shift in balance is directly related to the more diverse choices Gen Z workers have in an environment of shrinking talent pools, the increase in organizations’ demands for next generation skills, all against a backdrop of contracting immigration policies. [See Sidebar: “Rethinking the talent model.”]

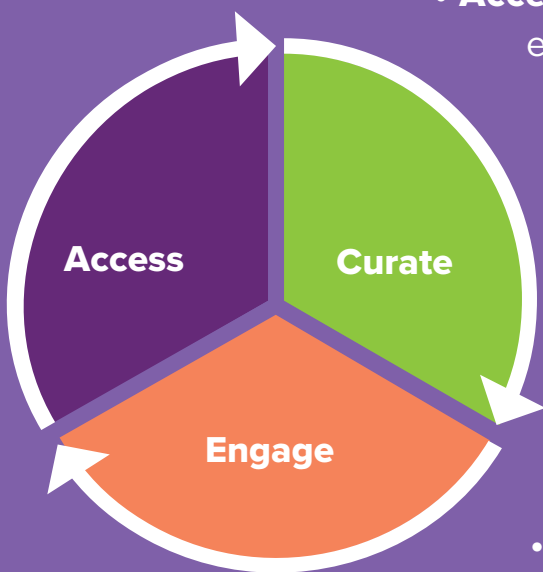
A new mindset. We think Gen Z will have the ability to demand greater personalization in how they move along their career journey. For organizations to attract and retain the best and brightest of the generation will require a different mindset. Employers will need to understand the behaviors and tendencies of a generation that expects much more personalization in how they want to be treated by their employer and is seeking more than just filling cookie-cutter roles. This personalization can be a positive change for all workers of all generations and can help attract and retain talent across generations. We break our recommendations into two areas: forward-looking and tactical actions, as organizations rethink the talent model.

RETHINKING THE TALENT MODEL

Not only have workforce demographics changed over the past 30 years — concurrently making the workforce older and more diverse — but the very social contract between employers and employees has altered dramatically as well. Organizations now have a range of options available to them for finding workers, from hiring traditional full-time employees to making use of managed services and outsourcing, independent contractors, gig workers and crowdsourcing.

The expanding continuum of labor sourcing options has created opportunities for greater efficiencies. At the same time, however, it has resulted in greater complexity. Orchestrating the use of different workforce segments may require new models. It could fundamentally change our view of the employee life cycle from the traditional “attract, develop and retain” model to one where the key questions are how organizations should access, curate and engage workforces of all types.

A new model for talent management



- **Access.** How do you tap into capabilities across your enterprise and the broader ecosystem (such as leveraging and mobilizing on- and off-balance sheet talent)?

- **Curate.** How do you provide employees and teams with the broadest and most meaningful range of development (including work experiences that are integrated into the flow of their careers and personal lives)?

- **Engage.** How do you interact with and support your workforces, business teams and partners to build compelling relationships?

Forward-looking actions:

We see three constructive actions for employers to consider in directing the forces of change:

- **Imagine.** Imagine the possibilities of the future by leveraging industry-specific data analytics and insights to define your ambition and strategy for transforming the workforce for the future. Set goals for the future of work that reach beyond cost and efficiency to include value and meaning.
- **Compose.** Analyze and redesign work, workforce and workplace options that take advantage of the value of automation, alternative talent sources and collaborative workplaces.
- **Activate.** Align the organization, leadership and workforce development programs to access skills, curate next-generation experiences and engage the workforce of the future in long-term relationships and business leaders in new ways of working.



Tactical actions:

To attract Gen Z, employers must be ready to adopt a speed of evolution that matches the external environment. That means developing a robust training and leadership development, with a real and tangible focus on diversity:

- **Companies need to fundamentally change how they organize, hire, retain and develop talent.** Gone is the day where an employer could simply match a job description with a college degree. Gen Z wants to gather a variety of different skill sets, rather than declaring a singular specialization. Marketing majors want coding and data analytic skills; computer programmers want literature and creative skills.
- **Develop the profile of a great employee, establish internal apprenticeship programs, or hire smart, talented people** and then match them with a role once inside the organization (similar to the consulting model).
- **To attract women candidates for tech roles,** consider partnering at the university level and identify top female talent, hire them before graduation and train them in-house, as fewer women than men are interested in going into the technology industry.
- **Create latticed career paths and multiple work formats.** Gen Z doesn't want to follow the traditional hierarchical path of moving up in an organization. Add more organizational formats to meet the needs of Gen Z talent (similar to retail store formats, where merchants are adding multiple ways to shop to attract different consumer segments).
- **Set up internal marketplaces** to match projects with needed skill sets.
- **Leverage the expertise of Gen X, Gen Y and Boomers to help mentor Gen Z into strong leaders,** given that Gen Z doesn't want to follow a typical career path, one that has deliberate development of leadership skills.
- **Consider the attractiveness of the industry you are in and the reputation of your company with Gen Z** and plan accordingly. Leverage social media similar to how brands are leveraging influencers.
- **Inclusion and diversity are critical factors Gen Z considers when deciding whether or not to join an employer.** If your leadership team is looking pretty homogenous, you need to be transforming the culture and the inclusivity of the workplace, which can benefit workers across generations.

CONCLUSION

Gen Z will soon surpass Millennials as the most populous generation on earth, with more than one-third of the world's population counting themselves Gen Zers. Its members are on the verge of entering the workforce and spending money on the products, services and solutions that you produce, provide and create. The generation is entering the workforce at a time when the overall workforce is shrinking. Understanding what matters to Gen Z will be critical to the success of companies in attracting the members and organizations in the future.

While money and salary matters a great deal to Gen Z, there are many other values it holds dear. It's important to Gen Z to work at organizations whose values align with their own.

Diversity matters to them through many dimensions, and isn't just isolated to race and gender, but also related to identity and orientation. Combining this with their preferences on how they work, where they work and who they work with means that companies will need to fundamentally change how they organize, hire, retain and develop talent. To attract and retain the best and brightest of the generation will require a different mindset. Employers will need to understand the behaviors and tendencies of a generation that expects much more personalization in how they are treated by their employer. Rather than try to fill cookie-cutter roles, instead develop the profile of a great employee, establish internal apprenticeship programs, or hire smart, talented people and then match them with a role.



AUTHORS:

Karianne Gomez
VP Strategic Value—NEW

Tiffany Mawhinney
Principal—Deloitte LLP

Kimberly Betts
Managing Director—Deloitte LLP

CONTRIBUTORS:

Kerri Sapp
Senior Manager—Deloitte LLP

Ahmed Brown
Senior Consultant—Deloitte LLP

Kara Santner
Senior Consultant—Deloitte LLP

ABOUT NEW

Founded in 2001, the Network of Executive Women represents more than 13,000 members, 900 companies, 120 corporate partners and 22 regions in the U.S. and Canada advancing all women and building business. For more information about NEW and its learning programs, events, content and insights, visit newonline.org. Connect with us on social media @newnational.

ABOUT DELOITTE

At Deloitte, we believe that we're only as good as the good we do. That's why we are continuously evolving how we work and how we look at marketplace challenges—so that we can continue to deliver measurable, sustainable results for our clients and our communities. With more than 150 years of hard work and commitment to making a real difference, our organization has grown in scale and diversity—approximately 245,000 people in 150 countries and territories, providing audit & assurance, tax, legal, risk and financial advisory and consulting services—yet our shared culture remains the same. But when people ask, "What's different about Deloitte?" the answer doesn't reside in how big we are, where we are, or what services we offer. What really defines us is our drive to make an impact that matters in the world.

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DESIGN STRATEGIES FOR THE HUMAN EXPERIENCE

Gensler

Everything we do is guided by our mission:
To create a better world through the power of design.



Atlantic Park, Virginia Beach, Va.
On the cover: Willis Tower, Chicago

Despite ongoing challenges, an enduring resilience is defining the built environment.



After almost two years of pandemic-infused stops and starts, we're seeing you, our clients, usher in a new era with a new kind of resilience. We're witnessing optimistic investments and plans to define the future of buildings and places with projects that respond to the new way that people work and live and that reflect the most influential issues we're facing today in climate change, inclusion, and community. This optimism is happening in spite of the pandemic, not because we've gotten past it.

Innovation is accelerating

The challenges you face remain significant. Across industries and time zones, companies like yours are feeling the pinch of supply chain woes and labor shortages. Climate change and its economic fallout have become a constant threat. Issues of equity and inclusion remain top of mind.

And yet, there's reason to be hopeful. The past two years have shown how tough times can accelerate innovation. New tools, techniques, and research have been able to bring people back together in purposeful, inclusive, and resilient spaces. Experience is the key to reinvigorating physical spaces — especially the workplace — and if you're looking to bring people back to the office or any physical space, you must create destinations rather than obligations. People are looking for twice the experience as before.

Shaping the future of cities

Likewise, cities must also look at the challenges they face through the lens of human experience. To position themselves as places where people want to live, cities must create convenient and walkable 20-minute neighborhoods, healthy green spaces

that promote wellness, buildings that have low-carbon footprints, and connected communities that embrace inclusivity for everyone.

Holistic design for the human experience

The most valued places prioritize the human experience, which is why human experience design is such a powerful opportunity for you and your communities. By taking a holistic approach to design, Gensler is creating places that feel inclusive, healthy, and purposeful — places that honor local context, while considering the health of occupants and planet alike.

This year's Design Forecast focuses on design strategies that will define the future of the human experience for the coming years. You'll find strategic advice, research, data, and projects from all 28 of Gensler's practice areas. We hope the trends in this publication will help you prepare for a new era of human experience.

DIANE HOSKINS
FAIA, IIDA | Co-CEO

ANDY COHEN
FAIA | Co-CEO



A
NEW
ERA
OF
HUMAN

EXPERIENCE

The resiliency and innovation we've witnessed across industries has given us a roadmap for how to move forward.

We're setting a new stage for how we live now.

In the past two years, the world has faced generational challenges. Lives have been changed, and that change is here to stay. And yet, optimism is in the air.

Design has offered innovative solutions to many of the challenges we've been facing, and the resiliency and innovation we've witnessed across industries has given us a roadmap for how to move forward. Our resourcefulness is slowly, but surely lifting the heavy veil of the pandemic.

We're not in the clear yet. Global instability, climate change, and social inequity remain difficult challenges, while the longer impacts of COVID — supply chain issues, labor shortages, and inflation — are driving competition as the world learns to live with some form of the virus for the foreseeable future.

While we are being confronted with tough new realities, we see a bright future ahead. It's a future where human experience is defined through the power design in the spaces we frequent, the communities in which we live together, and the air we breathe. Real estate is the stage on which life is lived, and because of that, its value is directly tied to how we experience the spaces where we live, work, and play. The path forward is the one designed with people at the center.



Riverfront Jacksonville Master Plan,
Jacksonville, Fla.

The impacts of COVID continue to disrupt the global supply chain and transform the workplace.

With the pandemic entering its third year, we're beginning to see new impacts of the virus, including supply chain issues, labor shortages, and inflation — all of which are driving competition for materials, talent, and resources like never before.

DESIGNING A MORE RESILIENT SUPPLY CHAIN ECOSYSTEM

We are taking action to improve the long-term resilience and sustainability of the building industry supply chain.

Across industries and time zones, our clients are facing delays and bottlenecks in the shipping of construction materials and furnishings for their properties. This is resulting in construction delays and ballooning costs. At Gensler, we are taking action to improve the long-term resilience and sustainability of the building industry supply chain by developing a new blueprint for specifying quality, low-carbon products. These new "green specifications" prioritize materials that reduce construction-related emissions, and promote locally extracted and manufactured materials. This initiative will help businesses avoid the fallout of unexpected bottlenecks by creating new systems that help to ensure the long-term health of our clients' portfolios with properties that already meet emerging safety, health, compliance, sustainability, and insurance requirements.

THE CRITICAL ROLE OF THE OFFICE FOR TALENT RECRUITMENT AND RETENTION

Organizations of all kinds are seeing large amounts of turnover in their staff. According to a survey by PwC of 1,000 U.S. workers, some 65% are looking for a new job. Competition for talent is at an all-time high, and until companies can fully staff up, they remain in limbo.

We see design playing a significant role in attracting and retaining top talent. In a time of increased hybrid and flexible work schedules, the physical workplace remains a critical asset. This is where companies can support and improve the health, happiness, productivity, and overall well-being of employees. In our 2021 U.S. Workplace Survey, Gensler researchers found that employees at top-performing companies in the U.S. consider their organization's workplace to be the best place for a wide range of activities. In fact, top-performing companies are three times as likely to increase their real estate footprint in the coming years. By reimagining the office as a destination rather than an obligation, and by creating a space that embodies company values and culture, companies can attract new hires while inviting existing team members back into an environment that truly prioritizes the human experience.

3x

Top-performing companies are three times as likely to increase their real estate footprint.

Source: Gensler U.S. Workplace Survey 2021



Organon, Jersey City, N.J.

In the war for talent, the workplace must appeal to new and existing employees as a destination rather than an obligation. Gensler designed Organon's activity-based-workplace with a variety of settings and features to support employee needs, choice, and flexibility during COVID.

Never has there been a greater opportunity for the building industry to act on climate change.

Extreme weather events — including heat waves, droughts, and floods — are now commonplace, and the grave impact of climate change will continue to have a profound impact on human life.

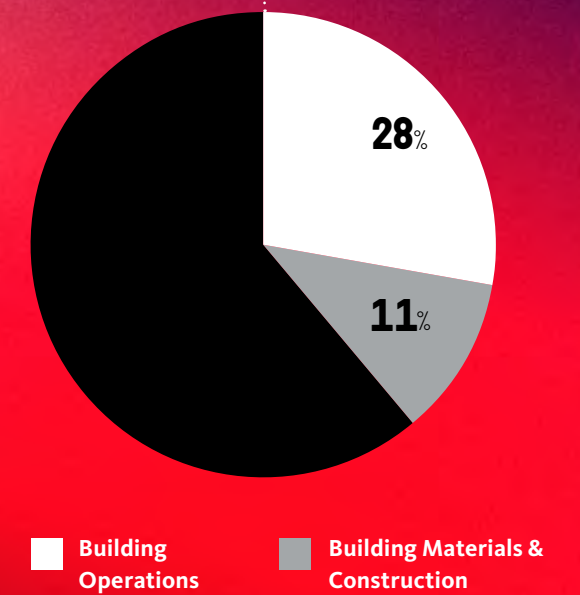
For those of us in the real estate sector, rising sea levels and extreme weather events are also putting property portfolios at risk. Even so, many in the industry have yet to admit that buildings are as responsible for carbon as cars.

The Gensler Cities Climate Challenge (GC3) is our commitment to achieving carbon neutrality in all our work within a decade. It is also a rallying cry to our industry, our clients, and our colleagues.

The real estate industry makes up 39% of global carbon emissions when accounting for construction and building performance. Most carbon reduction efforts in the building sector have focused on operational efficiency, but we can no longer ignore that building materials account for half of a building's total lifetime carbon footprint. To become carbon neutral, we need to eliminate or offset the impact of both operating and embodied energy.

To become carbon neutral, we need to eliminate or offset the impact of both operating and embodied carbon.

39% Constructing and operating buildings accounts for nearly 40% of global carbon emissions.



Source: Architecture 2030

The Old Post Office, Chicago (rooftop)

Adapting and reusing existing buildings is a critical step on the path to a net zero future. Chicago's Old Post Office, designed by Gensler and Hoerr Schaudt Landscape Architects, is the largest adaptive reuse project in the U.S. By reusing the existing structure and materials, we saved 87% of construction waste from the landfill.



Design will be the instrument of change in our cities and spaces.

We believe that design has the power to transform lives. The challenges we face now are not new, but they have taken on new sense of clarity and urgency because of the context in which we face them.

Over half the world's population now lives in cities. This massive shift will continue, so that by 2050 almost 70% of people will live in major urban centers around the world. This influx, combined with the impacts of COVID, climate change, and issues around social equity, have led to new scrutiny of urban life. According to the Gensler Research Institute's City Pulse Survey, less than half of the people we surveyed in 15 locations felt optimistic about their city's future.

To position themselves as places where people want to live, cities must embrace design as a way to create better experiences. Only then will we be able to create convenient and walkable 20-minute neighborhoods, healthy green spaces that promote wellness, buildings that have low-carbon footprints, and connected communities that embrace inclusivity for everyone.

Design is unique in its ability to address changing expectations and tackle the toughest challenges facing cities. We know we can make a difference. As we help our clients address climate change, social equity, supply chain issues, and labor shortages, we have to be smarter and more purposeful than ever before, and laser-focused on the human experience.

The challenges cities face now are not new, but they have taken on new sense of clarity and urgency because of the context in which we face them.

49%

Only 49% of people feel optimistic about their city's future.

Source: Gensler City Pulse Survey Fall 2021

Fifth + Broadway, Nashville, Tenn.

This entertainment district in the rising city of Nashville addresses some of what people want from their cities: convenience, community, and accessibility. Fifth + Broadway weaves together a mixed-use ecosystem of workplace, residential, sports and music venues, restaurants, and retail.

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RESIDENTIAL
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SPORTS

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SCIENCES
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WELLNESS



THE FUTURE OF CITIES

ENHANCING THE URBAN EXPERIENCE

Great neighborhoods, employment opportunities, affordability, and multimodal transportation are the foundations of a great city. But cities have their work cut out for them. The lasting impacts of COVID, and the health scare that came with the virus, have led people to question urban living. To position themselves as places where people want to live, cities must embrace design as a way to create better experiences.

Health and wellness will continue to be a priority. To attract talent, cities and urban developers must focus on affordability and racial and socioeconomic disparities. Concepts like the 20-minute neighborhood will continue to gain traction, as will new more-accessible modes of transportation.

Finally, as the effects of climate change cause larger and more-damaging weather events, investments in weather mitigation strategies and sustainable building practices will continue to reshape the urban experience for the better.

META TRENDS

Here are five key metatrends impacting the cities sector, and how design is responding:

Confidential Mixed-Use District
previous page: Block 7, Abu Dhabi

01

A FLEXIBLE PUBLIC REALM WILL DELIVER A MORE RESILIENT FUTURE

Cities have an opportunity to take the positive parts of our urban pandemic experience — open streets, outdoor dining, fewer cars — and bring them forward to create a more resilient future with people at the center.

02

20-MINUTE NEIGHBORHOODS WILL DRIVE EQUITY

For the 20-minute neighborhood to be applied through a lens of equity, investment strategies from both the public and private sector need to be put in place. This investment will attract development to these neighborhoods in ways that residents can benefit from and participate in.

03

CLIMATE ACTION DEMANDS WILL ADVANCE THE PATH TO NET ZERO

In the face of pressure to reduce their carbon footprint, airports, academic campuses, and data centers will continue to embrace new carbon-neutral and sustainability goals that will allow them to set industry standards.

04

CITIES AND ORGANIZATIONS WILL FOCUS ON REGENERATION AND REUSE

To respond to climate change, cities and organizations must strive to create sustainable, regenerative environments that make more efficient use of existing spaces and materials, thereby reducing waste and carbon emissions.

05

INNOVATION DISTRICTS WILL CONTINUE TO THRIVE

Campus planning used to be inward focused; now, institutions are looking at how they interact with surrounding communities. To spur innovation and create new synergies, developments have expanded from single-use facilities to mixed-use ecosystems.

AVIATION

OVERVIEW

The aviation industry has been grappling with uncertainty, but it has invested in changes that will further transform the passenger experience. In the coming years, airports will continue to invest in core infrastructure, new technologies, resilience strategies, and “front door” experiences. These public-facing spaces in and around airports can generate new revenue sources and serve as their own destinations, much like town centers.



TRENDS

01

Airports are focused on a carbon-neutral footprint for the future.

Social awareness on climate change will push airports to aggressively push for responsible solutions. This extends well beyond LEED certification. Airport facilities will look to wind, geothermal, and solar power to not only reduce carbon emissions, but to create self-sustaining facilities that do not rely on the grid for power. New carbon-neutral and sustainability goals will allow airports to set industry standards.

02

Airports will become more like town centers to generate new sources of revenue.

The idea of diversified revenue generation is moving toward the front door of the airport, with airports considering how their landside spaces can encourage non-travelers to come to the airport. This includes using adjacent land to create public space, such as public parks, mixed-use facilities, or amphitheatres. This is the concept of airports as town centers, and it's gaining momentum and will become the norm.

03

Growth opportunities for airports are through more efficient use of existing space, rather than adding capacity.

Airports are not feeling the need to add gates to increase capacity. Rather, the trend is to increase capacity by looking holistically at a better passenger experience in the terminal. While that may mean growing holdroom areas, it can also involve the better use of space by using technology to give confidence that passengers will smoothly get from landside to airside.

FEATURED PROJECTS

A. Clay Lacy Aviation, Costa Mesa, Calif.

B. Toronto Pearson International Airport Terminal 1 Redevelopment & Expansion Programme, Mississauga, Canada

C. JAL Check-in Area, Haneda Airport, Tokyo





04

To support future growth, airports will invest in core infrastructure.

Airports will invest heavily in the core infrastructure within the terminals, such as upgraded electrical and information technology (IT) to support future growth. This is important as the industry shifts to a completely touchless process that includes biometric technologies to help speed up the check-in, screening, and customs processes. Local laws will require terminals to self-generate certain amounts of power. As part of its Terminal Modernization Program, Pittsburgh International Airport has established a first-of-its-kind on-site microgrid using solar and natural gas to fully power the airport terminals, airfield, and additional buildings.

FEATURED PROJECTS

D. San Francisco International Airport
T1 Expansion, San Francisco

E. JFK Terminal 1
Redevelopment,
New York

“The airport will no longer be solely a place for coming and going, but a community hub where people come to interact and gather — a new town square in the heart of the airport.”

— Dialogue Blog by Tim Hudson, “Reimagining the Airport as the New Town Square”



05

The new focus for airports will be for on-the-ground experiences.

In lieu of using available funds on building new airspace and gate capacity, airports will focus on the ground experience, such as additional transit systems. Rail can be a connectivity point, with public transit systems designed to address door-to-door mobility from home to the airport. Integrating those different modes into a single location and providing smooth connections between them will drive a better passenger experience.

4



San Francisco International Airport T1 Expansion, San Francisco

Strategies for cities and airports to revitalize their facilities in a post-pandemic world

The way people think about travel is changing. At the same time, people are reexamining their relationships with their cities. This presents an opportunity to rethink how people want to travel in the future.

Here are four strategies we've developed that cities and airports can use to revitalize their facilities in the post pandemic world:

1 ANCHOR DESIGN IN LOCAL CONTEXT

The degradation of airports is typically caused by the inability to provide basic passenger needs. The opportunity to build a new facility or reimagine a terminal may only happen once in a generation, so design anchored in the city context is critical to long-term relevancy. Cities should reimagine airports as modern gateways, connecting people and building resiliency.

3 EXPERIMENT, TEST, AND LEARN

Spaces within a terminal are typically assigned and rented based on a long-term lease agreement. Rethinking that lease strategy will allow for experimentation. Airports could begin to think like modern tech companies where physical space becomes malleable to meet operational needs and stay ahead of trends, instead of being reactionary.

2 MAXIMIZE THE BUILDING, NOT THE PASSENGER OR AIRCRAFT COUNT

Most existing airports are constrained for space, particularly on the airside. Elimination of a gate could change the space allocated within the terminal. Layer in a more efficient gate utilization system with quicker aircraft turns. This way, the loss of gate capacity could be overcome via technology, instead of space, while maximizing passenger comfort.

4 REIMAGINE THE AIRPORT AS A DESTINATION

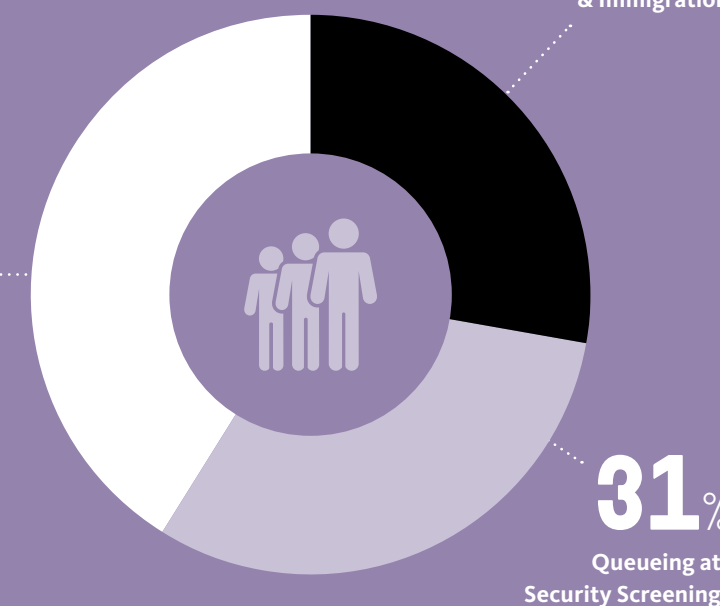
Instead of trying to move guests away quickly, airports can bring the city closer to the airport. The airport becomes less about airline branding and more reflective of the community fabric and regional tourism. The incorporation of regional materials, local makers, local chefs, and live entertainment make the airport a vibrant destination in itself.

STRATEGIES & RESEARCH

More than half of passengers say queuing at boarding has to improve.

Source: Schengen Visa

41%
Queueing at Boarding



Passengers' responses on immediate areas to improve for reducing queuing at airports

Domestic travel demand is on the rise.

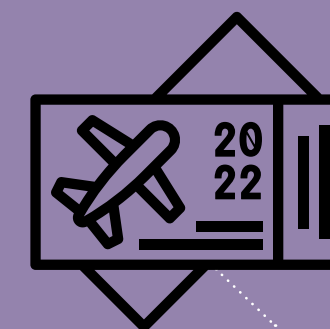
Source: Reuters

93%

Domestic travel demand is estimated to reach 93% of the pre-pandemic level in 2022 — an improvement of 20 percentage points from 2021.

Passenger revenue in 2022 is expected to jump about 67% year-on-year to \$378 billion.

Source: IATA



\$378 BIL

CITIES & URBAN DESIGN

OVERVIEW

Cities are at an inflection point. As concerns about global health continue and remote work trends take hold, people are beginning to question the need to live in big cities, especially as urban centers struggle with issues of affordability, low levels of transit ridership, overcrowding, and more. Cities can use this moment to imagine a new community-focused model for growth, one that is more convenient, inclusive, resilient, and healthy.



TRENDS

01

More cities will think regeneratively to combat climate change.

To address climate change, pollution, and natural resource depletion, a more regenerative, resilient approach is required to planning and developing cities. Urban centers with circular metabolisms, or “circular cities,” minimize sprawl, repurpose waste, and increase biodiversity. Green infrastructure and natural resource conservation are critical strategies. The engineered urban environment should be in balance with the carrying capacity of natural systems.

02

To reimagine downtown cores, cities will need to adopt a mixed-use mindset.

The trend away from single-use Central Business Districts (CBDs) into places with a greater mix of uses will continue. Diversity in building types and uses, and diversity at many different levels (city, neighborhood, building) are key. For example, more residential and pedestrian-oriented uses with more green space can be infused into CBDs to make them more inclusive, resilient, sustainable, and healthy. Cities should also adopt mixed-income and multigenerational communities to become more diverse and inclusive.



03

Equity and accessibility will continue to define the 20-minute neighborhood.

The 20-minute neighborhood concept is a tool to create social cohesions and strengthen sense of community, so equity is a critical part of the conversation. Equitable transportation, housing, employment, and technology infrastructure are key parts to well-rounded neighborhoods. Investing in accessible and affordable high-speed internet as a public utility is critical.

04

Investing in parks and flexible streets can create healthier cities.

Designers and urbanists will continue to prioritize pedestrian-oriented urban spaces over car-centric developments, which means outdoor spaces will be a key ingredient. Access to nature through landscaped public plazas, green spaces, sidewalks, and urban parks increases health benefits and creates community by reducing stress and depression, promoting positive emotions, and facilitating cognitive functioning. Privately owned public spaces (POPs) that connect to the public realm also help in creating these healthy places.

“Because remote workers can now go pretty much anywhere, cities are going to have to start focusing on attracting residents, particularly millennials, and that means providing that smaller city experience, and not just focusing on attracting businesses.”

— Sofia Song, Global Cities Lead, Gensler

FEATURED PROJECTS

- A. Confidential Mixed-Use District
- B. Al Bustan, Madinah, Saudi Arabia

05

Rising cities will provide compelling alternatives.

Rising cities are booming as people seeking more value and space look to relocate from large cities to more affordable, less dense places. To be a compelling alternative, a rising city should build arts and culture, look for ways to create more equity and diversity, and celebrate its local DNA in new developments.



06

Mobility's next phase will advance our cities.

From e-scooters to e-bikes, improvements in vehicles powered by an electric motor and battery are transforming first- and last-mile mobility. Beyond the benefits for tackling climate change, the shift to electrification has even broader implications for how we might reimagine our urban environments and city streets. For example, gas stations and parking garages could be repurposed for new uses that promote health and wellness. Using mobility innovation as a catalyst, we can remake our cities toward a much more human-centric model.



FEATURED PROJECTS

C. Adams Street
Activation Study,
Phoenix

D. The Ave on Chicago
Avenue, Chicago

“To address climate change, pollution, and natural resource depletion, we must take a more regenerative, resilient approach to planning and developing our cities.”

Source: Dialogue Blog by Carlos Cubillos and Daquan Zhou, “Why Circular Cities Play a Critical Role in Restoring Ecologies”

An average of 55% of people in the 10 cities we surveyed said their city is becoming less affordable.

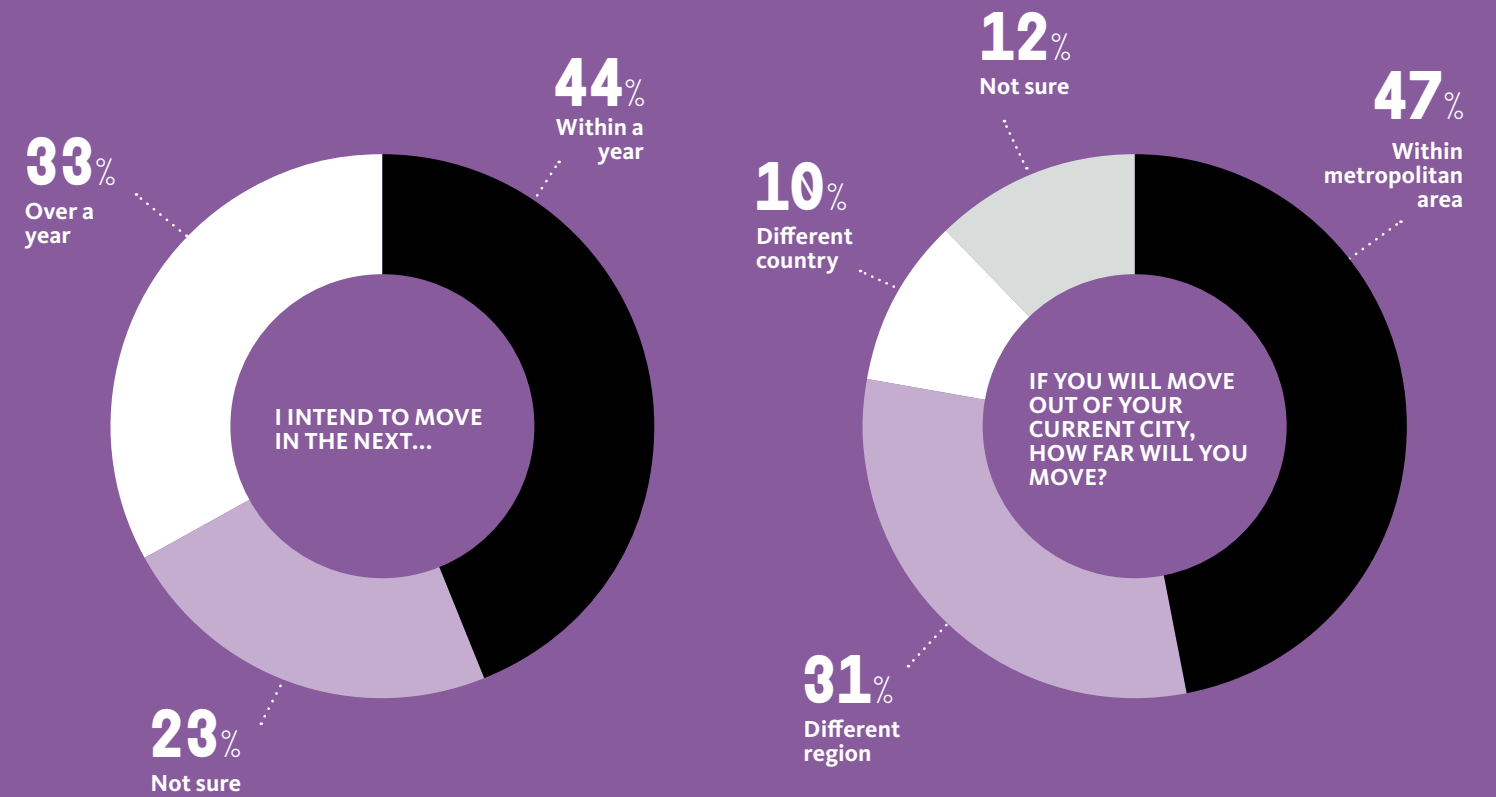
Source: Gensler City Pulse Survey Fall 2021

55%



Of those who want to move out of their city, most intend to move in the next year within their metropolitan area.

Source: Gensler City Pulse Survey Fall 2021



Only one in eight urban residents are considering moving to a larger city; the most popular destination is a smaller city.

Source: Gensler City Pulse Survey Fall 2021



37% of respondents are living paycheck to paycheck.

Source: Gensler City Pulse Survey Fall 2021

37%

CRITICAL FACILITIES

OVERVIEW

As demand for data continues to surge with no end in sight, data centers are playing an increasingly critical role in enabling and scaling rapid change. The shape, location, and size of these facilities are adapting to handle greater volume and improve speed-to-market capabilities, while becoming more resilient to meet market demands to address climate change.

With no decrease in demand for data, as well as increasing demand for colocation and hybrid cloud opportunities, the data center market is poised for growth over the next several years.

— CRN



TRENDS

01

Hyperscale leads the charge.

Spurred by explosive demand for digital cloud services, Amazon, Microsoft, and Google now account for 50% of all investments in data centers across the globe, and they are rapidly expanding their footprints. For hyperscale data centers, the focus on simplification, scale acceleration, and infrastructure optimization will continue as speed-to-market is more important than ever.



02

Edge data centers are the next frontier.

Data center clients are marrying hyperscale cloud computing with edge computing, which locates more processing power closer to the end user. This is improving performance, reducing costs, and helping to fuel the growth of next-generation technologies and applications such as 5G and Internet of Things (IoT).

03

Net zero strategies will influence design.

The market is increasingly demanding a more sustainable approach to the creation and operation of data centers, which have a massive carbon footprint. This demand is leading many large data center clients to embrace low-impact materials, heat-waste recovery, and emerging technologies, such as liquid cooling and renewable energy.

04

Immersive cooling could reshape the industry.

In seeking new ways to decrease carbon impacts and make data centers more efficient, designers are beginning to look closer at immersion cooling, an approach that submerges servers in liquid to cool them. This technology has the potential to radically change the shape, location, and size of data centers.

FEATURED PROJECTS

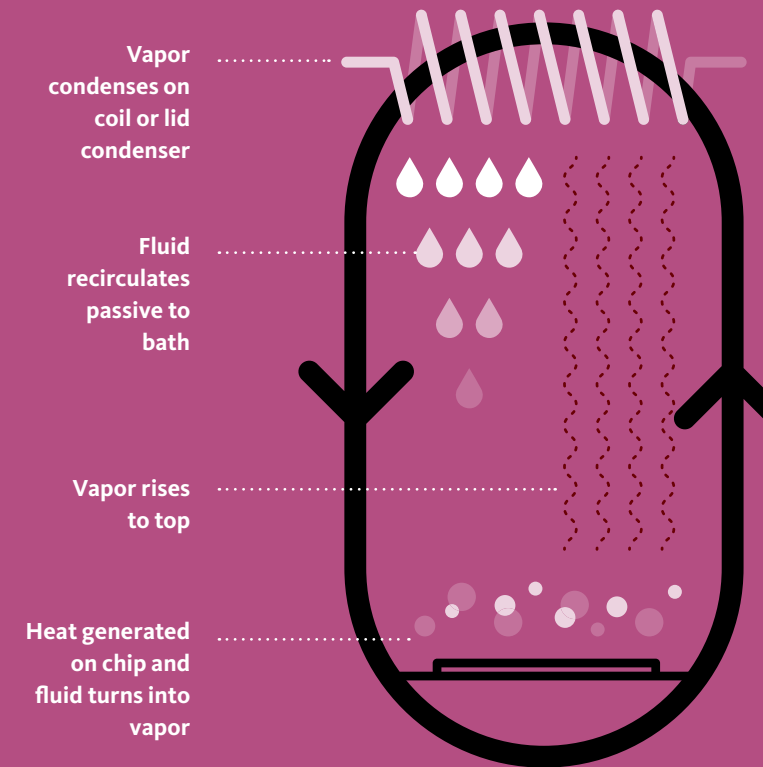
A. Databank - Georgia Tech Data Center, Atlanta
B & C. Future Digital Data Systems

By 2023, over 50% of new enterprise IT infrastructure deployed will be at the edge, rather than corporate data centers, up from less than 10% today.

Source: IDC

Liquid immersion cooling reduces power consumption.

Source: Business Wire/Graphic courtesy of 3M



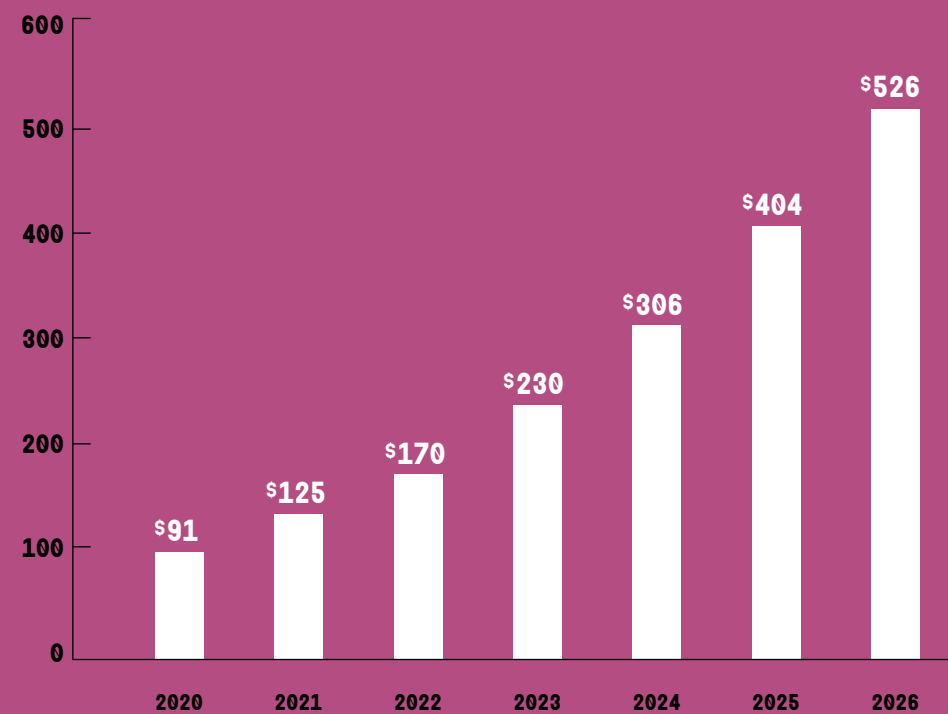
90%

Liquid immersion cooling systems consume 90% less energy compared to traditional air-based CRAC systems.

The cloud is dominating the sector.

Source: Structure Research

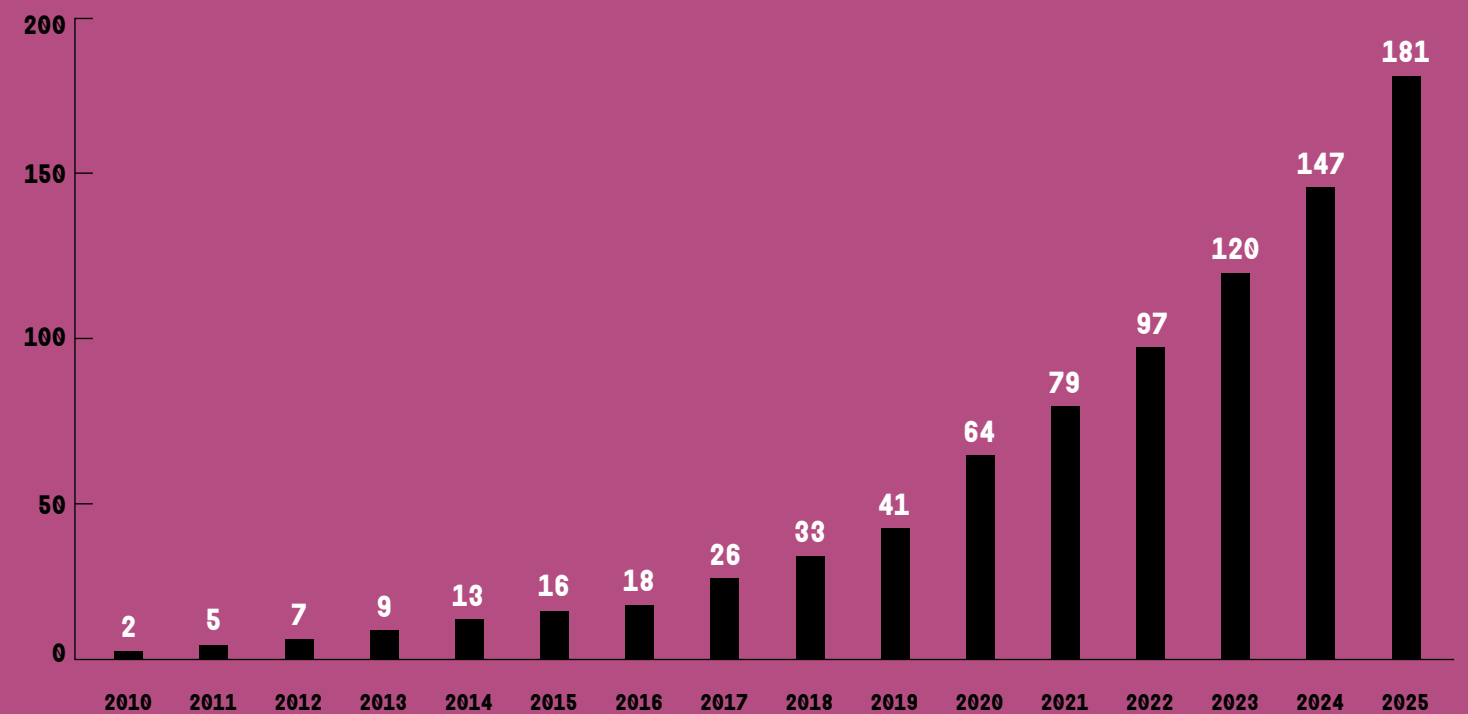
Total cloud revenue (in USD billions): 2020 – 2026



The global datasphere will continue to grow exponentially.

Source: IDC

Volume of data created and replicated worldwide (Data volume in zettabytes)



EDUCATION

OVERVIEW

Learning institutions are evolving to meet students' needs and adapt to a hybrid learning experience. As students look to schools not just as places of learning — but as places to feel safe, engaged, and included — there will be an ongoing emphasis on educating and nurturing the whole student and their well-being.



TRENDS

01

Future hybrid learning environments must embrace choice.

According to Gensler's Education Engagement Index, 68% of students and 74% of educators want a hybrid approach — a model that includes a combination of in-person and remote learning methods. For schools, this means designing for hyper-flexible and tech-enabled learning environments that can provide students and educators a choice. There is no one-size-fits-all approach. Technology allows institutions to engage with students in a personalized way, providing flexibility and agility.



FEATURED PROJECTS

A. University of California, Riverside Student Success Center, Riverside, Calif.

B. Georgetown Day School, Washington, D.C.

C. Columbia College, Chicago

02

Equity, safety, and engagement will be key design considerations.

To ensure success and address inequities in education, the post-pandemic school will need to address both equity and engagement, along with safety, belonging, and basic needs. Gensler's research has shown that the "average learner" is a myth, and instead of designing one optimal universal learning experience, it is imperative to design for multiple pathways for engagement for each student.

03

Creating wellness ecosystems on campus is essential.

To adapt to the post-COVID needs of students, schools, colleges, and universities need to explore how the concept of wellness can be integral to everyday campus life. Whether designing a new facility, creating a new master plan, or developing programs, solutions must be holistically student-centric and stigma-free. Building an ecosystem around wellness provides different access points for students on and off campus, and in virtual and physical settings.

04

The evolution of the academic workplace will impact campus planning.

Academic institutions are taking cues from other industries by planning and designing campuses that can welcome faculty and staff into a healthier, more engaging, and more effective workplace. In addition to workstations and offices, academic institutions should consider a toolkit of spaces that support creativity, collaboration, focus, and engagement with students and colleagues.



"If we are to design for all learners, our goal should not be to design one optimal and fixed experience for all students, but to design for diverse and evolving ways to engage."

— Dialogue Blog by Erin Cubbison, Patricia Nobre, Kyle Sellers, Allison Bulgart, "5 Considerations for Designing the Future of Higher Education"

5



University of San Diego Learning Commons, San Diego

Considerations for designing the future of higher education

Our Education Engagement Index 2021 research, which examined the experience of students and educators in learning and teaching during the pandemic, holds critical considerations for what the future of higher education might look like.

Here are five key findings:

1 STUDENTS FEEL LESS SUCCESSFUL ACADEMICALLY THAN BEFORE THE PANDEMIC

All learning modes suffered as a result of the pandemic, and nearly half (44%) of students now feel less successful academically — illustrating the deep impacts on learning.

4 RELATIONSHIPS CAN IMPACT STUDENTS' MOTIVATION AND WELL-BEING

Students with positive relationships reported higher scores for all motivational and emotional well-being factors. Institutions must recognize the connection between the health of relationships and learning outcomes, and consider how relationships can be supported in a hybrid model.

2 INSTRUCTORS MAY NOT UNDERSTAND THE SCOPE OF THE PROBLEM

Instructors overestimated students' self-reported effectiveness across all six learning modes at home. An empathetic lens for the student experience is necessary as administrators consider a future of in-person, mixed-interaction, and online learning.

5 COLLABORATION IS A TOP DRIVER FOR RETURNING TO CAMPUS

While the campus is essential for in-person classes, it is even more valued for connecting with others and facilitating daily routines. Hands-on activities and small class lectures are among the activities that students said they would return to campus for.

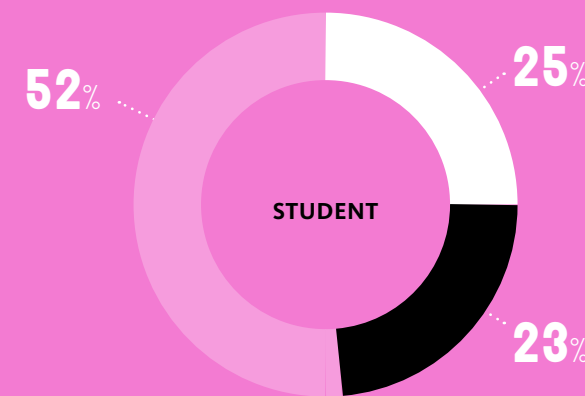
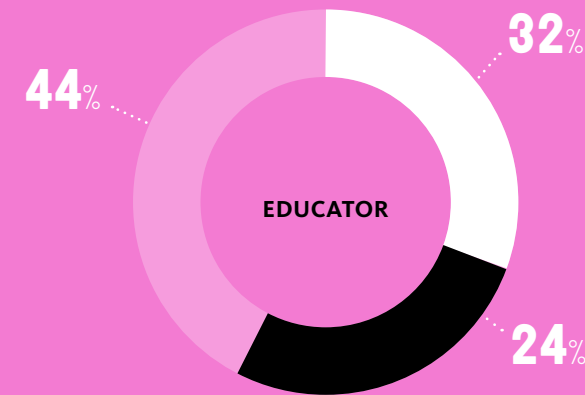
3 DESPITE CHALLENGES, HYBRID LEARNING IS PREFERRED FOR THE FUTURE

Although most report that learning was more effective on campus before the pandemic, 68% of students and 74% of educators want a hybrid approach — a model that includes a combination of in-person and remote learning methods.

STRATEGIES & RESEARCH

68% of students and 74% of educators want a hybrid approach — a model that includes a combination of in-person and remote learning methods.

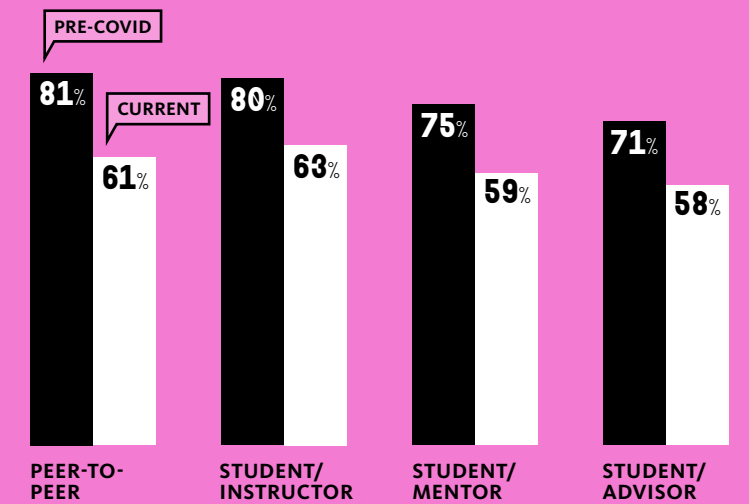
Source: Gensler Education Engagement Index 2021



Legend: Fully in-person classes (light blue), Fully remote classes (white), Mixed interaction classes (dark blue)

Students report a decline in all types of relationships.

Source: Gensler Education Engagement Index 2021

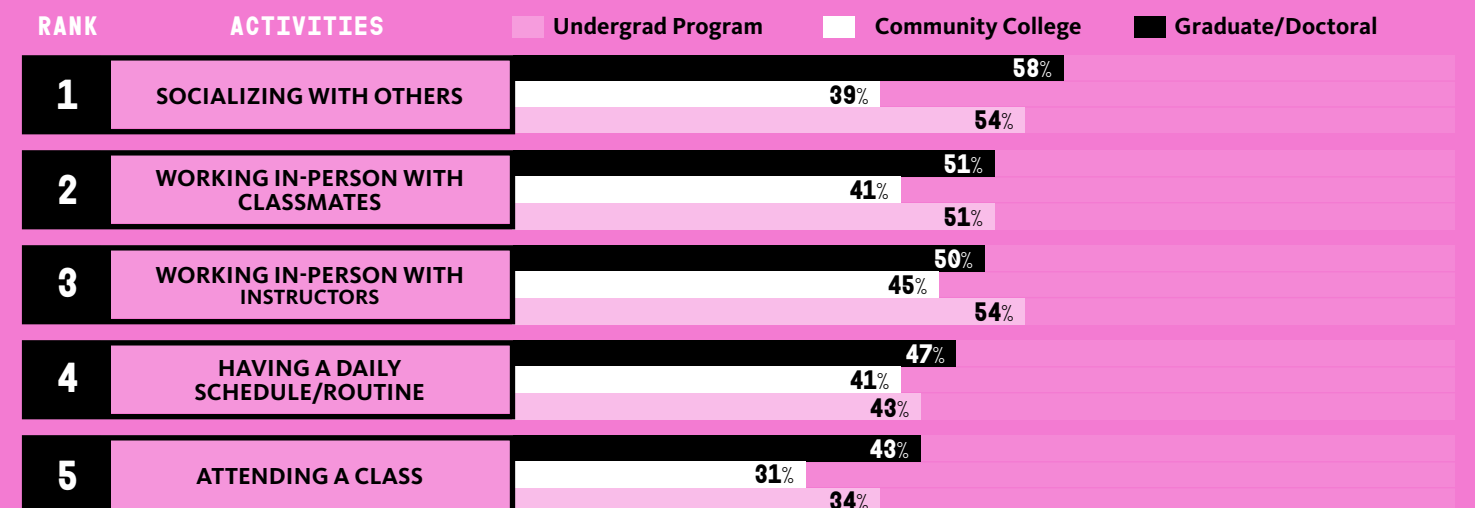


62%

62% of the students report feeling less motivated, less engaged, or that they are growing less academically since before the pandemic.

Among different learning activities, hands-on and small group activities rank as the most valuable to do in-person on campus.

Source: Gensler Education Engagement Index 2021



THE
FUTURE
OF

WORK

THE WORKPLACE EXPERIENCE

The workplace is changing at an unprecedented pace. Across the globe, we've seen a fundamental shift in how and where work happens. Amid these profound shifts, organizations, developers, and landlords want to know what they can do to optimize their real estate.

What will set them apart is the experience they design for tenants and employees. We know that workers around the world still place a great deal of value in the physical workplace for social interaction, mentorship, deep concentration, and collaborative work. We also know that to compete in a war for talent, companies must also support an ecosystem of workspaces — both in and out of the office — where talent can thrive.

This is an opportunity to rethink the physical workplace to offer a unique and fulfilling experience that can attract people, whether that's through new technologies or new types of spaces.

META TRENDS

Here are five key metatrends impacting the work sector, and how design is responding:

01

THE WORKPLACE MUST BECOME A COMPELLING DESTINATION

We're seeing a shift to the new role of the workplace as a "destination" — creating experiences that employees can't get working remotely. Top-performing companies understand the power of the physical workplace for their people to thrive, as well as drive creativity and innovation.

02

EXPERIMENTATION, PROTOTYPES, AND LEARNING ARE THE NEW NORMAL

We're entering a phase of experimentation, piloting, and learning. The new workspaces must be driven by purpose and research to dig in and figure out what is working, what is not working, and analyze outcomes. A key piece of successful piloting is to test and measure.

03

THE NEW WORKPLACE ECOSYSTEM WILL INCLUDE THIRD SPACES

Today's workers want an ecosystem of places to work both in and out of the office. Third places and coworking spaces are increasingly preferred for a variety of work activities. Developers and landlords should create spaces such as working lobbies or outdoor workspaces.

04

THE WORKPLACE WILL PLAY A CRITICAL ROLE IN FOSTERING EQUITY AND INCLUSION

Companies should extend equity beyond race, gender, and generations to create equitable work experiences for employees who are working in-person and remotely to create a culture of inclusivity and belonging.

05

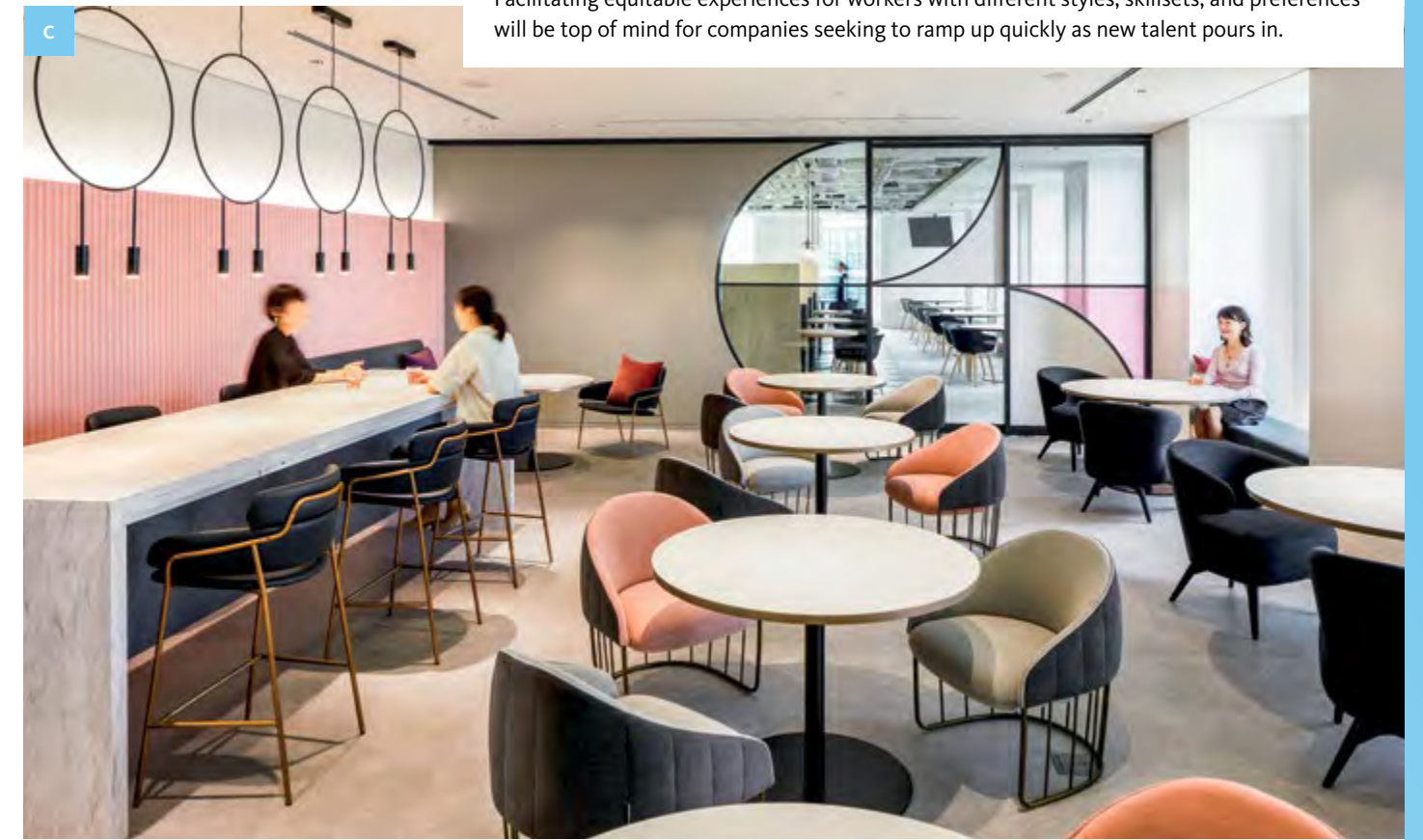
INVESTMENTS IN HEALTH AND WELL-BEING WILL DELIVER VALUE FOR EMPLOYEES

Employers should focus not only on enhancing workers' physical health through biophilia and wellness design, but also building personal and professional relationships for mental well-being.

CONSUMER GOODS

OVERVIEW

A consumer goods organization's workplace is increasingly expected to be a conduit to its consumers with engaging touchpoints bridging the gap between internal and external experiences. Companies are beginning to seek out design expertise that begins with workplace design services and then digs deeper — making sustainability commitments outwardly visible, telling comprehensive brand stories, and putting the product development process on full display.



03

Consumer goods companies are now competing for tech talent.

The acceleration of e-commerce has consumer goods companies competing for talent that understands and can create virtual experiences — typically the domain of technology companies. Facilitating equitable experiences for workers with different styles, skillsets, and preferences will be top of mind for companies seeking to ramp up quickly as new talent pours in.

“[T]here is immense hunger from employees to engage on topics that give them a sense of purpose — and decarbonization is a top-of-mind topic for many.”

— McKinsey

TRENDS

01

All-in-one real estate can blend product innovation with consumer engagement.

Consumer goods real estate is moving toward the development of holistic experience centers. These all-in-one sites blend workplace, research, and product showcasing. They help brands better understand their target audiences and provide consumers with a peek behind the curtain to learn how their favorite products are made.

02

Sustainable products will continue to attract consumers.

A concerted movement is underway to decarbonize as many products as possible, inclusive of the supply chains and workplaces that produce them. Among consumers on the hunt for ways in which their spending decisions can positively impact the environment, companies that commit to net zero real estate and workplaces will get high marks.



04

The workplace will continue to morph.

Consumer goods companies are constantly searching for new ways to engage customers, both in person and across various social media platforms. One growing trend in the industry is to use the office to create fully integrated, high-tech broadcast spaces that can generate engagement and set unique stages for product stories straight from consumers.

05

Real estate will continue to support a brand's mission and purpose.

There is an increase in demand for curated spaces that celebrate a brand's heritage and history, while also reflecting on the future of the business. Within consumer goods, such spaces serve a dual role, reinforcing a company's mission among its workers while also conveying it to consumers.

FEATURED PROJECTS

A. Knoll Chicago Showroom, Chicago

B. Pladis Global 2020 - New HQ Design, London

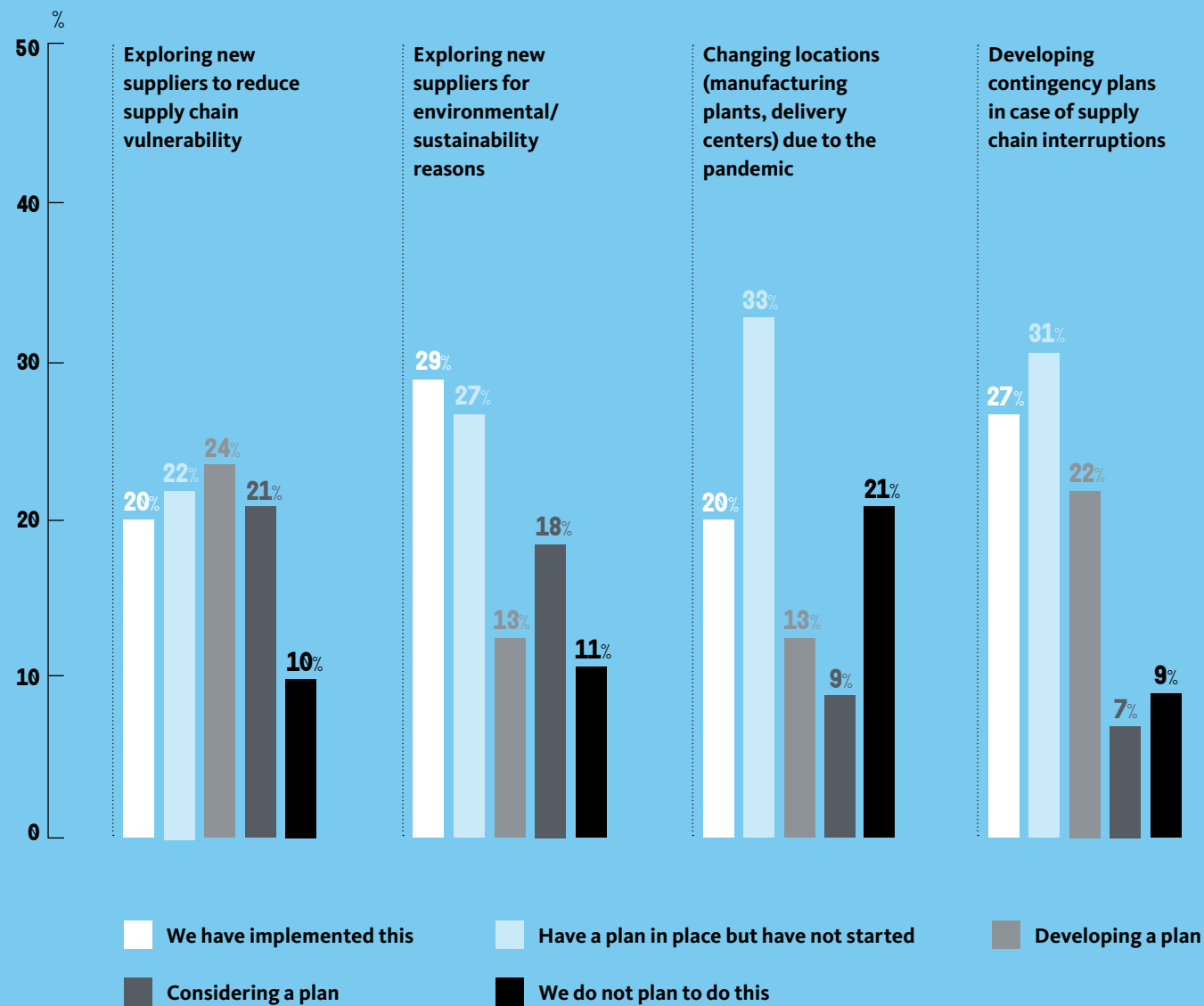
C. Shiseido Global HQ Renovation, Tokyo

“Real estate’s new source of value is that it is the platform outside of the home for experiences beyond the virtual.”

Source: World Economic Forum article by Gensler Co-CEO Diane Hoskins

Both supply chain interruptions and the environment are driving COO’s to explore new suppliers, though contingency plans remain underdeveloped.

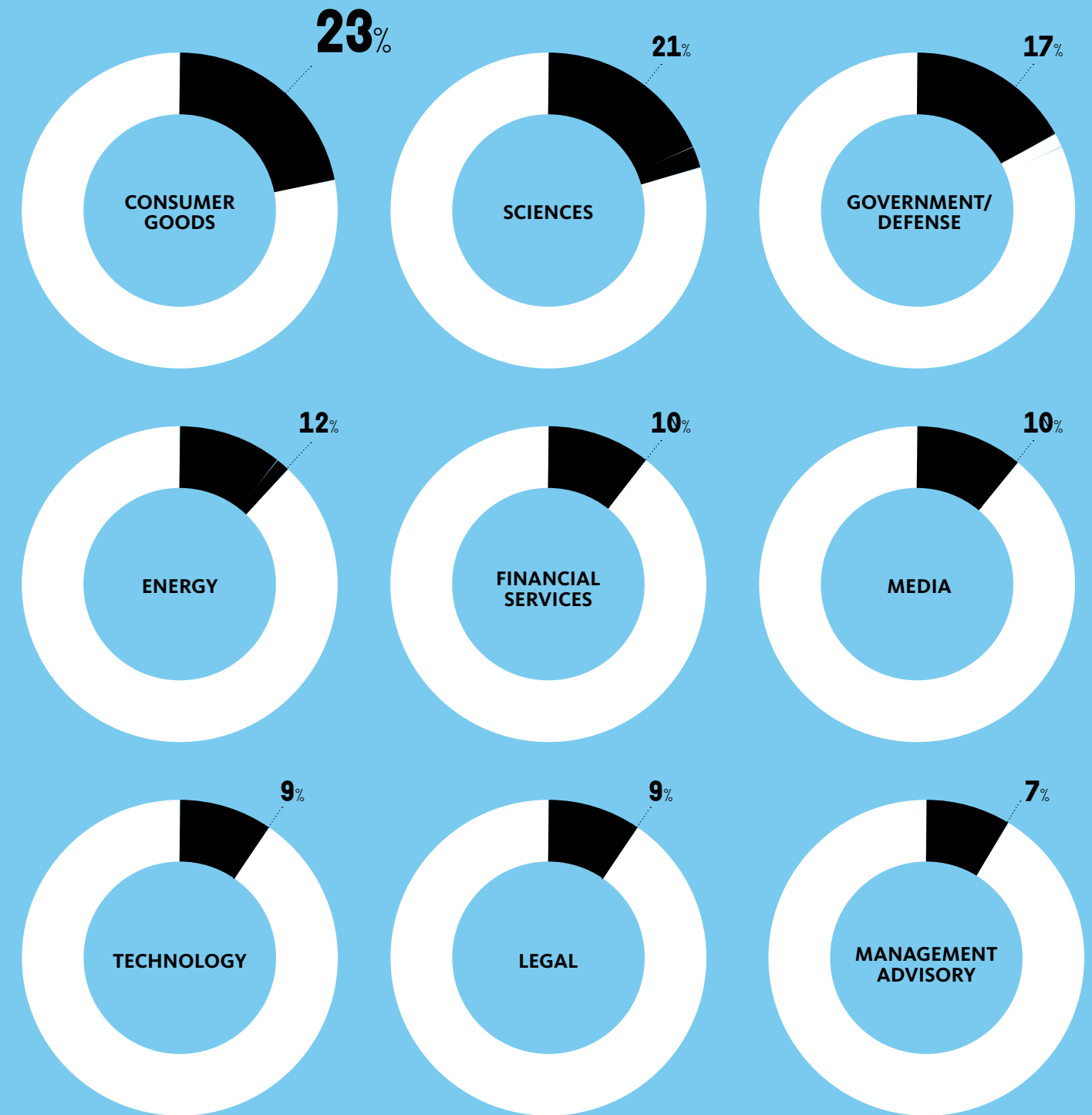
Source: PwC



More consumer goods workers would prefer to be in the office full time than in any other industry.

Source: Gensler U.S. Workplace Survey Summer 2021

■ Full time in the office



There are clear differences in work location preferences by industry.

ENERGY

OVERVIEW

A focus on sustainability and energy security will demand new solutions throughout the energy sector. The industry will continue to expand its offerings, including renewable energy, energy efficiency, renewable fuels, smart grid technologies, and energy storage systems as sub-sectors.



TRENDS

01

Investments in a sustainable future have become paramount.

A focus on sustainability has become a prerequisite for the oil and gas industry as pressure mounts to promote renewable energy, sustainability, and the energy transition. In the coming years, we will see many more companies embed resilience within projects to minimize environmental impact and increase operational efficiencies. These investments will also include worker health and safety, and community engagement.

02

Artificial intelligence will accelerate energy transformation.

Over the next 30 years, energy systems will need to change dramatically to meet climate goals. Decarbonization efforts and renewable energy generation is already growing rapidly. The next step is to leverage AI to enable more efficient and cost-effective decision-making for smart grids, sensor-connected power plants, and wind turbines. Smart technology will help the industry transition quickly and efficiently to a low-carbon global energy system.

FEATURED PROJECTS

A. Confidential Client, San Ramon, Calif.

B. Confidential Client, Midland, Texas





03

Resilience strategies will become essential for mitigating risk.

The energy sector must become increasingly resilient in addressing aging infrastructure and decarbonization. Additionally, the sector must prepare for and adapt to risks, such as supply chain disruption, cyberattacks, and the extreme weather associated with climate change. The transformation must take into account the inequities among low-income communities who might lack the resources to withstand or rebound after crises.

FEATURED PROJECT

C. Confidential Client, Houston

04

Flexible, purposeful spaces are fundamental to future success.

The energy industry can spur innovation with workplaces that are a collection of flexible and purposeful spaces, supplied with optimal technology. This will create an equitable experience for all workers, whether they're participating virtually or in-person. New space typologies should be introduced as an extension of the workplace rather than just a transition, with opportunities to pause, have a conversation, and work indoors and outdoors.

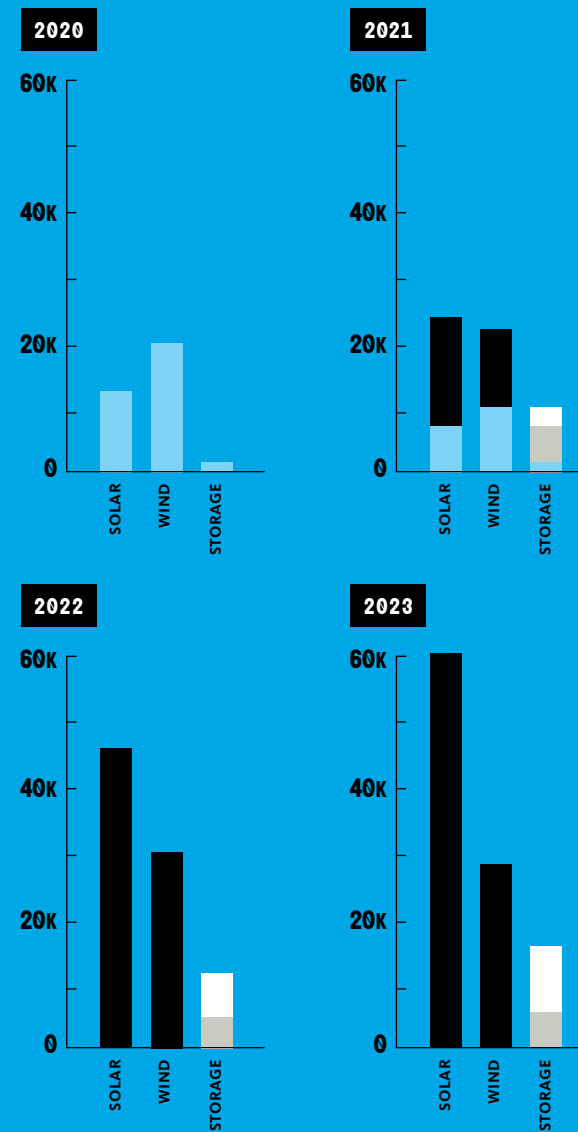
“Renewable energy generation is growing rapidly, driven by falling costs and growing investor interest.”

Source: World Economic Forum

Renewable energy development in the U.S. continues to gain pace.

Source: S&P Global Market Intelligence

Operating Planned
Planned stand-alone Planned paired storage



Energy-related emissions need to drop 30% below 2019 levels by 2030, and 75% by 2040, to reach net zero in 2050.

Source: BloombergNEF

Drop in emissions by 2030 relative to 2019

30%
to reach net zero in 2050

Drop in emissions by 2040 relative to 2019

75%
to reach net zero in 2050

Rate of emissions reduction to 2030

3.2%
year over year

FINANCIAL SERVICES FIRMS

OVERVIEW

In an industry where place — and the expectation to be present in that space — have defined company culture and the client experience for years, financial services firms are redefining how to enable employees to do their best work while reevaluating their real-estate portfolios. As the war for talent heats up, firms have an opportunity to lean into new, culture-defining space typologies to enhance the employee experience.



TRENDS

01

Space and policy can help win the war for talent in the years to come.

Amid upheaval, financial services firms are rethinking how they can deepen connections with employees and attract new talent from the tech sector. Banks have already started to reevaluate their cultures. Some will reconnect with the traditional workday prior to the pandemic, while others will embrace the agility and productivity that the pandemic brought to drive innovation and appeal to new talent.

02

Hybrid work will continue to reshape the trading floor.

New technology has enabled hybrid forms of collaboration, and this is influencing the space itself. Those executing trades will still need dedicated seats on the trading floor, but other supporting functions can be more agile on the floor, enabling organizations to add new types of spaces, such as informal collaboration rooms and decompression areas.



FEATURED PROJECTS

A. Elliott Davis Interiors, Greenville, S.C.

B. Confidential Financial Services Client, Tokyo

C. Hudson River Trading 3 WTC Relocation, New York



03

Financial services firms workplace design for the C-suite is becoming more transparent and accessible.

Today's workers expect leaders to be more accessible, and design is shifting to meet this. Executives are embracing a more collaborative workstyle and becoming more visible to the organization. In addition to evolving executives' individual workspaces, some firms are reconfiguring floor plans so that executives are closer to high-traffic zones.

“After seeing first-hand that the pandemic disproportionately affected younger workplace generations in terms of advancement and mentorship, financial organizations are doubling-down on spaces for learning, training, and networking with younger workers in mind.”

— Gensler Financial Services Industry Briefing, Fall 2021



04

The shift from individual to collaboration spaces will continue.

In the post-pandemic era, financial services firms are taking a critical look at improving enclosed spaces with a shift from “individual” to “team.” As firms lean into hybrid working, large, dedicated offices can no longer be justified. Instead, single-size offices are making way for enclosed rooms that are designed with collaboration in mind.

05

Firms will continue to integrate ESG goals into their portfolios.

With heightened regulatory, stakeholder, and policy pressures, financial services firms are grappling with how to respond to Environmental, Social, and Governance (ESG) concerns. Clients are in varying stages of maturity in their ESG commitments, but most are seeking guidance for how to integrate their aspirations on climate action and issues of social equity.

FEATURED PROJECT

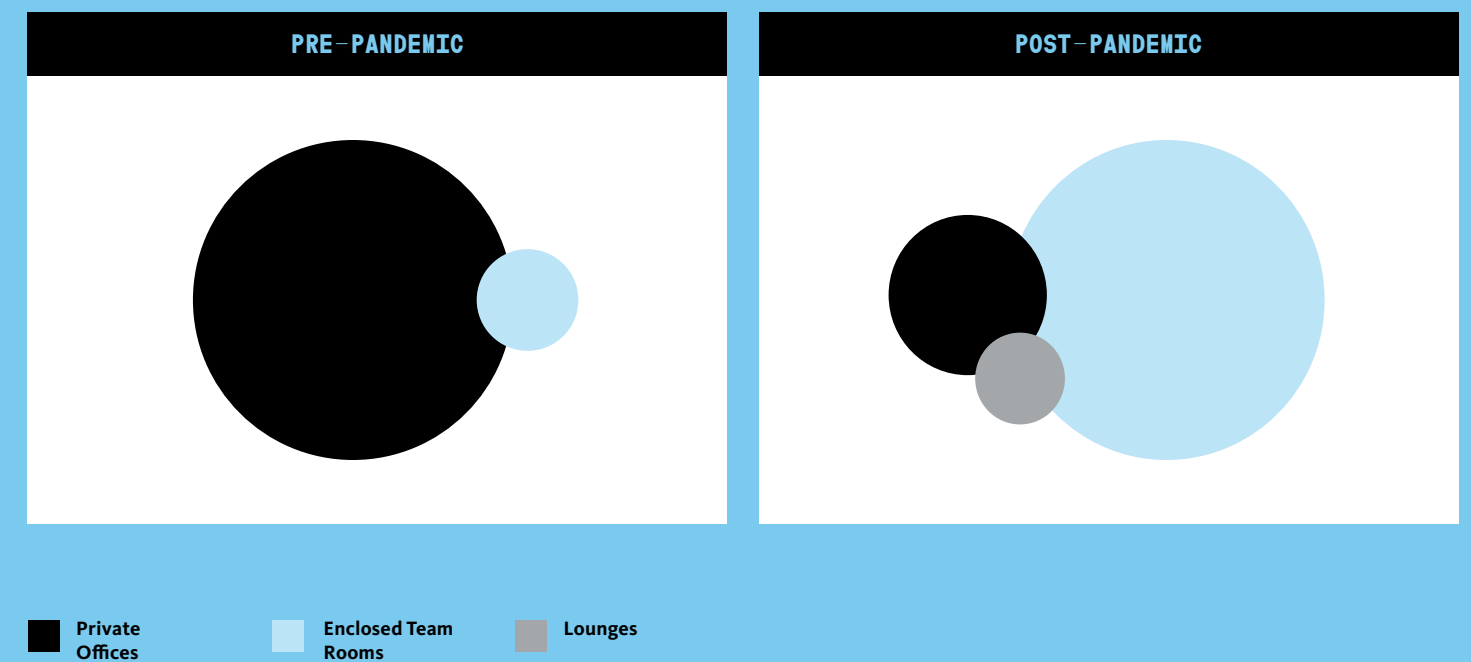
D. Confidential Financial Client, New York

STRATEGIES & RESEARCH

Share of enclosed team rooms will likely increase, while private offices decrease post-pandemic.

Source: Gensler Financial Services Industry Briefing, Fall 2021

THE DIAGRAMS BELOW SHOW THAT THE SHARE OF ENCLOSED SPACES IS STILL THE SAME — IT’S JUST BEING REPURPOSED TOWARD THE TEAM.



Top 6 Changes in C-suite Design

Source: Gensler Financial Services Industry Briefing, Fall 2021

RANK

- LEADERSHIP MODELING ORGANIZATIONAL CHANGE
- DECENTRALIZED EXECUTIVE SEATING
- LOCATION IN STACK
- APPROACHABILITY AND SECURITY
- CONORKING WITH EXECUTIVES
- LEVEL OF SERVICE OR FORMALITY

High Frequency
Mid Frequency
Low Frequency

FOUNDATIONS, ASSOCIATIONS & ORGANIZATIONS

OVERVIEW

In many ways, associations, nonprofits, and like-minded organizations feel socioeconomic changes most acutely because they are so closely embedded in their local communities. These local ties inspire a greater sense of responsibility for the relationships with their community and for the well-being of their employees. Organizations will continue to leverage their real estate to further their mission, support their members, and encourage citizenship in the community.



TRENDS

01

Virtual programming leads to expanded opportunities, locally and globally.

Connecting to membership and the broader community, convening spaces cast a larger net, create equitable experiences, and foster a deeper connection through increased programming, events, and organizational awareness. A new perspective has evolved, centered around funding opportunities and outreach. This perspective also strengthens the organization's mission, while fostering connection to the surrounding communities.

02

As the workplace becomes more diverse, wellness must be integrated into a variety of spaces.

The future of work involves people being more nomadic as they seek out diverse environments in which to work — quiet corners, meeting rooms, social hubs, and restorative outdoor experiences, which can encourage daily movement, and inspire and delight. This reflective period has led organizations to an integration of health and wellness in all aspects of the workplace, and with more ardent conversations around resilience.



FEATURED PROJECTS

A. REACH LA, Los Angeles

B. APTA Centennial Center Headquarters, Alexandria, Va.

C. Plywood People, Atlanta



03

Data and metrics will drive real estate decisions.

There is a deepening need for data and metrics to understand what like-minded organizations are doing to better support their teams and communities in order to drive decisions around their space needs. Organizations continue to use real estate to embody the organization's mission and serve its membership in new and innovative ways, establishing the office as a social hub with shared purpose and a connection to the mission.

“The long-term effects of the COVID-19 pandemic will keep rippling out across our politics, economy, and culture, including affecting the funding landscape for nonprofits.”

— Anna Galland, former executive director of MoveOn Civic Action, in the Stanford Social Innovation Review



04

Self reflection and recentering leads to higher relevance and purpose.

As advocates and leaders in diversity, equity, and inclusiveness, organizations lead with human experience and continue to quantify impact and increase focus on action by creating a range of DEI policy and design considerations leading to accountability, agency, and a fuller embodiment of their mission.

FEATURED PROJECT

D. Oxford Finance
Interiors, Alexandria, Va.

STRATEGIES & RESEARCH

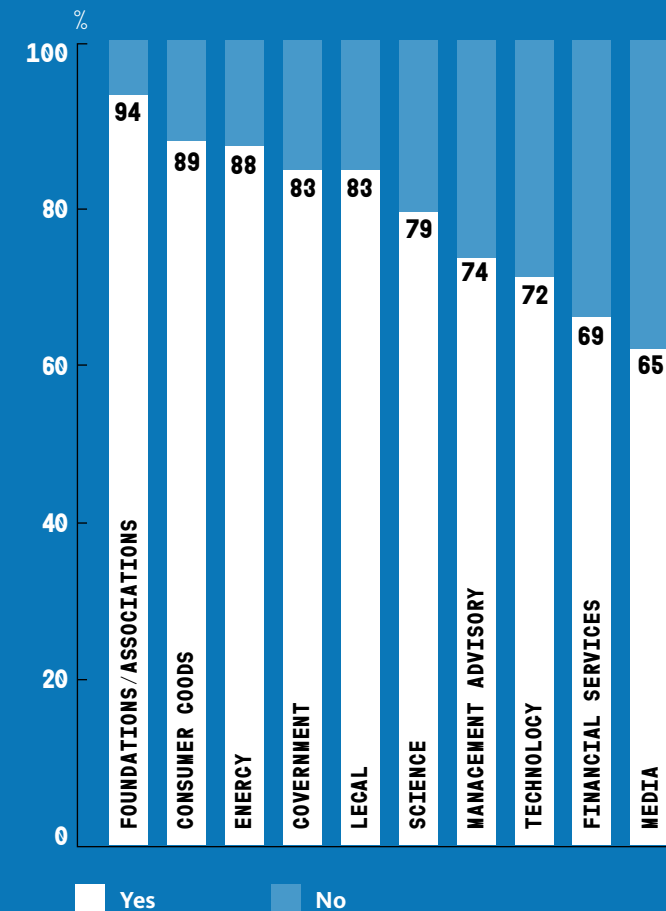
“This is a time to think about how our cities and communities can be places that celebrate diversity, support our residents, and lead with human experience.”

Source: Bevin Savage-Yamazaki, Foundations, Associations & Organizations leader, Gensler

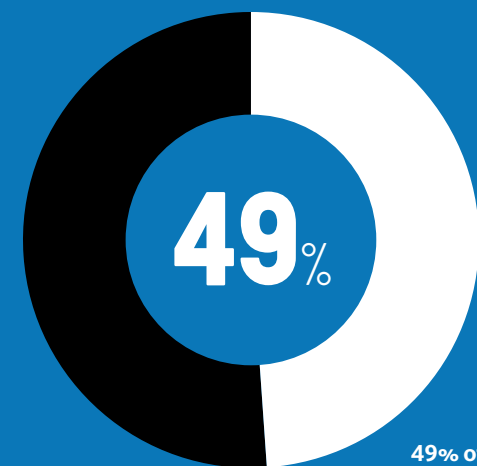
The portion of workers who have returned varies widely by industry — foundations/associations employees are most likely to have returned to the office.

Source: U.S. Workplace Survey Fall 2021

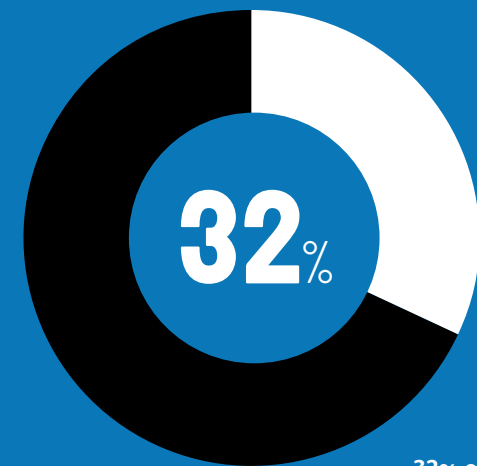
HAVE YOU WORKED FROM YOUR OFFICE AT ANY POINT SINCE THE PANDEMIC STARTED?



Source: Salesforce Nonprofit Trends Report



49% of nonprofits said that over the past 12 months their organization has changed its approach to DEI.



32% of all nonprofits surveyed said ensuring the mental health and well-being of their employees was a major issue for them over the past year.

GOVERNMENT & DEFENSE

OVERVIEW

Both government operations and the physical offices supporting them have entered a new era. Governments will be expected to lead on net zero carbon strategies, and their security approaches are evolving to incorporate measures to anticipate and survive climate change events. With walk-in services going virtual and workers embracing hybrid office strategies, many agencies will downsize offices and rethink how they allocate real estate in order to provide communities with critical services in more equitable ways.



TRENDS

01

Walk-in government services are going virtual, prompting redesigns.

Among walk-in services where governments have traditionally had in-person contact with the public — think permit reviews, driver's license renewals, and even social services such as counseling — hybrid and virtual models are taking hold. Governments are reimagining the offices that provide such services and reducing square footage. As this trend plays out, equity concerns will be paramount, as virtual services enhance convenience but risk excluding citizens without technology access.



02

As governments reevaluate square footage needs, many will downsize offices.

State, federal, and local governments are diving into a concerted review of their true square footage requirements. Governments have traditionally adopted conservative real estate strategies, but now many are embracing hybrid work environments. Many agencies are moving forward with renovations, lease renewals, and new office construction under the assumption that fewer workers will occupy the office full time in the future.

03

Security concerns will continue to redefine government buildings.

Increasing numbers of data breaches and more incidents of domestic political unrest will significantly affect the security infrastructure of government buildings. Design will play a key role in maintaining the balance between openness and security, promoting safety and democratic values. Vehicle barriers can take the form of well-designed benches, other street furniture, and landscape features, which can enhance the public realm. Crowd control barriers can be designed as easily erected elements that interrupt access only when needed.

04

Government will move toward resilient, "net zero ready" facilities.

Government facilities have an opportunity to lead on environmentally conscious design and construction, such as mass timber, and many have begun funneling investments in this direction. Businesses and nonprofits will look to governments to "walk the talk" on carbon reduction commitments, and to make green designs publicly visible. Extreme weather events will continue to threaten operations continuity, requiring resilient designs that can adapt to rising waters, high winds, the disruption of energy grids, and other emergencies. Governments that remain operational in times of crisis will gain public trust and, ultimately, save lives.



05

Public-private partnerships will reshape public real estate.

In addition to accommodating business offices, governments have started to rethink the use of public property to include space for housing and other social needs, often via public-private partnerships. On the local level, awareness is growing around the importance of locating resources close to the people who need them; successful implementation of the 20-minute city concept will therefore include ready access to government services.

FEATURED PROJECTS

A. LA County Department of Mental Health, Vermont Corridor, Los Angeles

B. U.S. Embassy, London

C. Wheaton Town Center, Montgomery County offices, Wheaton, Md.

D. City of Austin Permitting and Development Center, Austin

“We must balance security and openness to keep our public buildings public, and not close them off from the people they serve.”

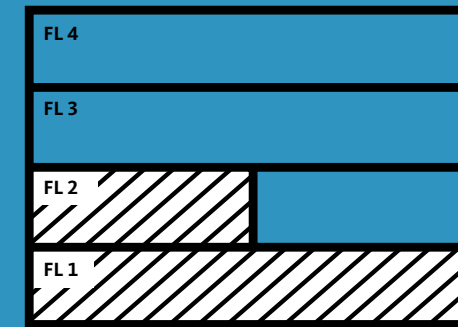
Source: Dialogue Blog by Robert A. Peck, “Security and Democracy: Designing Public Buildings for Safety and Accessibility”

Separating visitor areas from employee areas can keep public buildings open to the public.

Source: Security and Democracy: Designing Public Buildings for Safety and Accessibility | Gensler

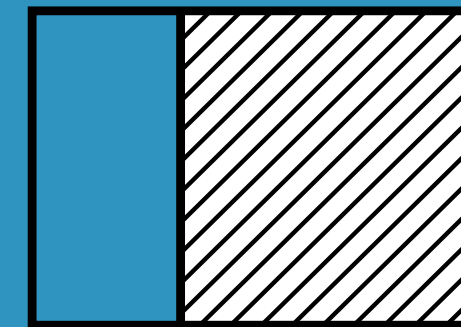
SECURITY ZONING

SECURITY BY VERTICAL SEPARATION



Locate public functions on floors one and two to limit traffic to staff floors.

SECURITY BY PHYSICAL SEPARATION



Isolate public space from private staff space with a combination of physical boundaries and security measures.

Private Staff
Public Area

“Inside, we can provide security best by separating visitor areas from employee areas horizontally, vertically, or both. The goal is to welcome citizens and unobtrusively limit access to non-visitor areas.”

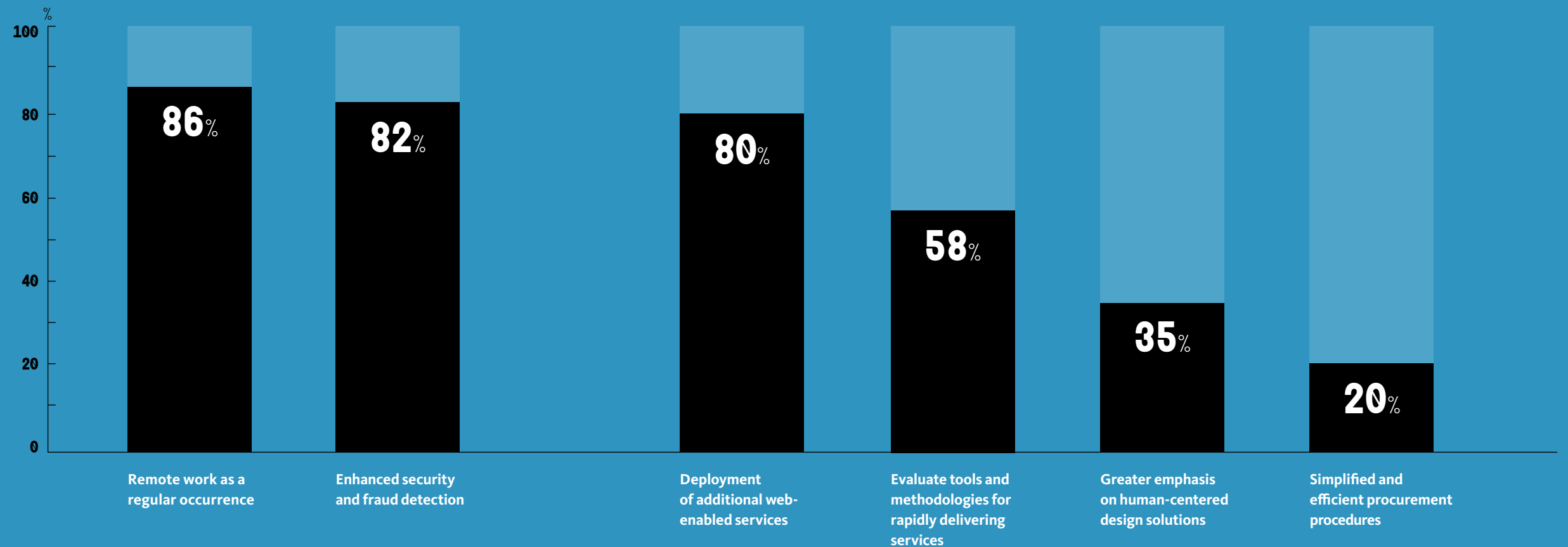
— Robert A. Peck, Government & Defense leader, Gensler

State government employees expect remote work to stay. Many also report that it has created new challenges for cybersecurity.

Source: National Association of State Chief Information Officers

WHAT DIGITAL SERVICES AND WORK PRACTICES INSTITUTED DURING THE PANDEMIC DO YOU EXPECT TO RETAIN?

(Respondents were directed to select all that apply)



MEDIA

OVERVIEW

The rate of change in the media industry has accelerated over the last year with the shift to tech-enabled streaming services, 5G, and digitization. The drive to attract and retain consumers is leading to a sharp focus on a constant supply of high-quality, differentiated, fresh, and diverse content. Creating indelible, immersive, brand-aligned experiences for employees, clients, partners, and customers will be key.



TRENDS

01

The race for content will define the media workplace.

Widespread global adoption of streaming platforms has set the global media industry on a trajectory of accelerated growth to meet rising consumer demand for fresh and diverse content. In addition to streaming video, providers are now adding games, music, and podcasts to capture more market share. The industry is in need of agile and adaptable workplaces that support a variety of content creation workflows and allow for seamless collaboration and cross-pollination between creatives.

02

The adoption of sustainable designs is growing rapidly.

The focus on sustainability and resiliency in the built environment has impacted the media industry in a big way. In the coming years, companies will embrace innovative adaptive reuse and energy efficiency strategies. As more data moves to the cloud, media companies are also able to reduce on-site operational systems, as well as the amount of square footage required to house these systems.



“As companies race to meet consumers where they are with an ever-expanding range of products, services, and experiences, the entertainment and media industries will grow more pervasive, more immersive, and more diverse.”

— PwC

FEATURED PROJECTS

A & B. NFL Media, Los Angeles
C. Confidential Client

The Culver Studios Innovation Plan, Culver City, Calif.

The innovation plan seeks to transform a 14.3-acre site into a dynamic, state-of-the-art media campus. With the addition of five new digital media buildings and redesigned flexible space, the plan seeks to sustain Culver Studios' prominent role at the cutting edge of innovation, essential to the production of entertainment and digital media for future generations.





03

Geographical diversification in real estate will become essential.

U.S. and global consumers are looking for diverse, differentiated, and fresh content. This consumer demand is driving production teams and facilities to hire more diverse talent and move to diverse geographies. Geographical diversification can also mitigate the impact of future crises since companies can always have production locations in the event one or more can't operate.

FEATURED PROJECTS

D. Confidential Client, Los Angeles

04

There will be a heightened focus on a distinctive employee experience.

As flexible work options become more widespread, there is a heightened focus on the employee experience in the workplace to make it a desirable place to be. To make themselves attractive to tech and media workers, media organizations need to create a workplace that is agile and adaptable to a fluid technology workflow. Alignment of values, and authentic communication of these values in the space, is essential to the employee experience and a key differentiator.

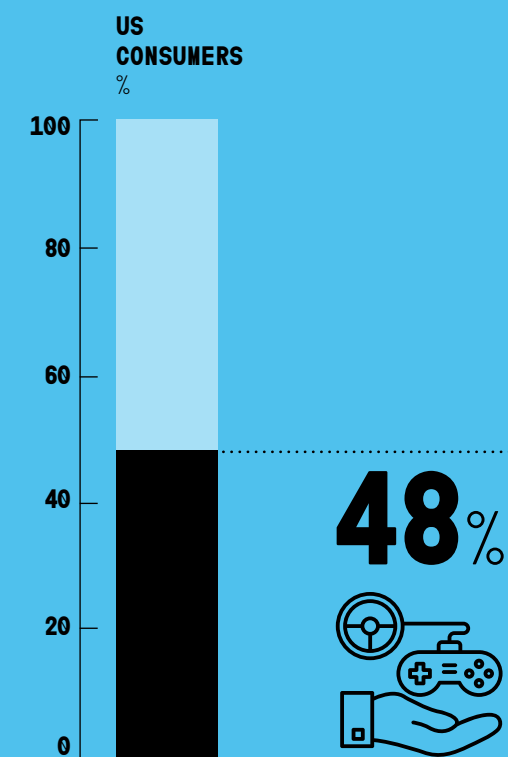
STRATEGIES & RESEARCH

“Streaming is not just displacing traditional sources of entertainment revenue such as pay-TV and linear broadcasting, it is actually expanding the global marketplace for video.”

Source: Streaming Media Europe

Gaming is on the rise.

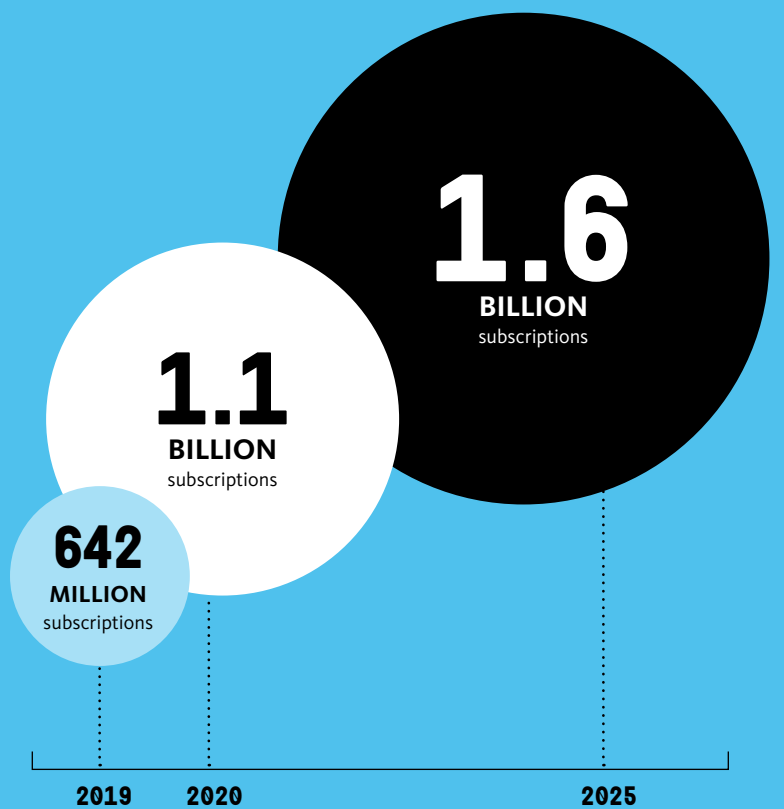
Source: Deloitte



SINCE THE COVID-19 PANDEMIC BEGAN, 48% OF U.S. CONSUMERS HAVE PARTICIPATED IN SOME FORM OF VIDEO GAMING ACTIVITY.

A deluge of new streaming platforms is transforming consumption.

Source: Global SVOD Forecasts 2021, Motion Picture Association's 2020 Annual Report



OFFICE BUILDINGS: DEVELOPER

OVERVIEW

As the role of the workplace evolves, new office buildings must provide workers with meaningful, immersive experiences that they cannot get while working at home or in older office buildings. How a building supports company culture, promotes wellness, and connects with the local community are the new drivers for great design and the new benchmarks for tenants.



TRENDS

01

New buildings must be adaptable and multiuse.

To adapt to uncertainty in the market and appeal to a larger range of tenants, developers should look to create more spaces with built-in flexibility that could work for the office or other, more specialized uses, such as life sciences. Core and shell design for office buildings is increasingly allowing for a multitude of uses through greater structural loading, higher floor-to-floor heights, expanded stairwells, and a focus on back-of-house operations.

02

Tenants want more common spaces for socialization that lead to casual collaboration.

Open stairways, lounges, and activated lobbies in common areas are in high demand because of the way they encourage movement, facilitate social interactions, and spur casual collisions with various companies within multi-tenant buildings. On-site public gardens also provide opportunities for meetings and collaborations among tenants and neighbors.

FEATURED PROJECTS

A. 225 Wyman,
Waltham, Mass.

B. 333 North Green,
Chicago

C. Confidential
Headquarters, Chengdu,
China



03

ESG, wellness, and biophilia will attract tenants.

To respond to tenant demands for spaces that contribute to health and wellness, developers are incorporating biophilia and other WELL Building Standard elements into the core and shell. Elevated and landscaped decks and outdoor zones, operable windows for fresh air, and open stairways are the types of enhancements that can increase a building's value and help developers position their projects as Environmental, Social, and Governance (ESG) investments.

04

Hybrid work will continue to influence office building design.

We are seeing the role of the office building change to adapt to a hybrid lifestyle where workers split their time between home and the office. This means we have an opportunity to design the office with more residential and hospitality elements and find ways to incorporate more services that offer convenience and efficiency.



Whole Foods Market East Block Office Building, Austin

The 140,000 square-foot build-to-suit office building turns the Whole Foods Market headquarters into an amenity-rich urban campus. The building's extended floor plates help with its energy efficiency by providing protection from sun exposure. Interior public spaces promote casual collaboration and incorporate biophilic elements to enhance the employee and visitor experience. An outdoor terrace offers an alternative workplace.

4



Morphable Office, Baltimore

Drivers impacting the future of office development

Work from home will continue as part of a hybrid work model, so the office no longer needs to be a container for people who can do focused work anywhere — instead, office buildings must support new ways of working and foster memorable experiences for the tenants who use them.

Based on our research, here are four strategies developers can take to drive future office buildings:

1 SUPERCHARGE EXPERIENCE TO BOOST CULTURE AND CREATIVITY

Culture, creativity, and innovation need in-person interaction; therefore, the office must focus on collaboration and connection, fostering long-lasting, memorable experiences.

3 USE GROUND FLOORS TO CONNECT TO THE COMMUNITY

Office buildings should be contributing to their surrounding neighborhoods, even when workers are not present. By integrating their ground floors into the community, office buildings will become anchors of the 20-minute city.

2 CONNECT TO THE OUTDOORS TO APPEAL TO NEW TALENT

To appeal to today's workers, office buildings must have connections to high-performance outdoor space — including areas equipped with mechanical systems, such as radiant heating and cooling to support meetings, focus space, and more.

4 INCREASE VALUE WITH ESG INVESTMENTS

Consider the broader impact these buildings have as investments. Incorporate sunshades, overhangs, energy recovery, and other features and systems that improve performance. As power generation shifts to more renewable sources, your building will maximize its long-term value.

“The best offices will be where employees will want to go, regardless of the commute.”

Source: Dialogue Blog by Dean Strombom, “Vuja De: Seeing the Office With Fresh Eyes”

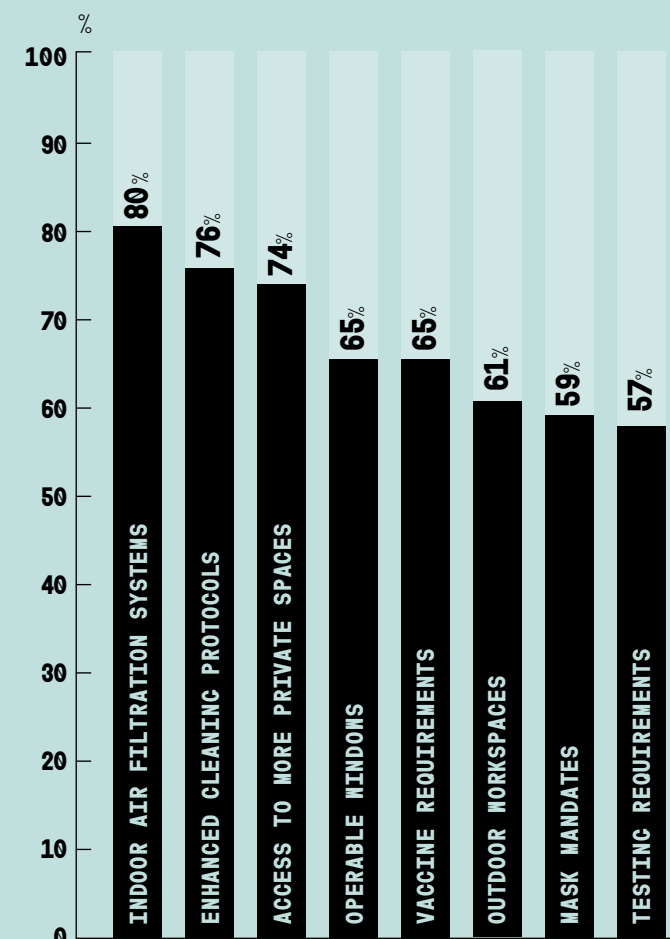
Enhanced air filtration, cleaning, and privacy would make those employees who have not yet worked in the office more comfortable.

Source: U.S. Workplace Survey Fall 2021

Work will not be the primary driver in bringing people back to their business districts; people want their business district to be a lifestyle hub.

Source: Gensler City Pulse Survey Fall 2021

WHAT WOULD MAKE YOU MORE COMFORTABLE GOING INTO THE OFFICE NOW?



WHAT ACTIVITIES DOWNTOWN DO PEOPLE MOST WANT TO DO POST-PANDEMIC?

RANK	Activity
1	GO SHOPPING
2	VISIT PARKS
3	SIMPLY HANG OUT
4	DINE OUT
5	CULTURE & ENTERTAINMENT
6	GO TO WORK
7	RUN ERRANDS
8	SEEK HEALTHCARE
9	VISIT FRIENDS/FAMILY WHO LIVE IN THE AREA
10	ATTEND PROFESSIONAL EVENTS
11	GO TO BEAUTY SALONS/SPAS
12	GO TO CYMS/FITNESS CENTER

OFFICE BUILDINGS:

REPOSITIONING & LANDLORD SERVICES

OVERVIEW

The lifestyle and wellness choices of today's workforce are the major factors influencing the office market and will continue to do so in the years to come. Markets will continue to place a premium on spaces that support flexibility, resiliency, and quality of life. Landlords and building owners will continue to have opportunities to convert or reuse existing buildings in order to address these needs.



TRENDS

01

Resilient buildings will become easier to finance and lease.

The influence of Environmental, Social, and Governance (ESG) will continue to drive innovation. As such, socially and environmentally responsible office buildings will become both easier to finance and easier to lease to tenants who are increasingly demanding workplaces that support the health and well-being of occupants and the planet. Adaptive reuse of older buildings is a key resilient strategy and selling point.



02

Well-being and inclusivity can offer tangible benefits.

Landlords and owners are realizing the tangible outcomes of creating "healthy" and inclusive buildings. Research shows that better indoor air quality leads to increased productivity and reduced sick leave. Biophilic design can lower stress and anxiety and can also attract sought-after tenants and higher rental yields. Addressing equity and inclusion with core elements, such as gender-neutral restrooms and other common areas for an increasingly diverse workforce, is also a tenant draw.

03

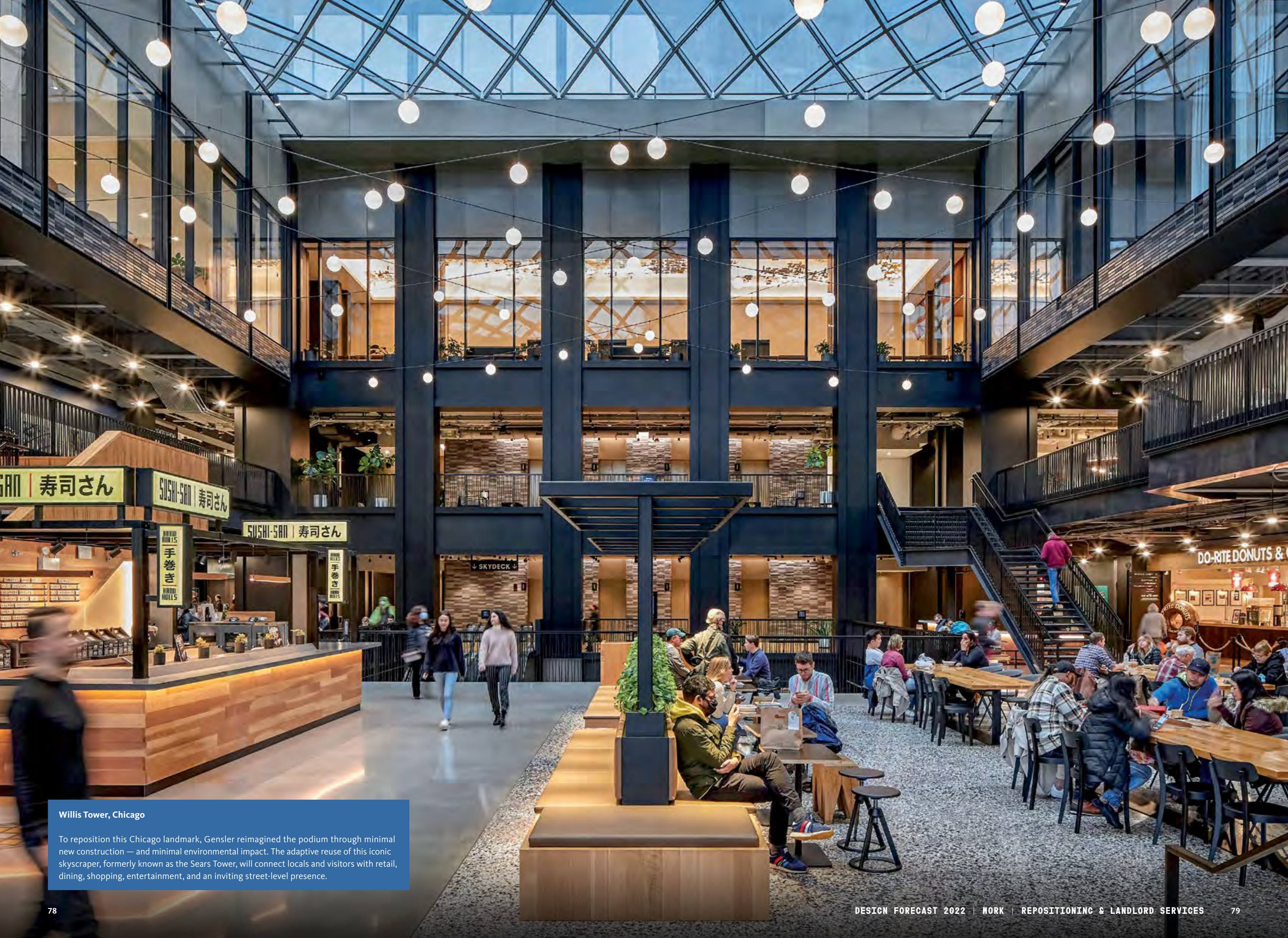
The demand for quality experiences in the workplace will continue.

In a competitive market with more flexible attendance policies, buildings must provide special experiences that are different from the home to bring people into the office. Tenants will continue to seek out more modern, amenity-rich, and sustainable spaces. Opportunities for adaptive reuse and building conversions will continue to grow.



FEATURED PROJECTS

- A. The Post Office, Chicago
- B. Cargo Crossrail, London
- C. The Link, Denver



Willis Tower, Chicago

To reposition this Chicago landmark, Gensler reimagined the podium through minimal new construction — and minimal environmental impact. The adaptive reuse of this iconic skyscraper, formerly known as the Sears Tower, will connect locals and visitors with retail, dining, shopping, entertainment, and an inviting street-level presence.

5



Park Point Business Park, Durham, N.C.

Conversion strategies for office buildings

In today's evolving office market, how can developers and building owners assess whether to upgrade an older, poorly performing building as office space or convert an existing office building to other uses, in order to get a better return on their investments?

Here are five strategies for enlivening assets and driving performance:

1 MULTIPLE ENTRIES SUPPORT A MIX OF USES

Buildings with multiple entries can help future-proof a building to support an anchor tenant private entry or a mixed-use entry for residential or other use.

3 CONSIDER INDUSTRIAL BUILDINGS FOR CONVERSION

Growth in emerging cities has pushed development into former industrial areas, which are often attractive to the creative class and create a need for nontraditional office space. Industrial buildings, with their wide spans and high bays, can be good targets for conversion to life science and creative campus tenants.

5 ADD PLENTY OF COMMUNAL SPACES

Adding communal spaces (both indoors and out) that apply urban forms, such as main streets and courtyards, can help former industrial spaces come alive when converting for mixed-use, office, or residential uses.

2 SPLIT ELEVATOR BANKS CAN PROVIDE FLEXIBILITY

Buildings with split elevator banks support a good foundation for a mixed-use building. Splitting residential and commercial across the low-rise and high-rise banks provides great flexibility.

4 SMALL FLOOR PLATES CAN EASILY BE SUBDIVIDED

Office buildings with small floor plates — around 8,000 to 10,000 square feet — are generally very desirable and can be easily subdivided into a good mix of residential units.

“Far and away the best way to reduce carbon is to reuse existing buildings. By recycling structure, we can save up to 40% of emissions. These targets are achievable now.”

— Juliette Morgan, former head of Sustainable Development, British Land

The Evolving Role of Amenities

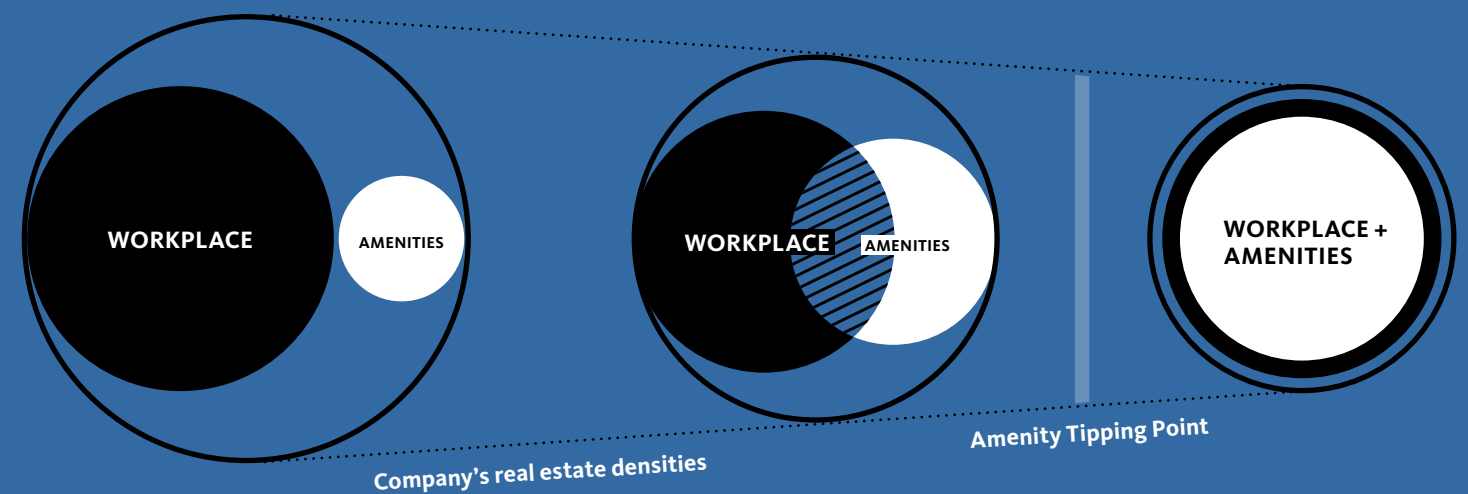
Source: Gensler

What amenities might deliver the greatest returns in today's evolving work landscape? Many agree that collaborative environments, fluid locations, access to outdoors, proximity to food & beverage, and healthy enjoyable experiences will attract and retain talent, and drive well-being. These are the attributes that will drive the workplaces of the future.

SUPPLEMENTING BUSINESS
2010 – 2015

OPTIMIZING BUSINESS
2016 – 2019

DRIVING BUSINESS
2020 – CURRENT



PRODUCT DEVELOPMENT

OVERVIEW

Furniture, interior finishes, and other products are most valuable when they respond to end-user demand quickly and include the kind of insights that can address a broad set of needs. As the market evolves, clients are looking for a larger scope of services — including sustainability consulting, ADA compliance reviews, and design visualization — to enhance the impact of their products.



TRENDS

01

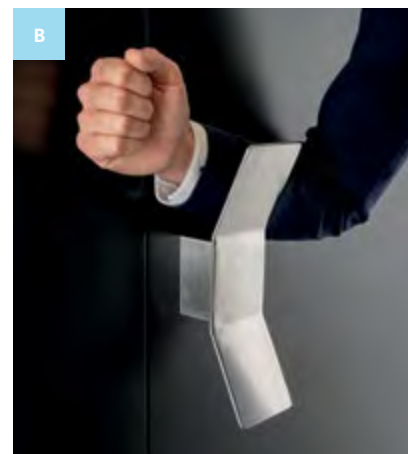
In-office and home office furnishings will support flexibility more than ever.

Office spaces are becoming dynamic hubs of innovation and connectivity. As such, office furnishings are evolving to support greater flexibility, allowing for enhanced collaboration, as well as individual work. At the same time, with more people working from home, the demands on the home office will continue to evolve, and consumers' performance expectations for home office equipment are projected to increase.

02

Hygiene protocols and wellness safeguards are here to stay.

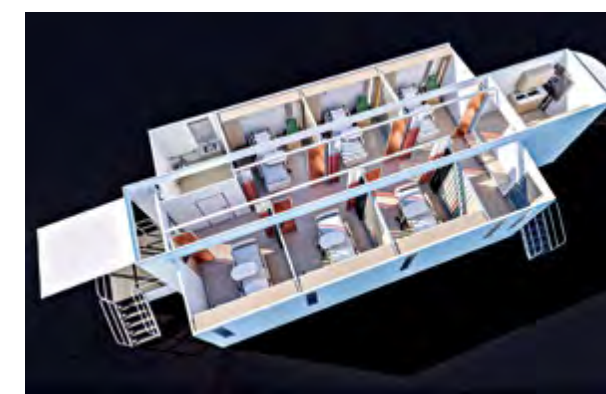
The realization that COVID-19 will be an ongoing global health battle is prompting a long-term expectation and demand for heightened hygiene protocols and wellness safeguards in the places people visit and occupy. Manufacturers that address these concerns through smarter, more hygienic, and more inclusive products will gain a competitive edge.



03

The climate crisis will continue to drive resilient product solutions.

The climate crisis has accelerated the need for resilient product solutions that minimize the impact on the planet and the people who use them. Issues related to climate action, well-being, and the circular economy are driving product development strategy. Manufacturers that reduce carbon emissions and improve material transparency will benefit occupants and positively impact their bottom line.



04

More new products will focus on user safety and wellness.

COVID-19 and the resulting global health crisis proved the need for greater preparedness and greater respect for measures that ensure life safety. Air quality, safety protocols, and general cleanliness are among the most important considerations for people to feel comfortable and safe in returning to the office. Addressing these safety elements will help companies prepare for future crises.

FEATURED PROJECTS

A. Stylex Free Address Furniture

B. PBA Hands-Free Pulls

C. Amerlux Active-CLEAN Lighting

D. Craftsmen Mobile Modular Hospitals



FEATURED PROJECTS

E. L&M Architectural Signs 60|30 Glass Films
 F. Stylex Free Address Furniture

STRATEGIES & RESEARCH

“Post-pandemic, people’s focus on hygiene will continue to be elevated, so it’s no surprise that many of Gensler’s endeavors are focused on products that will foster a cleaner built environment.”

Source: Dialogue Blog by Scott Star, “Product Design in Times of Crisis”

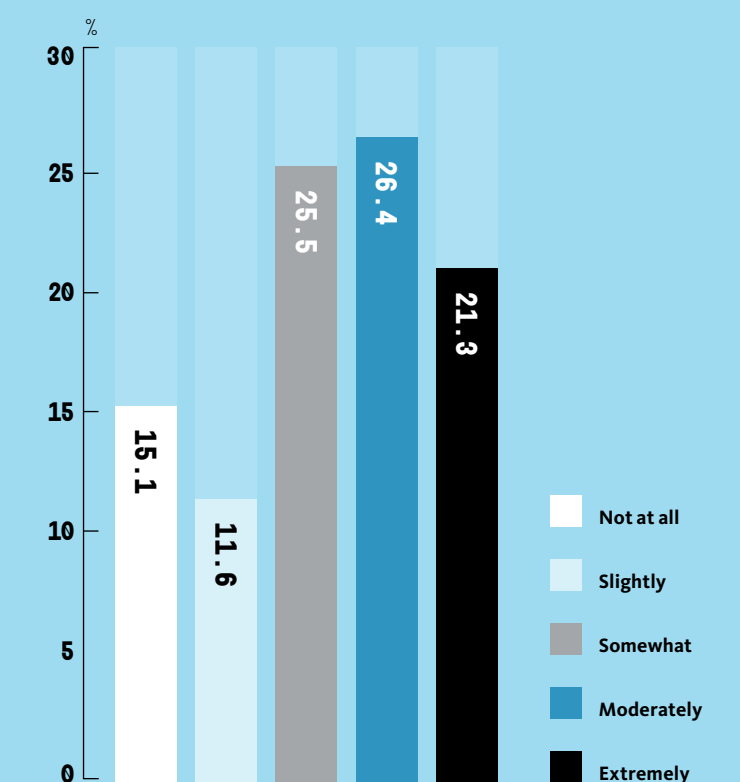
92%

of office workers feel that hygienic, easy-clean materials are important relative to the comfort and enjoyment of their work environment.

Source: Gensler Consumer Research Survey

To what extent has your perception of the hygiene/cleaning protocols in place in your company’s office impacted your decision to return to the office instead of working exclusively from home?

Source: Gensler Consumer Research Survey



PROFESSIONAL SERVICES FIRMS

OVERVIEW

For professional services firms, the pandemic has opened up key areas of change: mobility, choice and variety of spaces in the office, and health and well-being. By building upon these core principles in the years to come and focusing on the employee experience, management advisory and legal firms can attract the best talent and deliver great experiences for a diverse, multigenerational workforce.



TRENDS

01

Diversity and well-being will continue to prioritize inclusive design.

A broad definition of inclusive design embraces cultural diversity, as well as the mental and physical well-being of all employees. To attract and retain diverse talent, professional services firms should create an empowered work experience based on choice and flexibility that is inclusive. Gender-neutral restrooms, mothers' rooms, and other spaces are increasingly common to accommodate diverse needs.



02

The future legal office should support collaboration and social gathering.

To attract and keep talent, the legal industry must think of the office as a destination — or a type of work club. Spaces that promote knowledge sharing, mentorship and coaching, meetings, and collaboration will be the hallmarks of the new law office.

“Smart professional services firms are looking to incorporate a hybrid work model that embraces mobility, increases amenities, and delivers a great workplace experience for a multigenerational workforce.”

— Dialogue Blog by Barbara Dunn, “Reset: The Future Law Firm Workplace”

03

Reframing the office as a destination will remain an industry driver.

As the primary purpose of the workspace shifts to accommodate more collaboration, mentoring, and impromptu social gathering, professional services firms will continue to experiment with amenities. Team rooms, food service areas, work-focused lounges, informal meeting areas, and outdoor connections will continue to be part of the mix.

04

Operating in beta mode is a worthwhile investment.

As clients reexamine their portfolios, being in “beta mode” will become part of real estate thinking. Testing ideas by launching pilot programs can be low-risk, high-reward solutions that enable clients and designers to experiment and then pivot. By embracing new technologies and ways of working, professional services firms can better understand staff needs, find new ways of building and promoting firm culture, and test drive new concepts.

FEATURED PROJECTS

- A. The Manor, McCann Worldgroup, London
- B. Confidential Client, Washington, D.C.
- C. Gensler Raleigh



Buccini/Pollin Group Headquarters Renovation, Wilmington, Del.

This commercial real estate developer's headquarters exemplifies how purpose-driven design can breathe new life into older buildings. With a modern, hospitality-influenced design aesthetic, the newly renovated workplace reflects the company's brand and position as a leading office landlord while showcasing the site's potential to future tenants.



05

Now is the time to turn corporate net zero carbon commitments into action.

As pressure mounts to take action to prevent the worst effects of climate change, a growing number of management advisory firms have made net zero carbon commitments. Now is the time for real estate teams within these firms to establish a workplace design sustainability roadmap that aligns with these commitments and identifies measurable criteria. Roadmaps will prove to be invaluable, providing a prioritized set of applicable sustainability strategies, performance criteria, implementation methods, and clear governance.

FEATURED PROJECT

D. Confidential Client,
New York

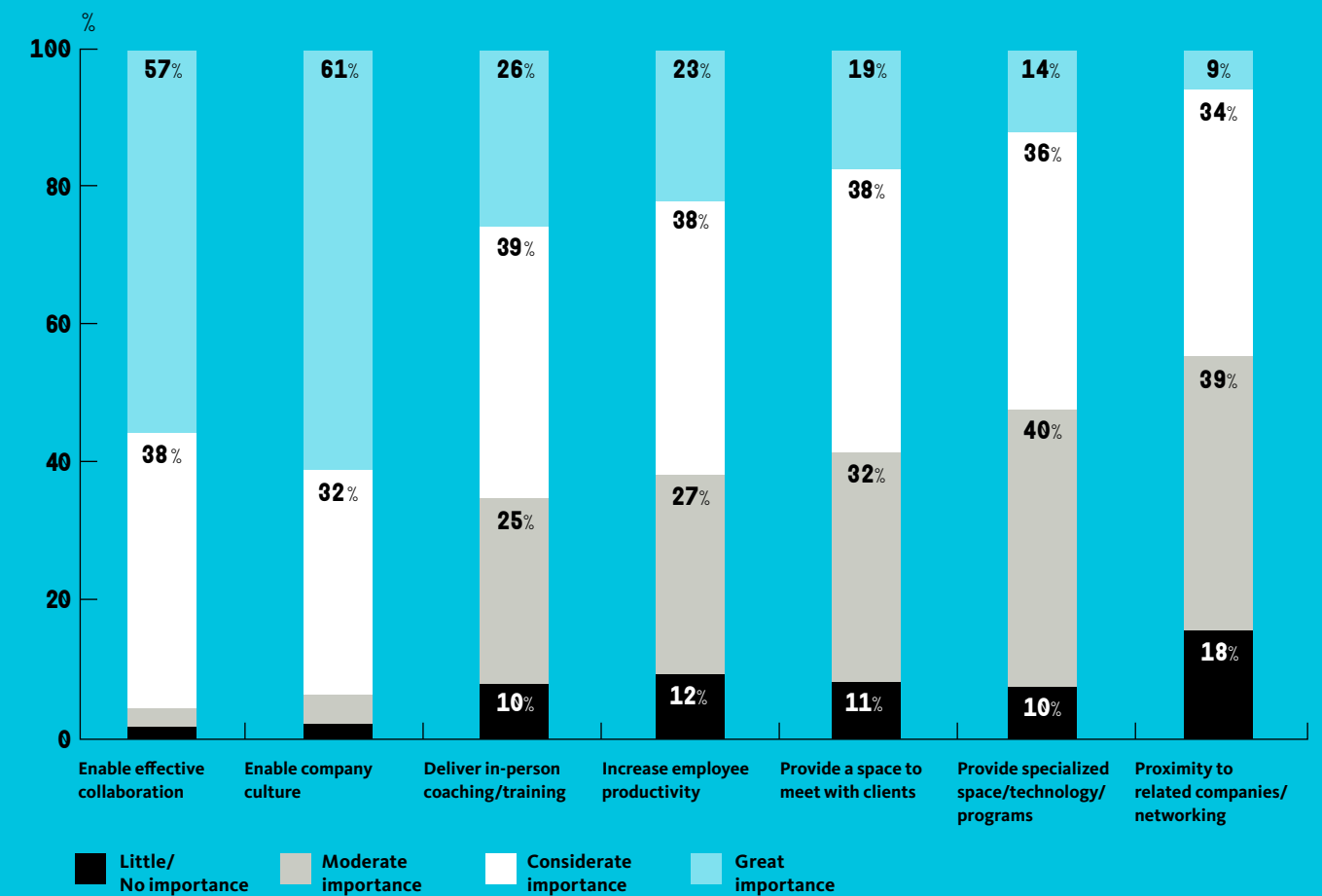
STRATEGIES & RESEARCH

“As we continue with a hybrid model, combining remote and in-the-office work, professional services firms will need to develop planned activities and programs that connect people and build culture and comradery.”

Source: Dialogue Blog by Barbara Dunn, “Reset: The Future Law Firm Workplace”

What will be the primary value drivers for companies to maintain a future physical office footprint?

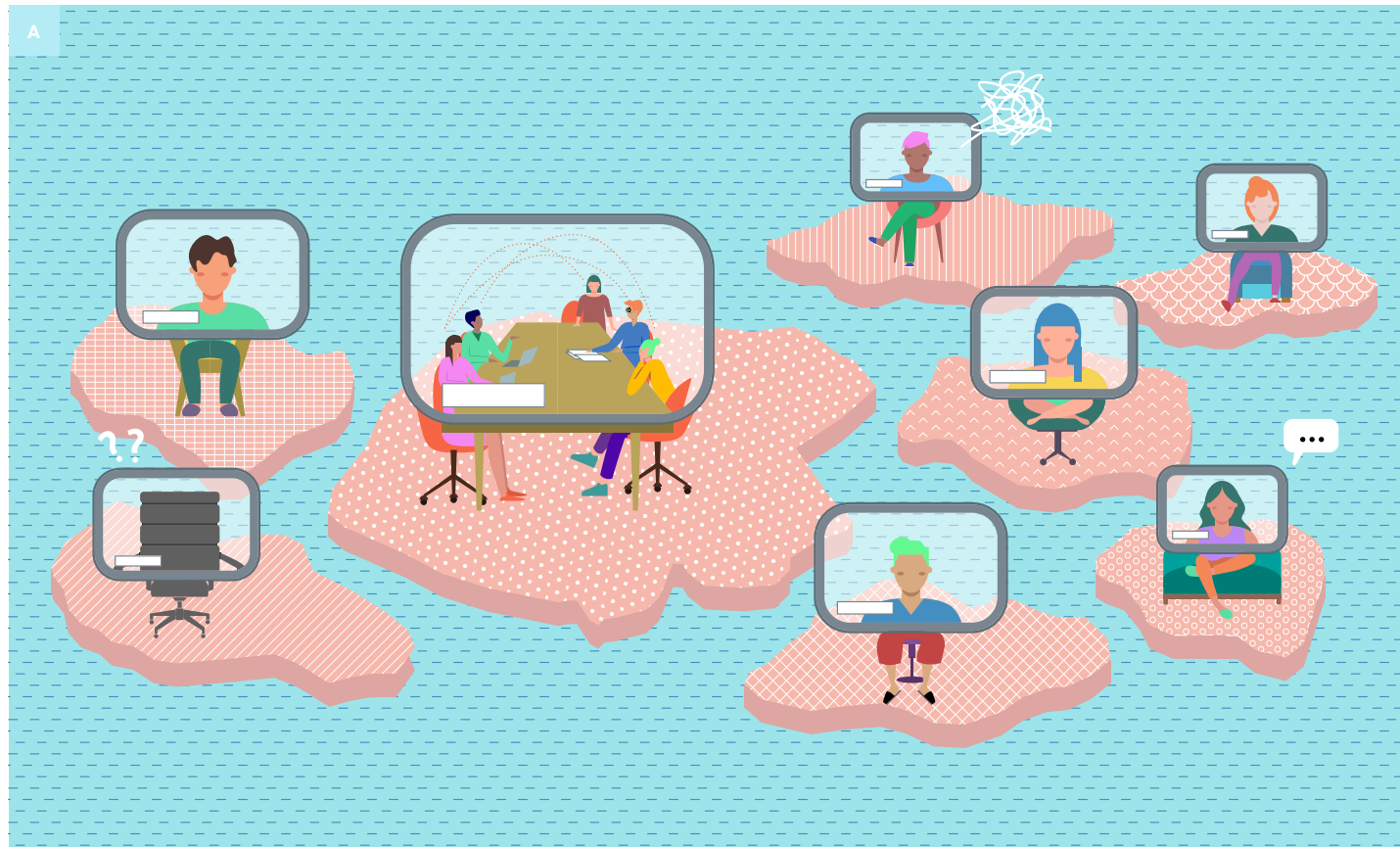
Source: PwC and ULI, Emerging Trends in Real Estate 2022



REAL ESTATE & CONSULTING

OVERVIEW

In the coming years, organizations will operate with a deeper understanding of how the world's challenges, such as climate change, global health, and social inequality intersect with one another, and how they impact real estate. By helping organizations understand these intersections, we can unlock the potential for real estate decisions to meaningfully respond to change both within and across cultures.



TRENDS

01

The need for empathy in the workplace will remain front and center.

Many diversity, equity, and inclusion (DEI) initiatives are still in their infancy. Over time, these taskforces and roles will formalize, taking on more permanent institutional functions. Understandings of inclusivity will expand beyond race to encompass more nuanced attitudes around gender, cultural background, neurodiversity, and the benefits of an intergenerational workforce.

02

Matching mission to action will enable organizations to stand out.

How should companies align social justice, public health, and environmental demands with economic objectives? For many companies, living up to their socially conscious missions will mean investing in spaces that can have a positive local impact, such as walkable areas, outdoor recreation places, and other public features that build community.

03

The Great Resignation will keep reframing conversations around talent.

The 2021 labor shortage and Great Resignation will continue to push organizations to rethink their fundamental understandings of talent. An emerging focal point is psychological well-being. Workplace real estate will become more flexible and responsive to work-life balance, burnout, and mental health. Designs that address these things will shift in priority from "nice to have" to "must have."

FEATURED PROJECTS

- A. Hybrid Dystopia, Singapore
- B. Gensler Miami

04

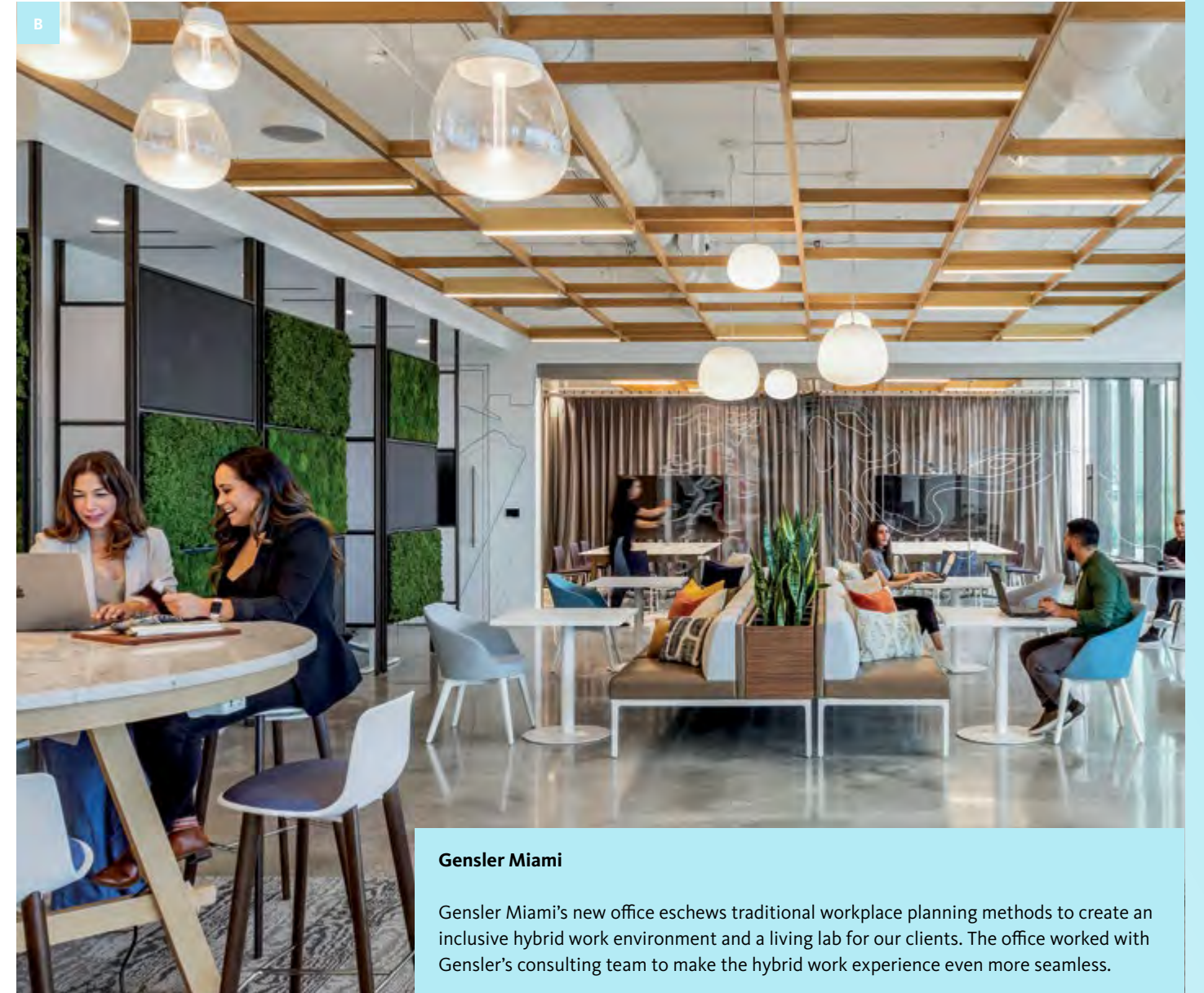
Pilot spaces will grow in value in an evermore hybrid landscape.

The future will not be static. In the years to come, we'll see more hybrid-distributed workplaces that allow workers to live in more affordable towns and cities. Optimizing company culture in this new hybrid reality will be a decades-long challenge that will constantly evolve with the emergence of new communications tools. Within this context, the importance of experimentation will increase, as will the relevance of pilot spaces.

05

New work patterns are driving tenants to look beyond their traditional building preferences.

In this new environment, tenants will gravitate toward the properties that best solve for flexibility, adaptability, and well-being. In response, building owners and developers should explore new real estate design strategies that can differentiate them from the competition and adapt to this new marketplace.



Gensler Miami

Gensler Miami's new office eschews traditional workplace planning methods to create an inclusive hybrid work environment and a living lab for our clients. The office worked with Gensler's consulting team to make the hybrid work experience even more seamless.

"Pilot spaces enable both clients and designers to test concepts about which they aren't 100% sure, and then pivot if they don't love the results. This allow us and our clients to experiment more radically than we otherwise would because the risks are much lower."

— Dialogue Blog by Cheryl Duvall, "The Power of the Pilot: A Low-Risk, High-Reward Real Estate Solution"

“It is important to emphasize that workplace strategy is never a one-size-fits-all solution. A cultural norm may work in one place but not another, especially depending on how leadership shows the way and normalizes the change.”

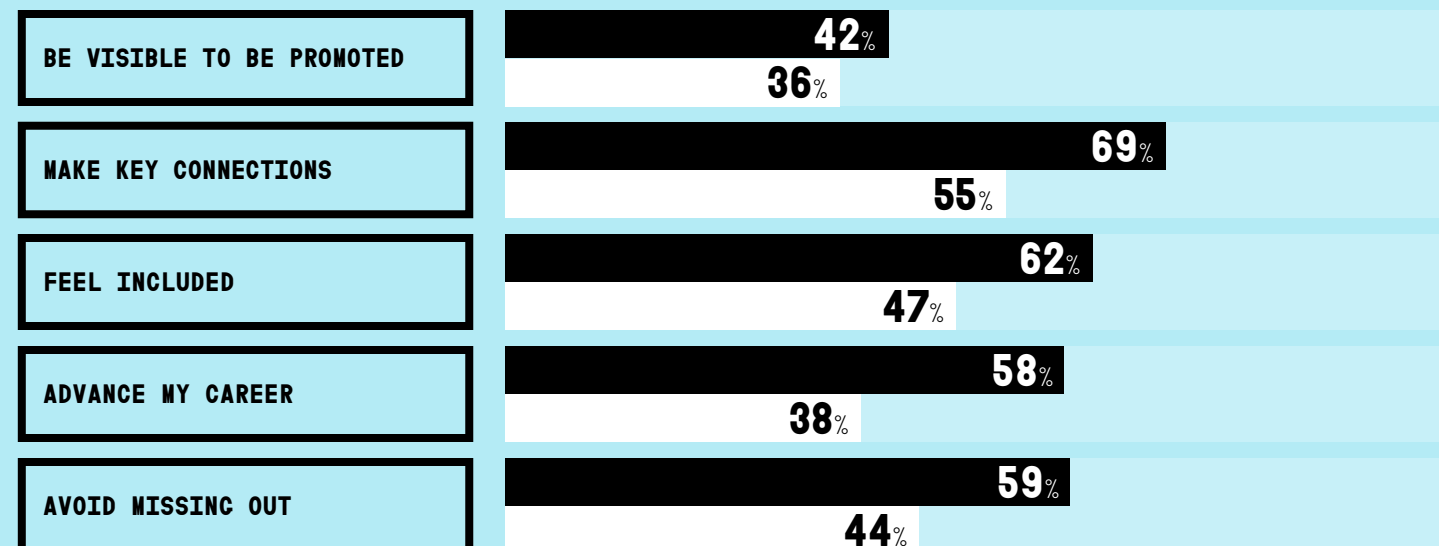
Source: Dialogue Blog by Elizabeth Baudler, “Three International Lessons for U.S. Workplace Well-being”

People who have worked in the office see it as more crucial to inclusion, career development, and FOMO.

Source: U.S. Workplace Survey Fall 2021

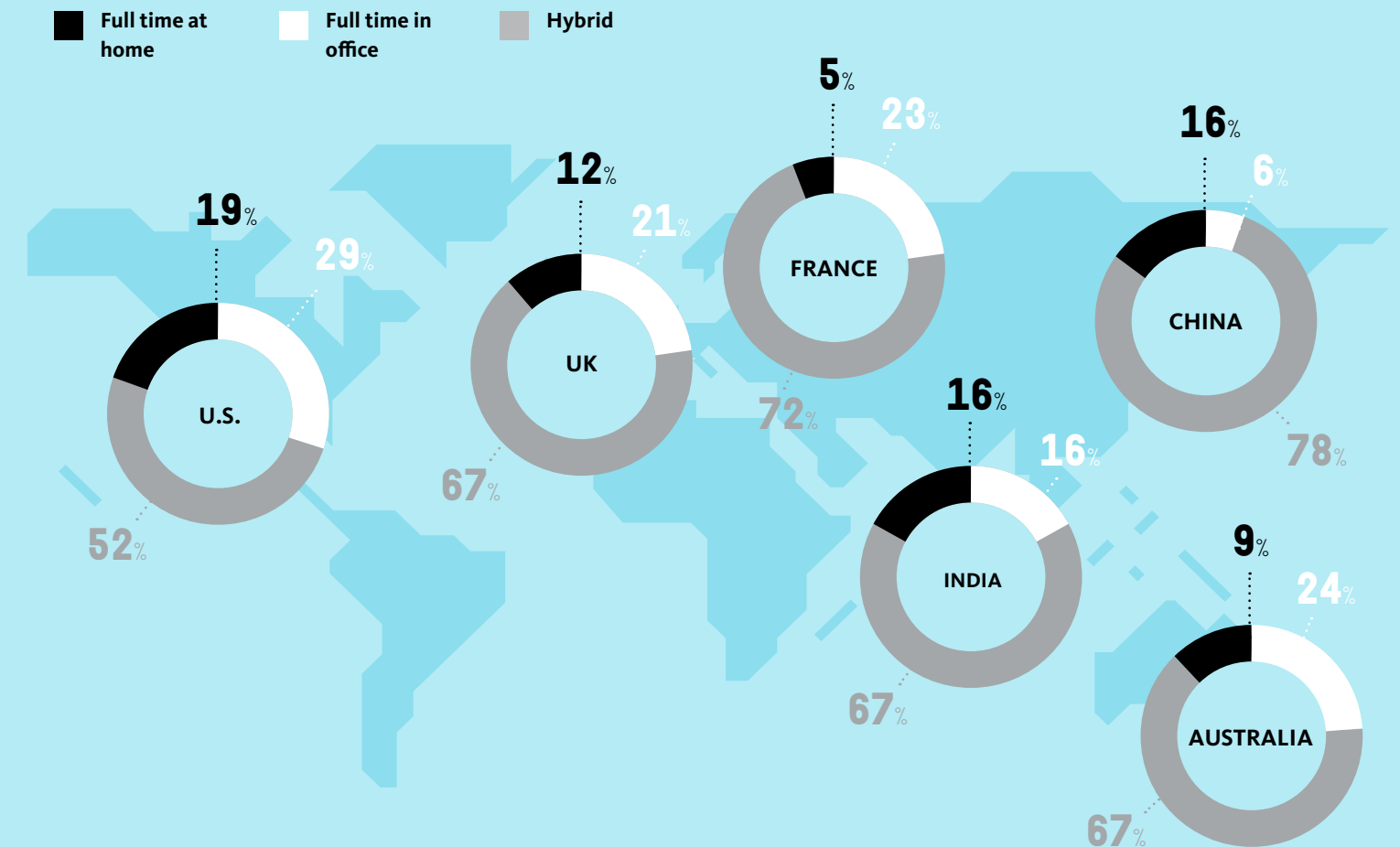
IN THE FUTURE, I FEEL LIKE I NEED TO BE IN THE OFFICE TO...

■ People who have worked from the office since COVID □ People who have not worked from the office since COVID



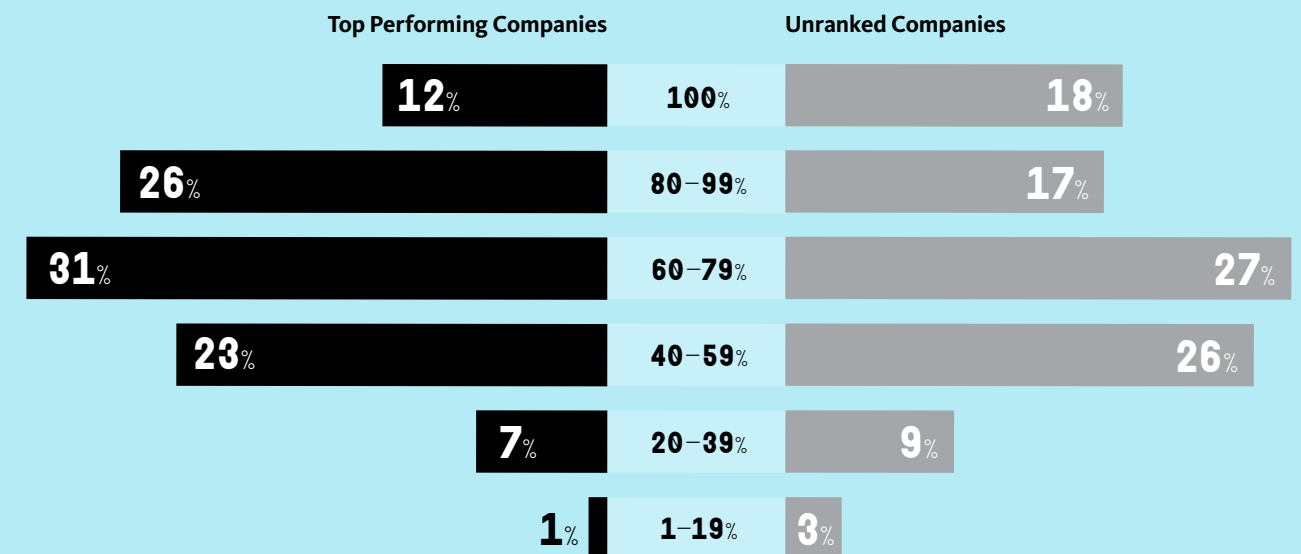
Hybrid WFH demand is varied and is leading to more nuanced future solutions.

Source: Gensler Global Workplace Surveys 2021



Top-performing companies are more likely to expect the majority of staff in the office concurrently in the future.

Source: Gensler U.S. Workplace Survey Summer 2021



TECHNOLOGY

OVERVIEW

The tech industry is facing scrutiny from all angles, while also undergoing big changes in work practices and resilience strategies. There's never been a more critical time to experiment with new work models and embrace initiatives that rebuild community and trust, both within their workplaces and with the world at large.



“As we look ahead and reexamine policies, there’s an urgent need to craft new routines that reinstate work/life boundaries.”

— Dialogue Blog by Brian Stromquist, “Meet the New 9-to-5: An Enhanced Approach to Hybrid Work”

TRENDS

01

Pilot projects and test labs will be the norm.

Pre-pandemic, pilot projects were occasionally used but often effective opportunities to temporarily test out different workplace models without investing in an office-wide makeover. Now, they're becoming more widely used — and more permanent. They allow companies to explore new furniture systems, experiment with inclusive collaboration technologies, investigate modular architecture, and explore sustainable workplace strategies, such as low-carbon building materials.



FEATURED PROJECTS

A. Confidential Client, San Francisco
B. Confidential Client, Sunnyvale, Calif.
C. Confidential Client, New York

02

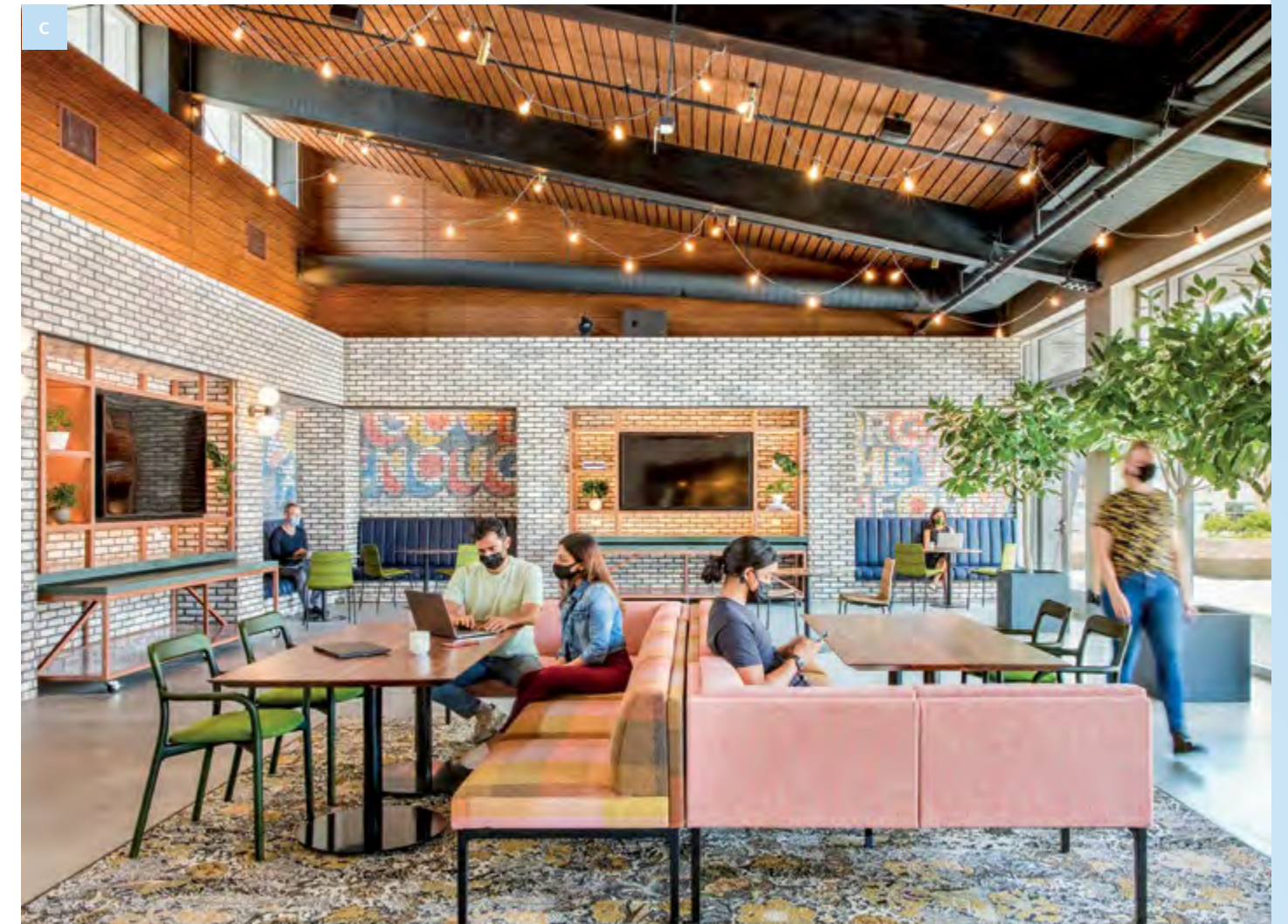
Design will help tech become a better member of the community.

Meaningful design and inclusive programming will help the tech workplace focus on spaces that bring the community in. These public-facing space types — reception, all-hands, and culinary spaces — are opportunities for programming that establish tech as good neighbors and contributing members of the cities and suburbs in which they establish themselves.

03

Ongoing interest in health will push wellness amenities.

The pandemic has resulted in a heightened interest in wellness in the workplace, a trend which continues to increasingly focus on mental health, personal relationships, and self-care. The next generation of wellness amenities will stitch together quiet rooms, prayer and meditation rooms, and biophilic spaces to create a wellness ecosystem that provides opportunities for reflection and self-betterment in an uncertain and unpredictable world.



04

Workplace metrics graduate from basic algebra.

Instead of basing programming metrics on a single workplace population (such as in-office workers), the tech industry is taking a much more nuanced approach to developing program calculators that address both a variety of work populations and a variety of workplace postures. The new metrics not only address a shift in workplace demographics and patterns of attendance, but they also provide a new set of levers that allow for unprecedented experimentation and flexibility — critical given the unknowns both now and post-pandemic. When linked with utilization sensors and dashboards, they allow for agile, real-time adjustments of sharing ratios, furniture settings, and attendance policies.



LinkedIn, Omaha, Neb.

This technology company's campus creates an inviting, inclusive space for employees to connect with global teams. The dynamic, hybrid work environment supports autonomy and choice with places to focus, connect, and express team identity, such as focus zones, coworking neighborhoods, respite rooms, and unique food and beverage offerings.

“We’re seeing a lot of clients want to test a site or location that has a variety of people to simulate what a future work environment is going to be.”

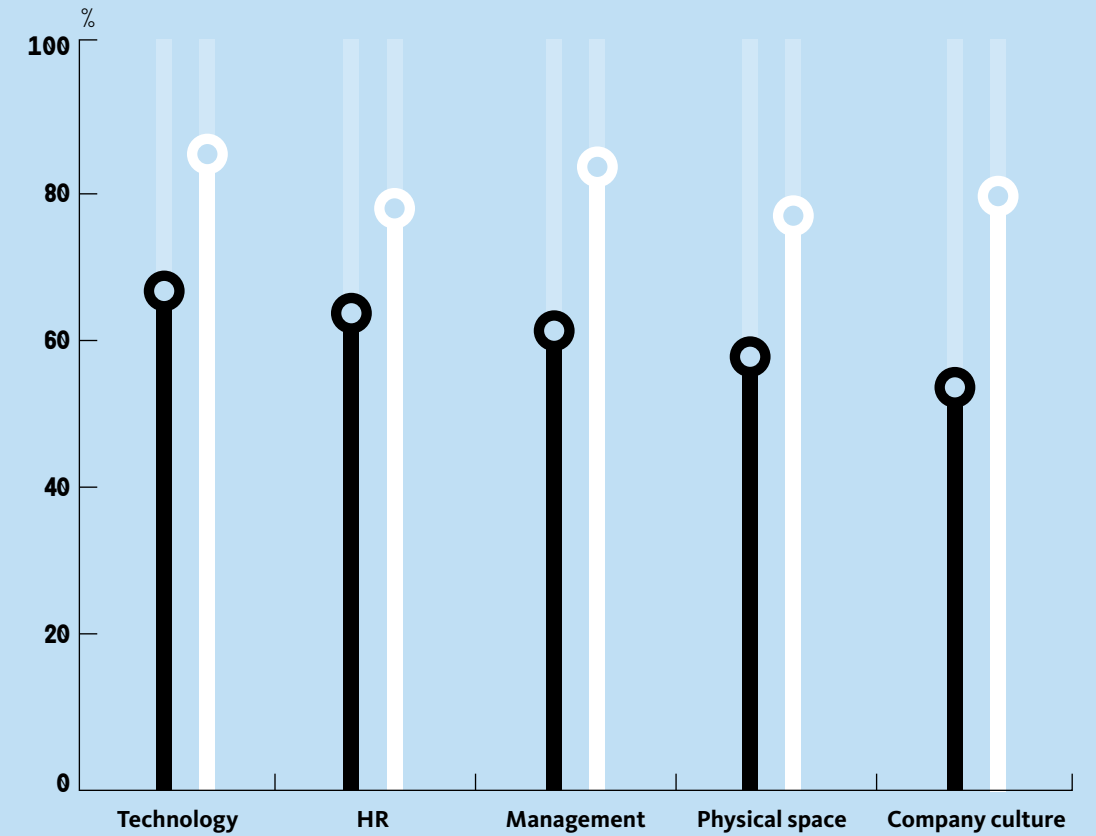
Source: Natalie Engels, global work sector leader

Top-performing companies are more prepared for a hybrid future.

Source: U.S. Workplace Survey Fall 2021

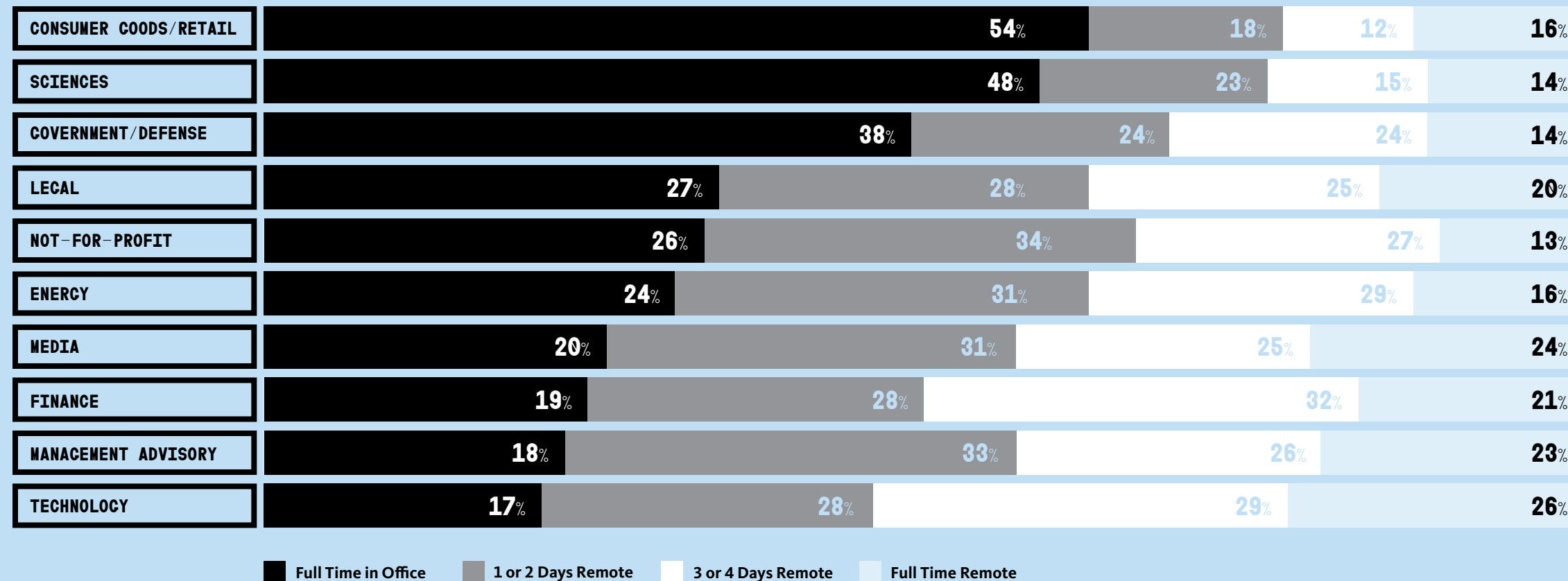
MY COMPANY IS PREPARED FOR HYBRID WORK IN THE FOLLOWING AREAS...

■ Average
■ Top-Performing Companies



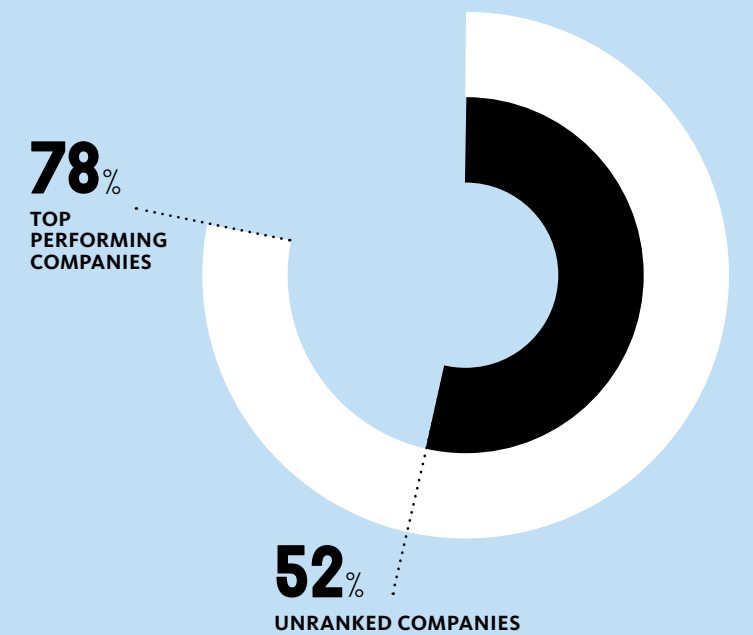
Technology, management advisory, and finance report the highest preference for hybrid or full-time remote work.

Source: Gensler U.S. Workplace Survey | Summer/Fall 2020 (Gensler Global Workplace Comparison)



Employees at top-performing companies feel that their companies are better prepared for hybrid work.

Source: U.S. Workplace Survey Fall 2021



THE
FUTURE
OF

LIFESTYLE

CREATING AN AUTHENTIC COMMUNITY EXPERIENCE

Lifestyle brands have long taken pride in having a deep understanding of their consumers' needs and expectations. Today, that's as important as it's ever been, especially because of the momentous shifts the world has experienced in the past two years because of the impacts of COVID, climate change, and social equity.

For lifestyle brands to succeed and deliver better experiences, they must understand this new context and be better at anticipating what's next. At the top of the list for brands looking to attract and keep consumer's attention: community, belonging, and cultural relevancy.

Lifestyle companies will increasingly look to design spaces that can be flexible and multipurpose in order to serve multiple functions for the people and communities they're in.

META TRENDS

Here are five key metatrends impacting the lifestyle sector, and how design is responding:

01

BELONGING AND PLACEMAKING WILL BRING PEOPLE TOGETHER

Strategies that incorporate brand, culture, and place are a means to draw people from diverse backgrounds to come together. In an increasingly distributed world, brands and companies should cultivate a strong sense of belonging for everyone and meet them wherever they are.

02

AMENITIES THAT DRIVE COMMUNITY WILL BE HIGHLY VALUED

The amenities race is back, but the focal point has changed to prioritize space types that drive collaboration, community, and health and well-being — from gathering hubs and food & beverage services, to inclusive wellness spaces, such as prayer and meditation rooms.

03

FLEXIBILITY WILL BECOME A CRITICAL INVESTMENT

Flexible spaces that allow different uses and events are a huge asset. Developers should build in flexibility and sustainability so they can pivot and adapt to market needs — converting aging office stock to housing, or programming outdoor space. Spaces need to be agile to accommodate different groups of people.

04

DIGITAL AND PHYSICAL WILL BLEND TO DELIVER CONNECTED EXPERIENCES

Clients are clamoring for technology infrastructure and strategic planning to bring a much nimbler, equitable, and more connected ecosystem of experiences to their end users. Integrating technology on-site can provide more seamless, self-service, and personalized experiences.

05

PLACES FOR GATHERING WILL BECOME NEIGHBORHOOD CATALYSTS

Places that bring people together while making them feel safe — from museums to libraries — are becoming neighborhood catalysts and anchors for revitalization. Developers have an opportunity to reimagine single-use spaces as multiuse destinations that serve diverse communities.

BRAND DESIGN

OVERVIEW

Brands must do more than “just say the right thing” — they must deliver on their promise to the greater public. Companies and organizations are connecting with their audience through more outspoken public stances, and they’re being rewarded with increased customer loyalty and more passionate employees.

TRENDS

01

Brands must keep promises, not just make them.

During the protests of 2020, many companies pledged to confront social issues and contribute to solving them. Consumers and employees took notice — and they still haven’t forgotten. Such promises cannot be treated like just another marketing campaign; brands must follow through on their pledges to help fix longstanding inequities.

02

Organizations will be expected to show their impact.

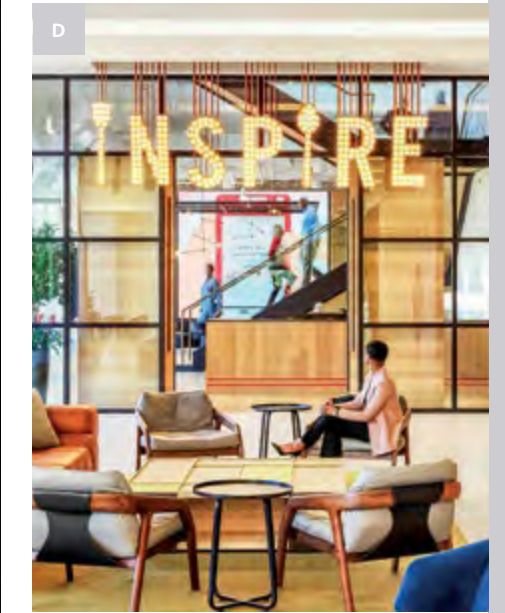
Millennials and Gen Z expect companies to clearly demonstrate their public purpose, so brands are increasing transparency and showing measurable accomplishments to cultivate trust from the communities they serve. In addition, an organization’s facilities, company culture, and products must visibly champion issues of public concern, from climate change to social equity.



03

Engaged employees will define your brand purpose.

Brands are built from within. The culture of an organization, whether product or service-oriented, drives reputation. A strong culture strengthens a brand’s purpose and builds community inside and out (internally and with customers).



04

Brands will continue to find value in brick-and-mortar experiences.

Brick-and-mortar is not dead. Online spaces are great to reach a wider audience, but the most effective brands are using their digital presence as a segue to real-world experiences. Companies and organizations are maximizing brand engagement by designing their physical spaces to incorporate digital experiences.

FEATURED PROJECTS

A. Coca-Cola Northpoint Experience Tour Brand Design, Houston

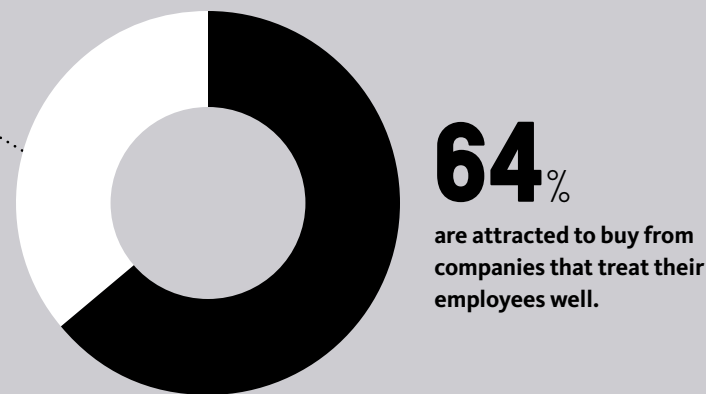
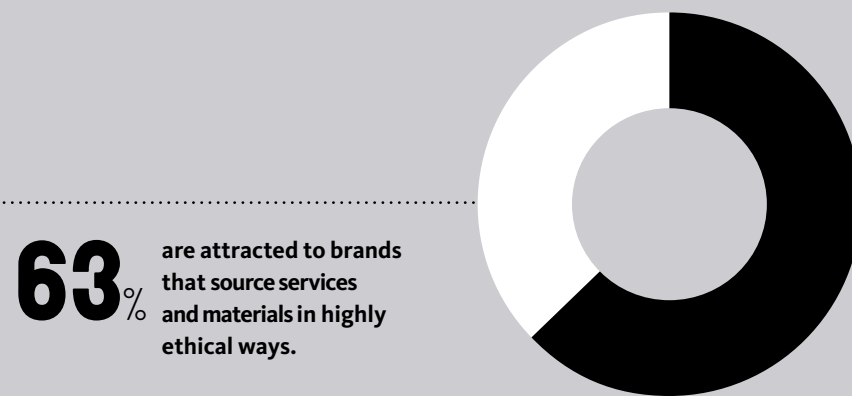
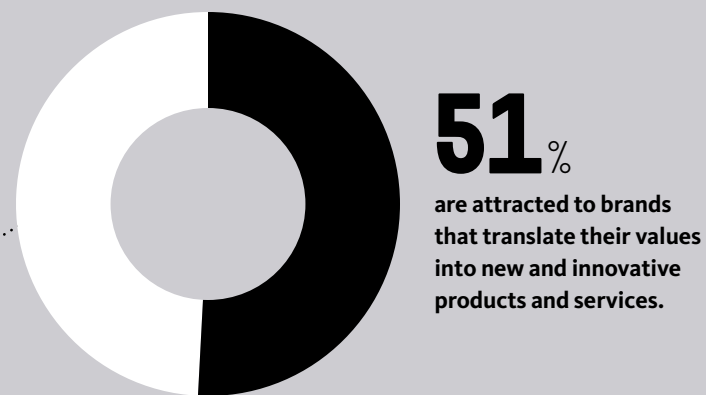
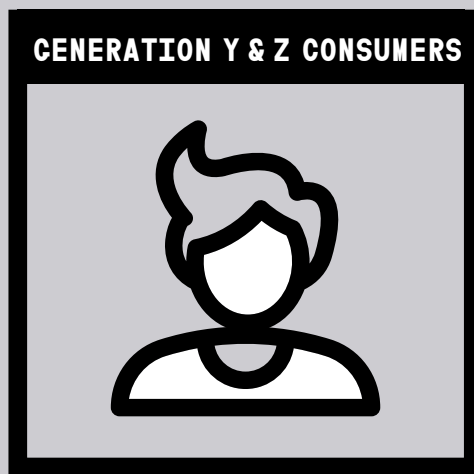
B. The Ford Foundation Center for Social Justice, New York

C. SFO Sustainability Campaign, San Francisco

D. Inspire Brands Headquarters, Atlanta

“A majority of consumers — and especially those in the Gen Y and Z cohorts — expect brands to be rooted in a greater purpose and companies to make their commitments known in multiple ways.”

Source: Accenture, “Generation P(urpose)”



Organizations with a distinctive culture have better business outcomes.

Source: PwC, “Organisational culture: It’s time to take action”

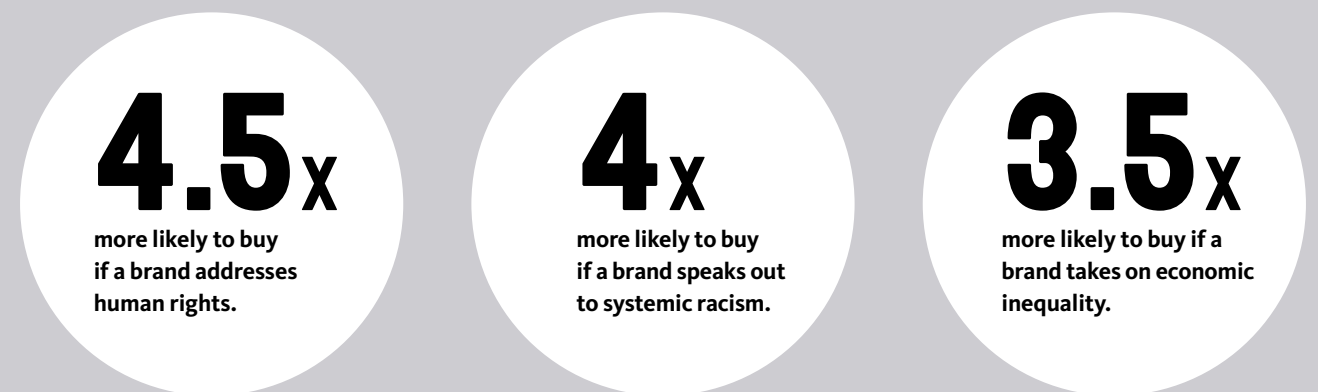
Survey respondents who say they have a distinctive culture were more likely than those who do not say they have a distinctive culture to see an increase in:



Brand trust drives growth.

Source: Edelman, “Trust, the New Brand Equity”

CONSUMERS ARE . . .



CULTURE & MUSEUMS

OVERVIEW

During the disruptions and shutdowns of the past two years, cultural institutions redesigned their physical spaces and overhauled their operations. Now that normal activities are slowly resuming, they plan to retain the best lessons learned during the pandemic to maximize attendance and reimagine their role in the community.

“Venues that curate unique experiences for an ever-widening group of users will increase repeat visits.”

— Dialogue Blog by Kai Westermark and Stella Donovan, “The Future of Live Music Venues”



02

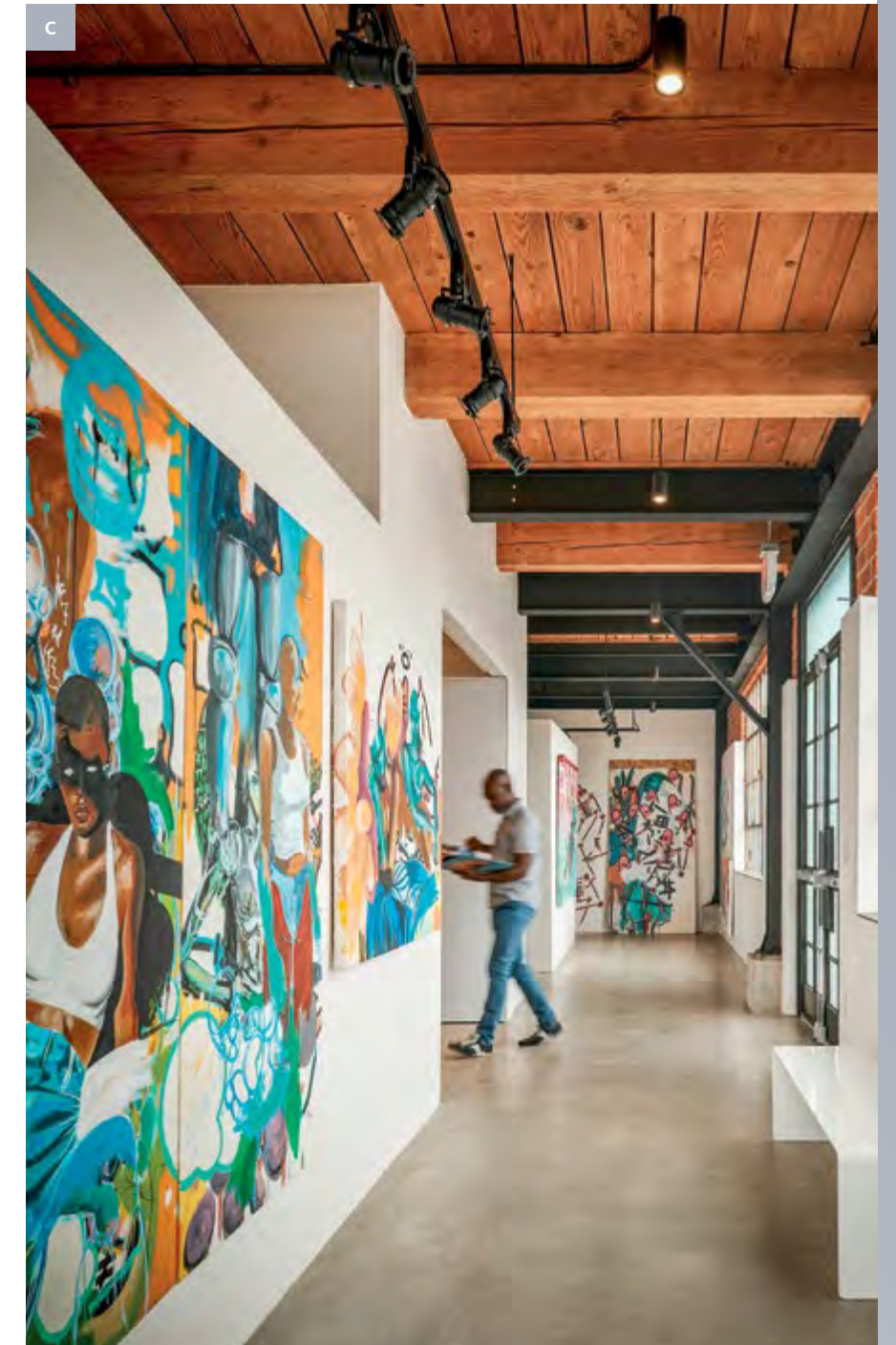
Outdoor spaces are here to stay.

Most institutions opened outdoor spaces during the pandemic out of necessity. Now, they're here to stay after organizations realized the benefits. In the coming years, venues will renovate outside areas to offer a wider range of attractions and accommodations, essentially becoming extensions of their main facilities. This also helps “future-proof” their operations in the event of further disruptions.

03

Audiences will continue to get more diverse.

Cultural institutions realize that their mission must include visitors who traditionally have not been on their radar. Museums are designing new spaces dedicated to more diverse communities and appointing executive staff who can sincerely cater to overlooked audiences.



TRENDS

01

Flexible design is an important consideration for future planning.

More diverse audiences mean cultural spaces need to be agile enough to accommodate different groups of people. Design plans for such institutions are keeping versatility in mind to provide experiences to visitors from widely varying backgrounds and incorporating them into the mission. Spatial flexibility is now a fundamental design principle.



FEATURED PROJECTS

A. LaGrange Art Museum Expansion, LaGrange, Ga.

B. Frisco Public Library, Frisco, Texas

C. Gallery 90220, Los Angeles



04

Virtual exhibits will remain a valuable part of the program.

Greater relevance is fueled by a greater audience — whether in-person or online. Many venues discovered that virtual spaces were another pandemic pivot that grew their visitor base beyond the usual boundaries. Now, cultural pillars like the Louvre are erasing geographic limits by opening their entire collections to anyone with an Internet connection.

FEATURED PROJECT

D & E. International Center of Photography (ICP), New York
 artwork featured: (D) James Coupe, "Warriors: Sixty Thousand Soldiers," March 20, 2020 | (E) Tyler Mitchell, "Laundry Line," March 20, 2020

STRATEGIES & RESEARCH

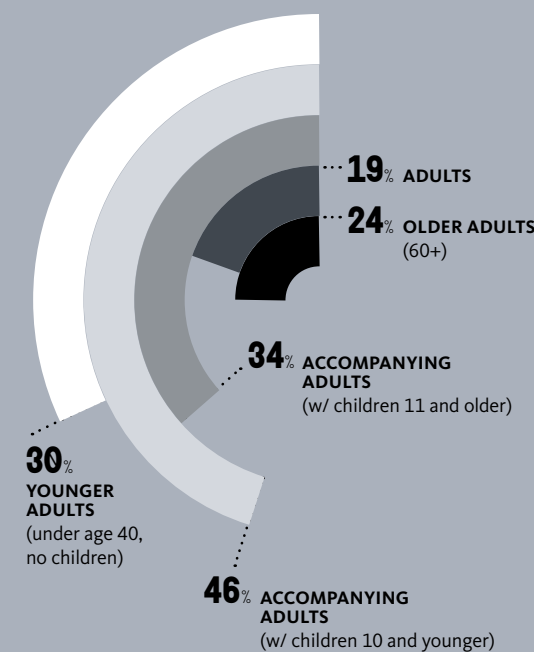
“The reality is that people who visit museums come from lots of different demographic backgrounds. And more casual visitors to museums are more diverse across different demographic criteria than more frequent museum visitors.”

Source: Gensler Museums Experience IndexSM

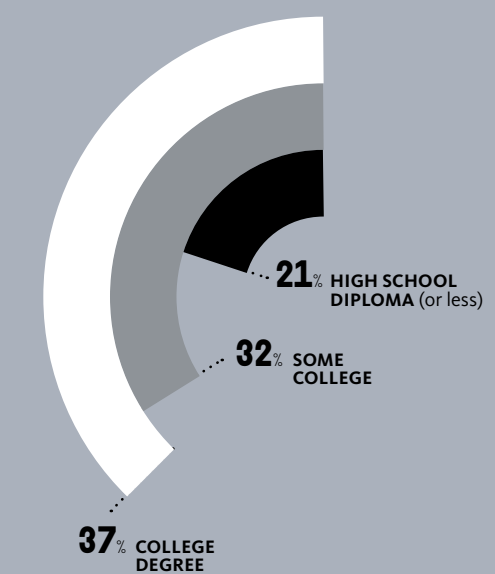
A closer look at museum visitors

Source: Wilkening Consulting

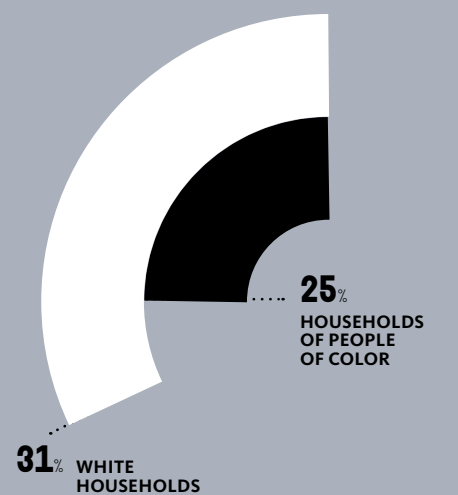
AGE



EDUCATION



RACE & ETHNICITY





Newark Community Museum of Social Justice, Newark, N.J.

The community-driven museum highlights Newark's history of activism against racial injustice and provides a focus for community aspirations. Gensler worked with the City of Newark to convert the 1st Police Precinct, the flashpoint of the 1967 Newark Rebellion, into a community museum dedicated to learning, healing, storytelling, and an equitable future.

DIGITAL EXPERIENCE DESIGN

OVERVIEW

Designing the most sought-after experiences for people in built environments increasingly means integrating digital experiences into our physical spaces. The more tech-savvy people become, the more they will expect the places they visit to accommodate their connected needs. And as work becomes more hybrid and our workplaces evolve, companies will need thoughtful digital design to mix virtual and in-person experiences.

TRENDS

01

Customers will want more data transparency.

Customers love personalized experiences, but they have grown more wary of how their personal data can be misused, and this trend will only continue. Businesses should continue to emphasize data security, while drafting clearer policies for how customers' personal information is collected, protected, and applied in their interactions.

02

The “connected commute” will become part of the new workplace experience.

As offices reopen, it will be common for employees to commute irregularly and at off-hours. Commuters will also rely more on transit apps to provide real-time information on schedules, traffic, and transportation availability. Cities and developers will need to leverage such digital solutions as they reimagine the commute experience and plan for future innovations in travel-related technology.



03

Mobility design has come to workspaces.

As employees routinely split time between home and the office, companies are prioritizing mobility in their workspace designs. Mobile integration is becoming part of the master planning process rather than retrofitting layouts after the fact. The result is a more agile work environment and a more seamless experience for employees.

04

The tech ecosystem will continue to drive design decisions in the workplace.

Companies are no longer focused on single-point workplace technology, like hot desking or conference room booking systems. Instead, they're adopting more holistic tech ecosystems to unify employees under a common connected experience. This trend will continue to grow as businesses become more departmentally and geographically diverse.

FEATURED PROJECTS

A. Confidential Client

B. 88 Kearny, San Francisco



AT&T Headquarters Lobby at the AT&T Discovery District, Dallas

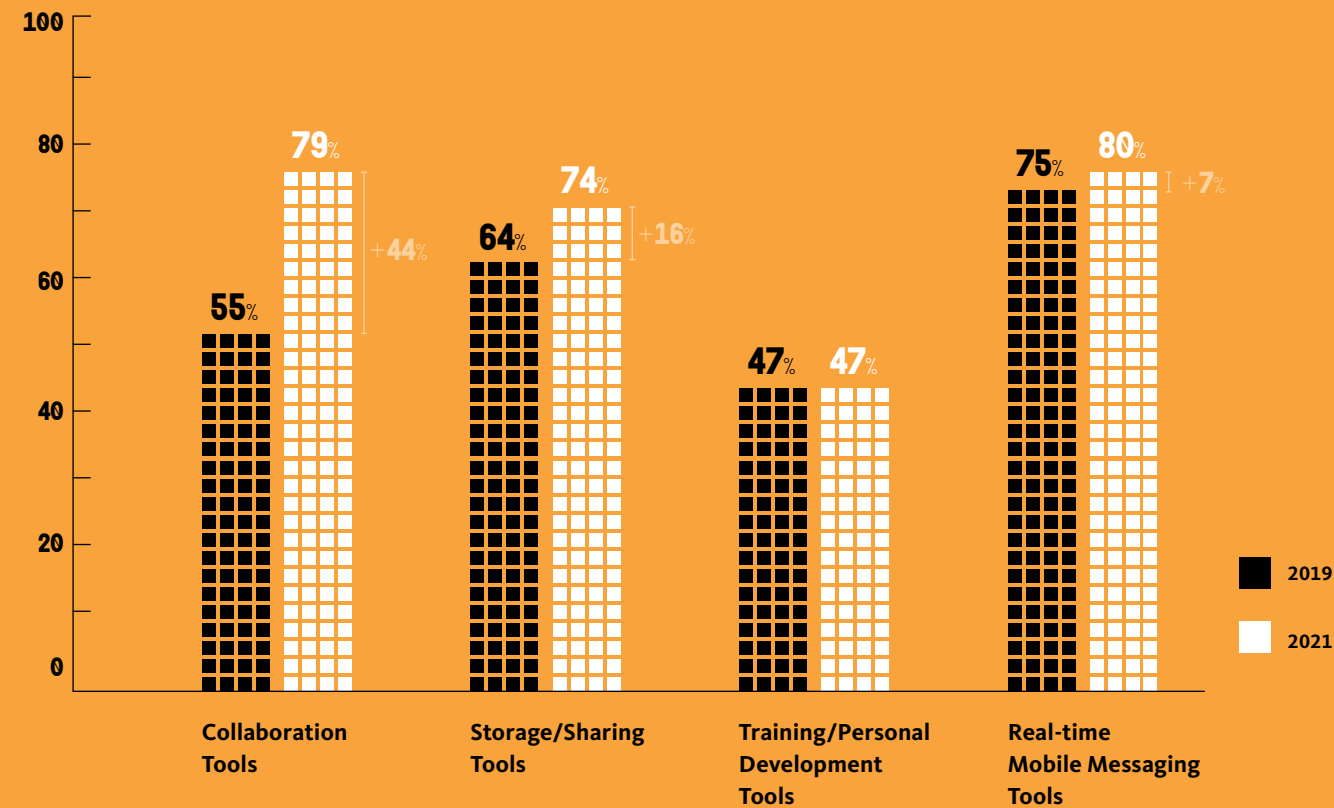
The AT&T headquarters lobby creates an immersive visual and audio experience for employees and the public. Serving as a gateway to the AT&T Discovery District, the 20,000-square-foot lobby, visible through a 30-foot glass façade with custom-created content on display, dissolves the boundary between architecture and media — unifying the campus.

“While having a digital touchpoint might help retailers meet minimum consumer expectations, they should look for additional capabilities to differentiate themselves as customer acquisition costs rise.”

Source: Deloitte, “2021 Retail Industry Outlook”

Digital workplace technologies will be essential for enabling innovation in a hybrid workforce.

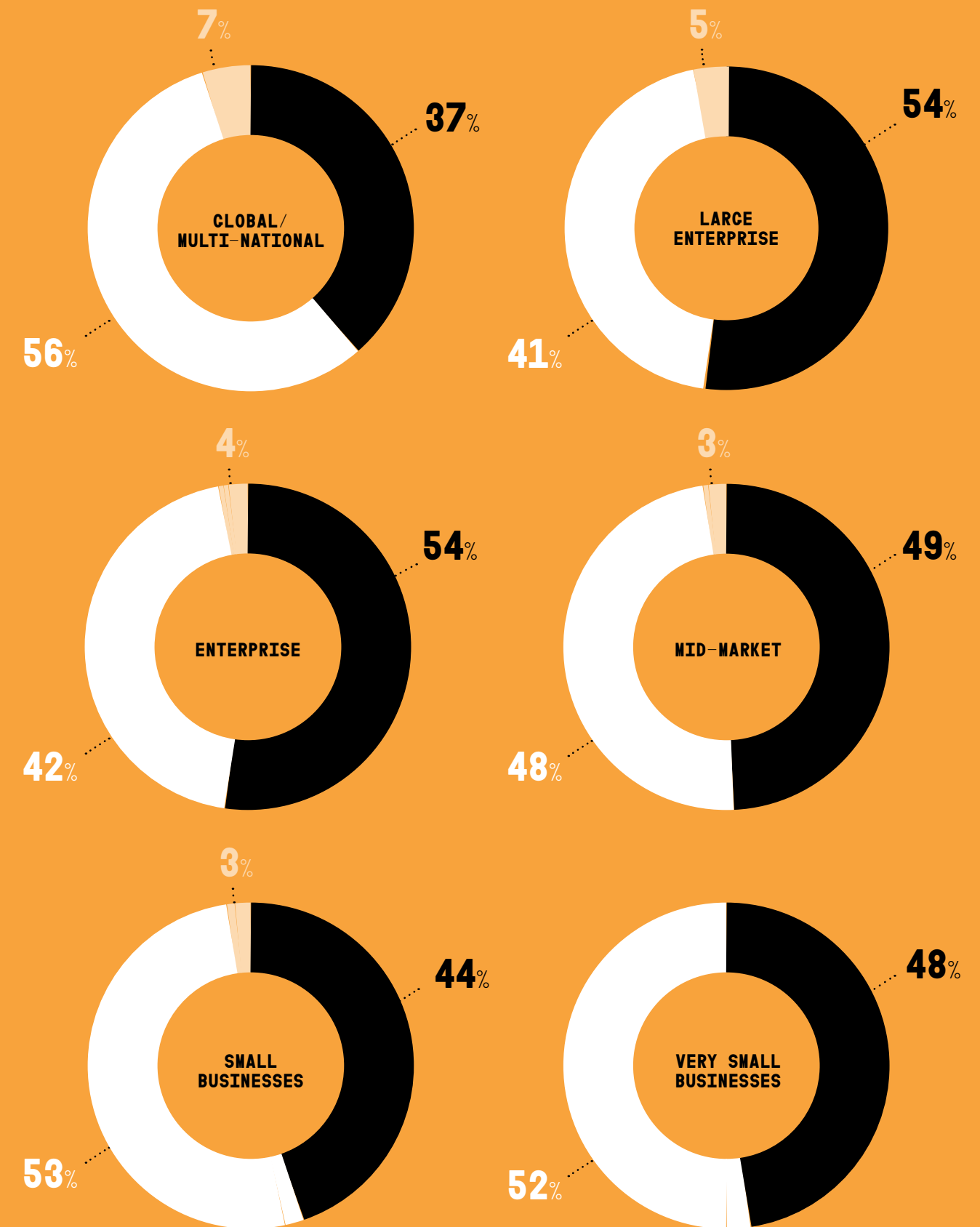
Source: Gartner, “Gartner Survey Reveals a 44% Rise in Workers’ Use of Collaboration Tools Since 2019”



From 2020-2025, how much do you expect your customer data platform (CDP) budget to grow?

Source: The Segment (Twilio), “The CDP Report 2021: A new era for Customer Data Platforms”

High (>25% increase) Medium (10% to 25% increase) Low (10% and lower)



HOSPITALITY

OVERVIEW

The hospitality sector is notoriously slow at adopting new changes. Nevertheless, the pandemic provided a long-overdue catalyst for hotels to reimagine the experiences they provide and the roles they play in their communities. As the industry recalibrates, versatile layouts and innovative design will be key to long-term sustainability.

04

The hospitality industry will cover more types of needs.

Multiuse hospitality developments are on the rise to accommodate a wider array of visitors. The sector is looking to incorporate coworking spaces, extended-stay hotels, and branded residences to better serve the evolving needs of guests and increase profitability.



TRENDS

01

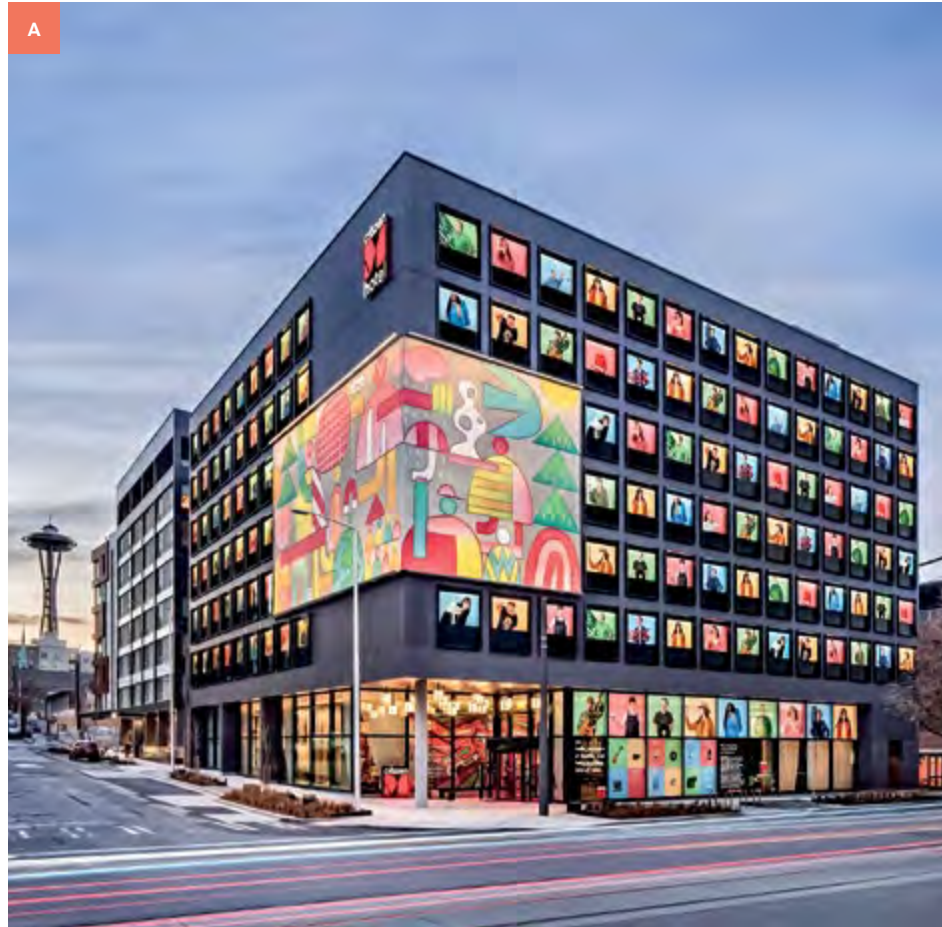
Remote work is attracting new guests and driving a new demand.

Many employers are implementing flexible work policies as a result of the pandemic. Now, hotels are seeing a rise in guests with travel-friendly hybrid work arrangements. As more people enjoy the perks of remote work, they will book extended trips beyond what traditionally may have been a quick weekend getaway.

02

Hybrid conventions will be the new norm.

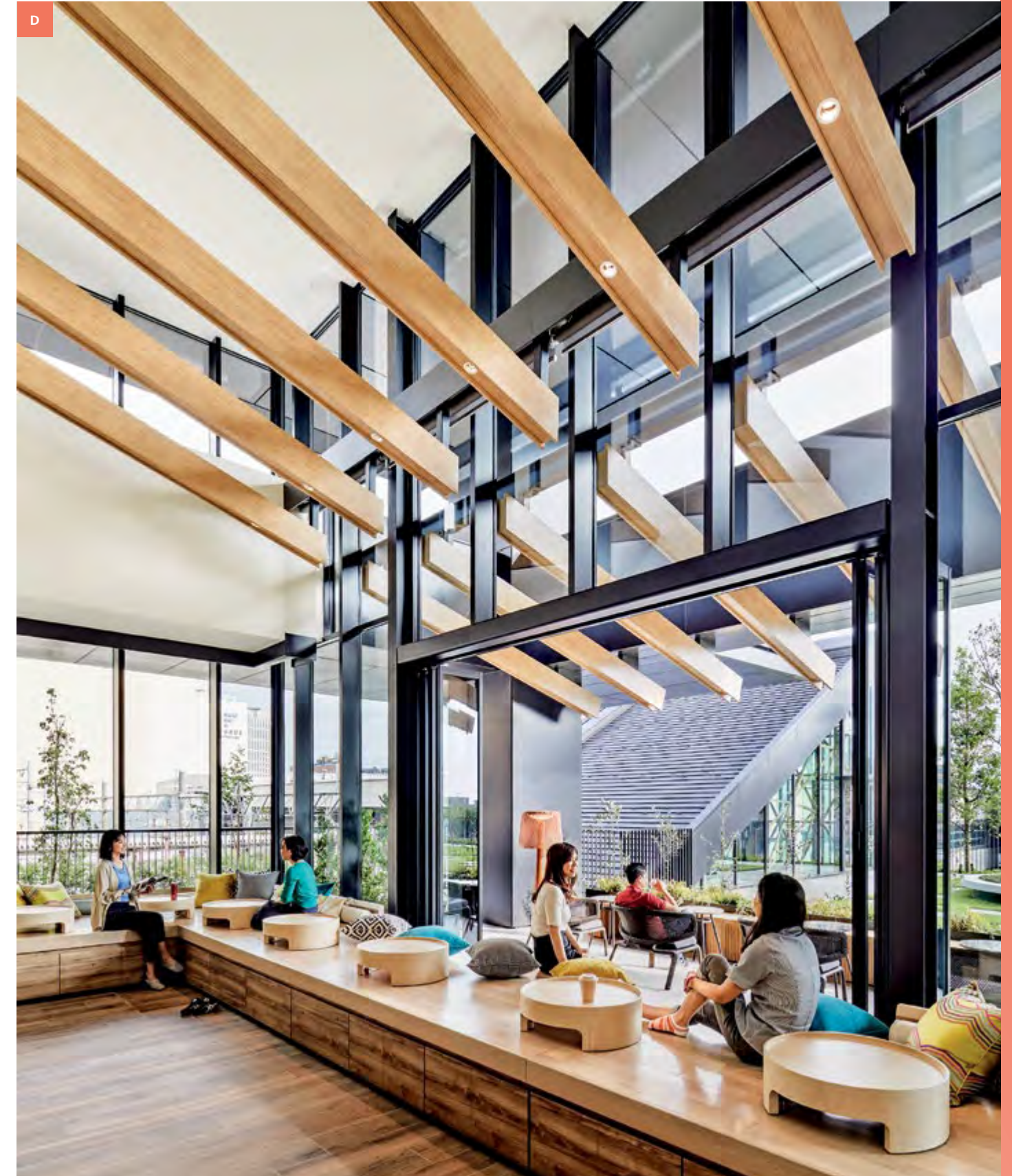
As business travel resumes, hotels are reimagining their meeting rooms and multipurpose areas. Instead of indoor exhibition halls, hotels will host "hybrid conventions" with more virtual connectivity and seamless integration with outdoor areas. Flexibility will continue to be essential when designing alternate options within existing spaces to maximize usage and revenue.



03

Tech-savvy travelers will drive new types of personalized experiences.

Hotels have started to integrate technology into their designs to future-proof their establishments. By offering a hybrid "physical-digital" experience, hotels will be able to cultivate guest loyalty with thoughtfully personalized service. New technology will also help free up physical spaces for renovation as more functions, such as concierge services and wayfinding, are offloaded to virtual platforms.



FEATURED PROJECTS

A. citizenM Seattle South Lake Union, Seattle

B. Cocoa Beach Westin, Cocoa Beach, Fla.

C. Crystal Palace Lobby, The Londoner Macao, Macao

D. Hyatt House Kanazawa, Ishikawa, Japan



Hilton La Sabana, San José, Costa Rica

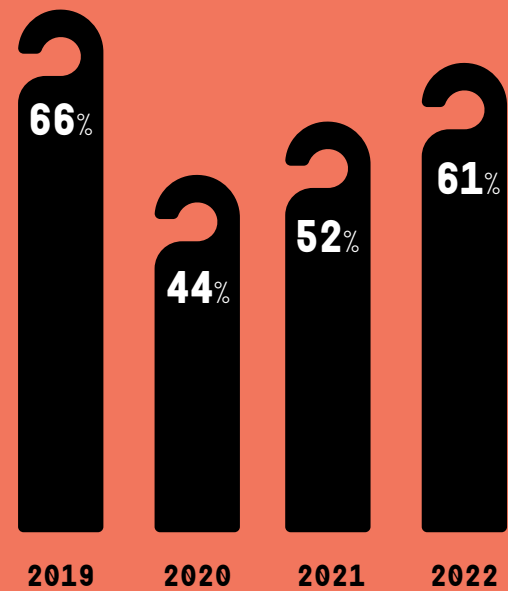
Located within Costa Rica's tallest building and nearby National Stadium and La Sabana Park, the city's most popular tourist destinations, this hotel offers a unique experience with panoramic views, locally-sourced artwork, and amenities for both leisure and business travelers.

“Many travelers are ready to return to shared spaces and common areas — but they still also want access to fresh air.”

Source: Gensler U.S. Hospitality Pulse Survey 2021

Hotel Room Occupancy

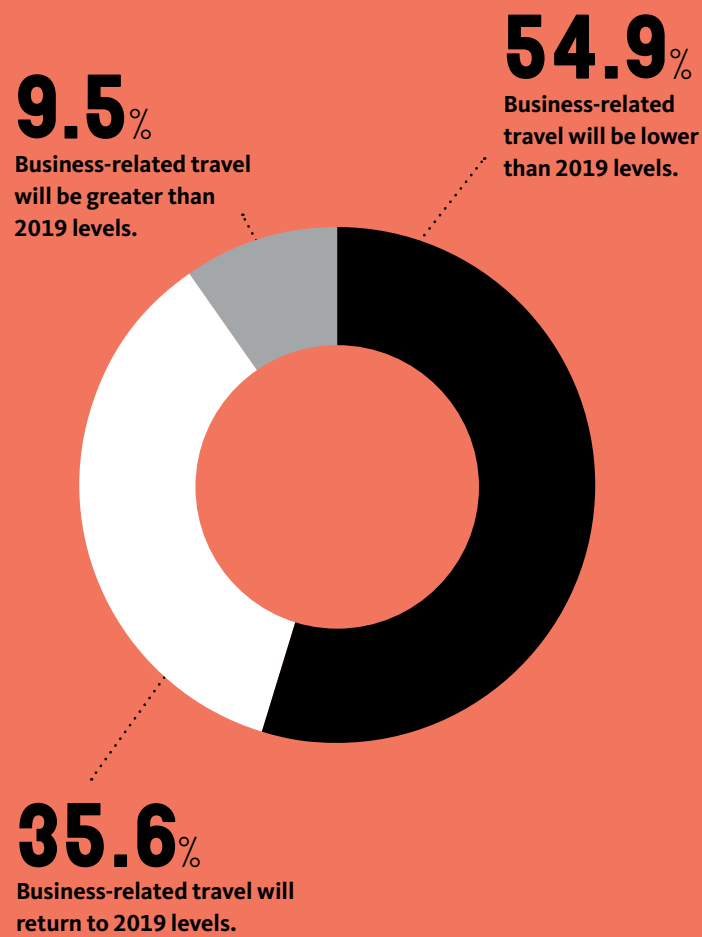
Source: American Hotel & Lodging Association State of the Hotel Industry 2021



In 2021, hotel occupancy is projected to average just 52%, compared to 66% in 2019.

People don't expect business travel to bounce all the way back to 2019 levels.

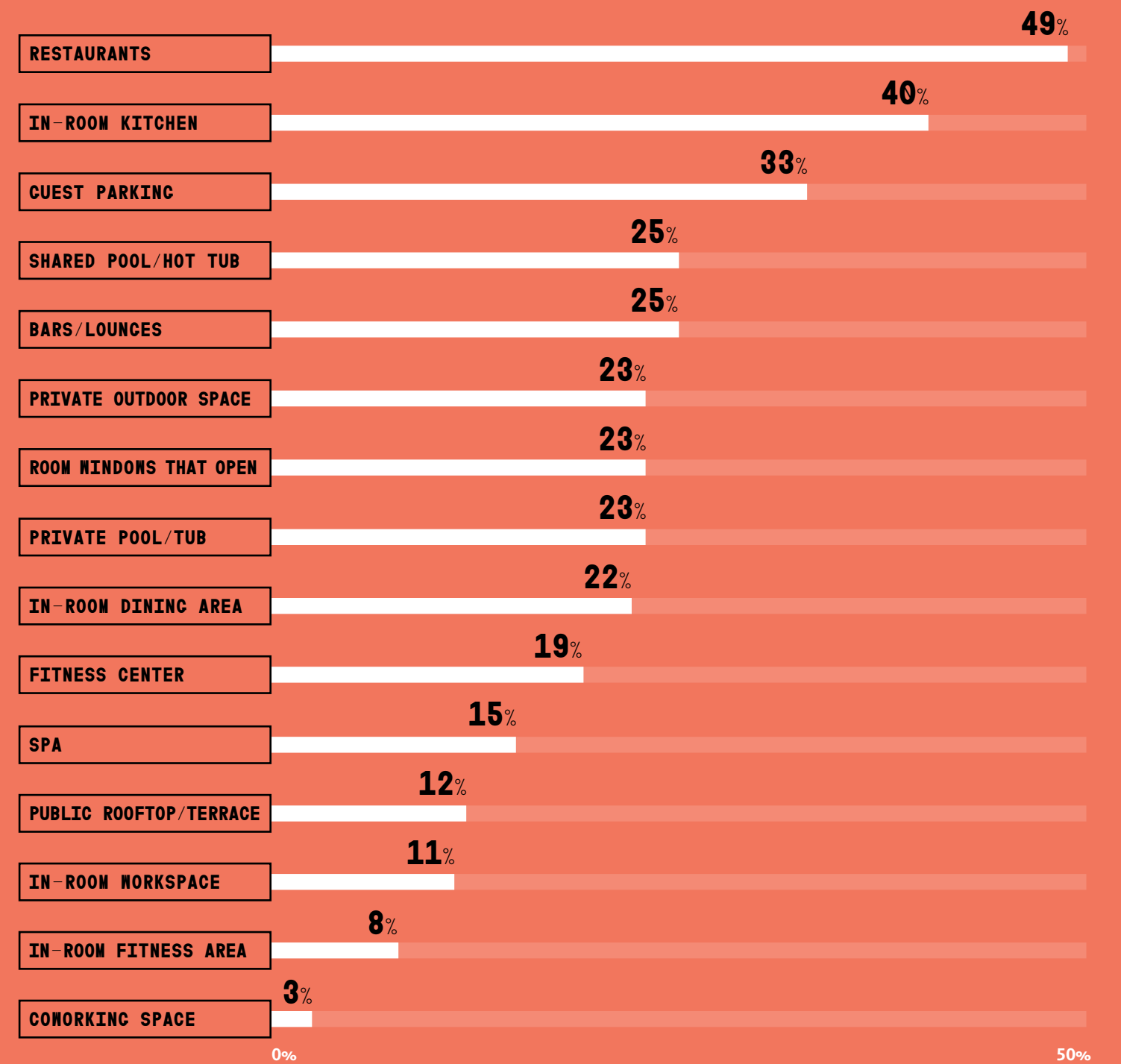
Source: PwC and ULI, Emerging Trends in Real Estate 2022



Restaurants and shared spaces are among top amenities that travelers booking hotels are looking for.

Source: Gensler U.S. Hospitality Pulse Survey 2021

What sorts of spaces, features, and facilities were most important to you when choosing your upcoming accommodations?

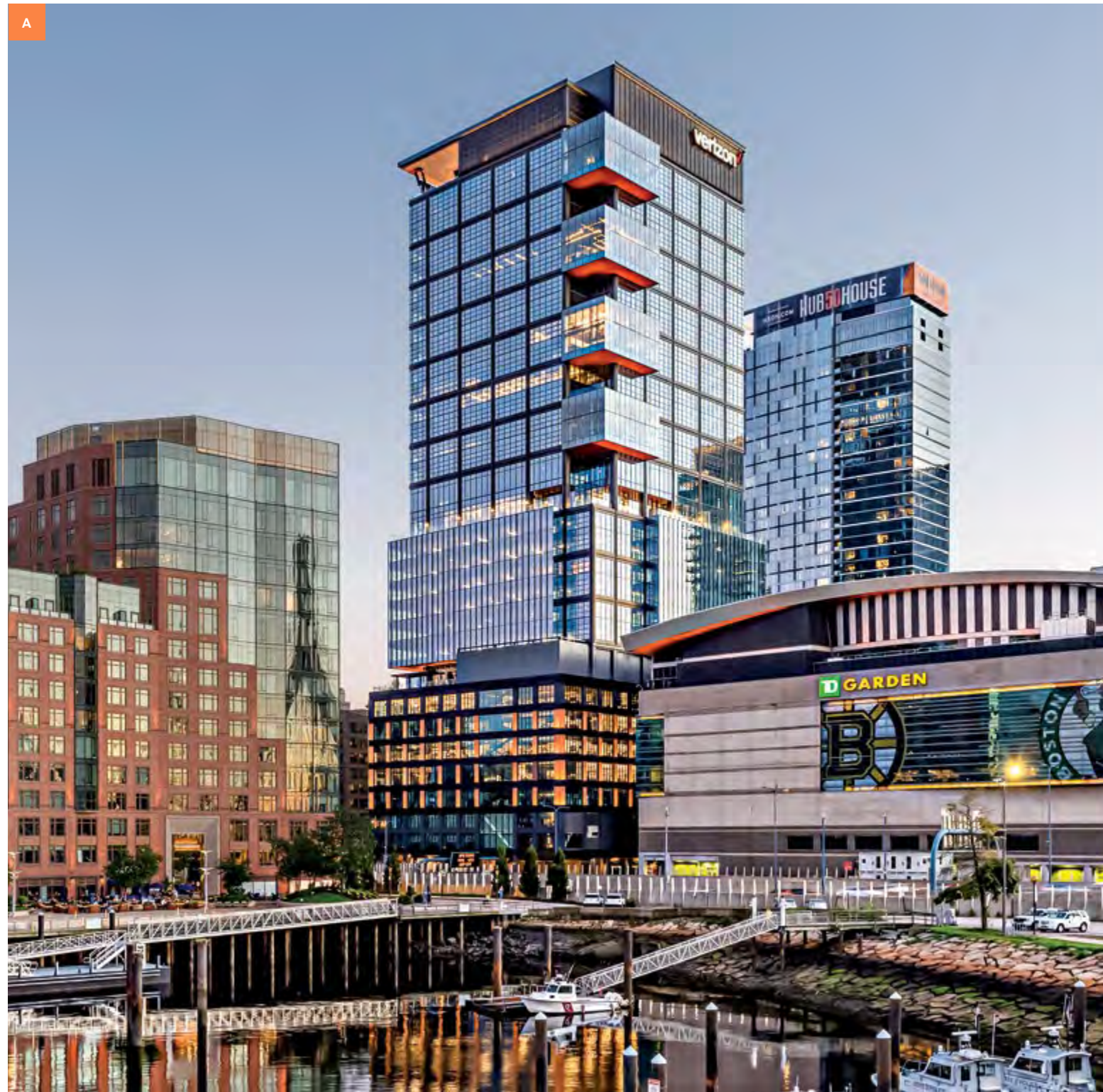


Total Exceeds 100% because respondents could select up to 5 options.

MIXED USE & RETAIL CENTERS

OVERVIEW

Mixed-use developers have an increasingly keen understanding of how their developments contribute to and benefit the overall community. Residents, guests, and customers are now conscious of how their own neighborhoods affect their health and happiness. Mixed-use developers are following suit with the perks and flexibility needed to best accommodate people and businesses alike.



FEATURED PROJECTS

- A. The Hub on Causeway, Boston
- B. Fifth + Broadway, Nashville, Tenn.
- C. Toyota Music Factory, Irving, Texas

TRENDS

01

Open space has become a necessary asset.

The pandemic forced retailers to reprioritize open space as an essential part of their layouts. Open space allowed businesses to stay running during the pandemic shutdowns. Now it's a way to future-proof for potential disruptions since it readily can be adapted for new uses. Communities have come to value open areas for their mixed-use capabilities and seamless integration into the public ecosystem.

02

Biophilic design principles are trending up.

Biophilic design principles are increasingly driving design plans because of their prioritization of public health and sustainability. Integrated green spaces encourage better mental health and well-being by promoting more human reconnection with nature, and they can turn urban industrial spaces into ecologically beneficial areas. The result is a design that is better received by the public and the natural environment.

03

Communities increasingly want 20-minute neighborhoods.

Mixed-use spaces are crucial for achieving "20-minute neighborhoods," a concept in which every commercial, residential, and institutional need is within a 20-minute walk or bike ride of each other. Mixed-use developments help facilitate walkability by reimagining single-use residential and commercial blocks as multiuse spaces that cater to a variety of needs and experiences.



04

Micromobility will continue to displace car traffic.

New mixed-use projects are being designed with micromobility in mind from the start, specifically favoring hop-on shuttles, electric scooters, and bike shares. Many cities now require new developments to be sustainable or net zero, so reducing car traffic is an easy way to meet such mandates. As a result, street space is being reclaimed for parks, outdoor dining, and a variety of uses besides driving and parking.



The Central Park, Phoenix

This catalytic mixed-use development offers a rich experience for tenants, residents, and visitors, giving new life to Phoenix's mid-town market. The integrated live, work, and play community includes office, hotel, residential, and retail space, as well as an outdoor plaza. The design fuses nature, culture, and leisure to produce a distinct sense of place.

5



The Highlight at Houston Center, Houston

Principles for retail center repositioning

With the massive transformation of real estate spurred by the pandemic, retail centers will emerge as one of the most valuable asset classes in a post-pandemic landscape, as building owners, investors, and developers look to reposition aging, vacant, or underutilized properties — converting them into vibrant, mixed-use developments that will unlock latent value and meet consumers' rapidly changing demands.

Here are five principles to reposition retail centers for a more resilient future:

1 MODIFY THE ANCHORS

The traditional anchors are changing. Experience, culture, and open space are the new draws. These aspects are increasingly important in a post-COVID landscape as people are seeking to reconnect with each other and their communities. The new anchors are communal and healthy: entertainment venues, elevated food and beverage, wellness facilities, and large outdoor social spaces.

4 ENERGIZE THE SOFT SPOTS

Analyze the existing plan to prioritize the adjustment of "soft spots," or challenged retail spaces, and reexamine how to reposition them from a program perspective to potentially generate new revenue streams. Whether spaces in isolated interior areas or on levels above grade, retail that is set up to fail should be prioritized for change of use or reconfiguration.

2 MIX IT UP

Resilient developments are diverse in use, providing an economic buffer, bringing a new diversity of users, and varied experiences to the centers. Educational institutions, medical offices, coworking spaces, assisted living communities, and fitness studios are all examples of new users looking for space in distributed suburban locations close to large residential populations.

5 ACTIVATE LANDSCAPES

Open spaces are now an integral part of the value proposition for both new and repositioned buildings. Actively programmed, healthy, and equitable outdoor environments are crucial across all types of developments.

3 REIMAGINE MOBILITY

Seek to connect existing networks and accommodate increases in ride share and other forms of transportation and micro-mobility, including bicycles, scooters, and the critical last mile for transportation. As our communities evolve to rely less on automobile ownership, mixed-use environments must look to the future. In the short term, sites must accommodate more ride-share vehicles, both in queuing and incentivizing.

STRATEGIES & RESEARCH

Places that support a variety of activities and behaviors yield better experiences overall. The best environments support a diversity of activities and experiences.

Source: Gensler Residential Experience Index 2021

Features of a 20-Minute Neighborhood

Source: The Conversation



RESIDENTIAL

OVERVIEW

The past two years have reemphasized the central role of the home in people's lives. Residential amenities are not as important as they used to be. Instead, people are willing to forgo the extras for the right balance of affordability, quality, and space in their units. In the coming months and years, there will also be a big push to identify and design for middle-income residents in the form of workforce housing.

TRENDS

01

In-unit experience now matters more than outside amenities.

Developers traditionally have enticed tenants with building amenities and neighborhood attractions. However, residents now prioritize the in-unit experience more than outside perks. Specifically, residents value well-designed units with features like natural light, storage space, and in-unit laundry over communal amenities like multipurpose spaces, children's play areas, or proximity to local landmarks.

02

Well-designed space is better than more space.

Residents like space, but they're willing to trade it for better unit design — especially if the design retains a feeling of more space. As a result, developers are finding new ways to optimize living space within a finite area. The most effective ways to accomplish this are unit designs that offer more storage, better layouts, and reduced noise levels.

“In pursuit of more affordable housing solutions, people are open to making tradeoffs when it comes to building amenities.”

— Gensler Residential Experience Index 2021

FEATURED PROJECTS

A. Mira, San Antonio

B & C. Central Park House, Burnaby, Canada



B



03

Developers will continue to balance amenities with affordability.

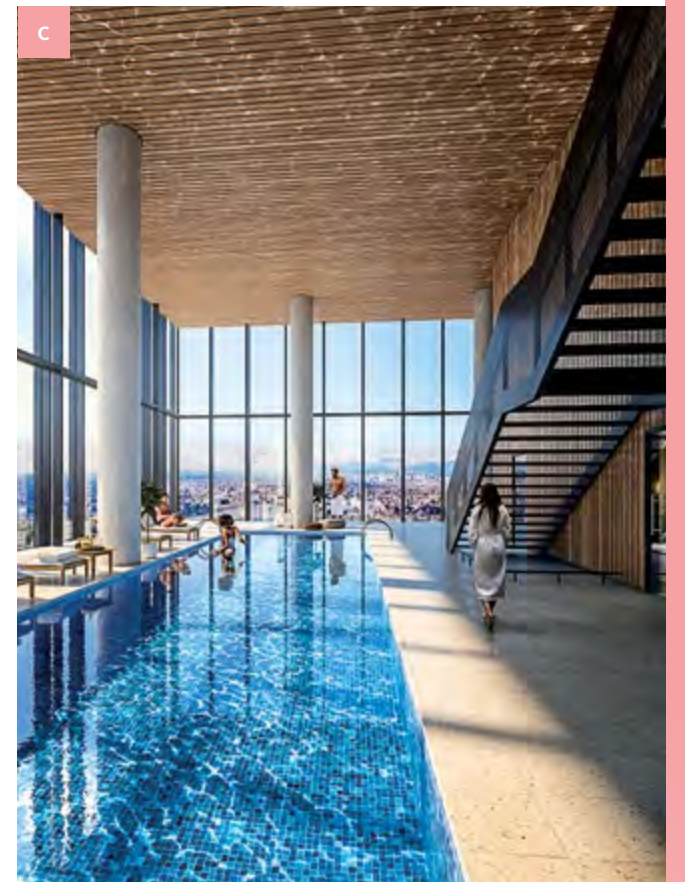
No matter their income, people want more affordable ways to live. A majority of residents across nine global markets say they're willing to make trade-offs with building amenities for lower rent. Consequently, developers are seeing higher levels of tenant satisfaction and retention by designing experiences that thoughtfully balance amenities and services with residents' own priorities.

04

The best residential experience will be one that prioritizes flexibility.

Residents' tastes are not universal. Every tenant likes to personalize their space for their own lives, and developers are responding with more flexible designs. It will be crucial for developers to understand their audience and tailor designs to provide a more fulfilling residential experience. User-centric homes can better accommodate the diverse lifestyles, interests, and long-term expectations of residents.

C



3



Aspire Post Oak, Houston

Insights driving the future of residential design

The pandemic has fundamentally altered residential experiences. Remote work creates new needs for residential units, and rising housing costs forces compromise on what to prioritize. Among the factors impacting people's decisions about where to live, what matters most? Gensler's Residential Experience Index unpacks this question, investigating residents' housing experiences and asking what they value for the future.

Here are three insights driving the future of residential design:

1 AFFORDABILITY IS THE PRIMARY DRIVER FOR RESIDENTS

Affordability fundamentally permeates residents' housing decisions. It is the top driver behind people's housing decisions and the home they will choose next. While some spaces are more important to residents, many would be willing to sacrifice extraneous amenities and features in exchange for a reduction in their housing costs.

2 DESIGN HAS AN ENORMOUS IMPACT ON SATISFACTION, ESPECIALLY WITHIN THE UNIT

After affordability, a home's design quality is the top priority. Recently, residential design has concentrated innovation on shared spaces and amenities, but the largest opportunity lies within the unit design and experience — driving 53% of overall home satisfaction.

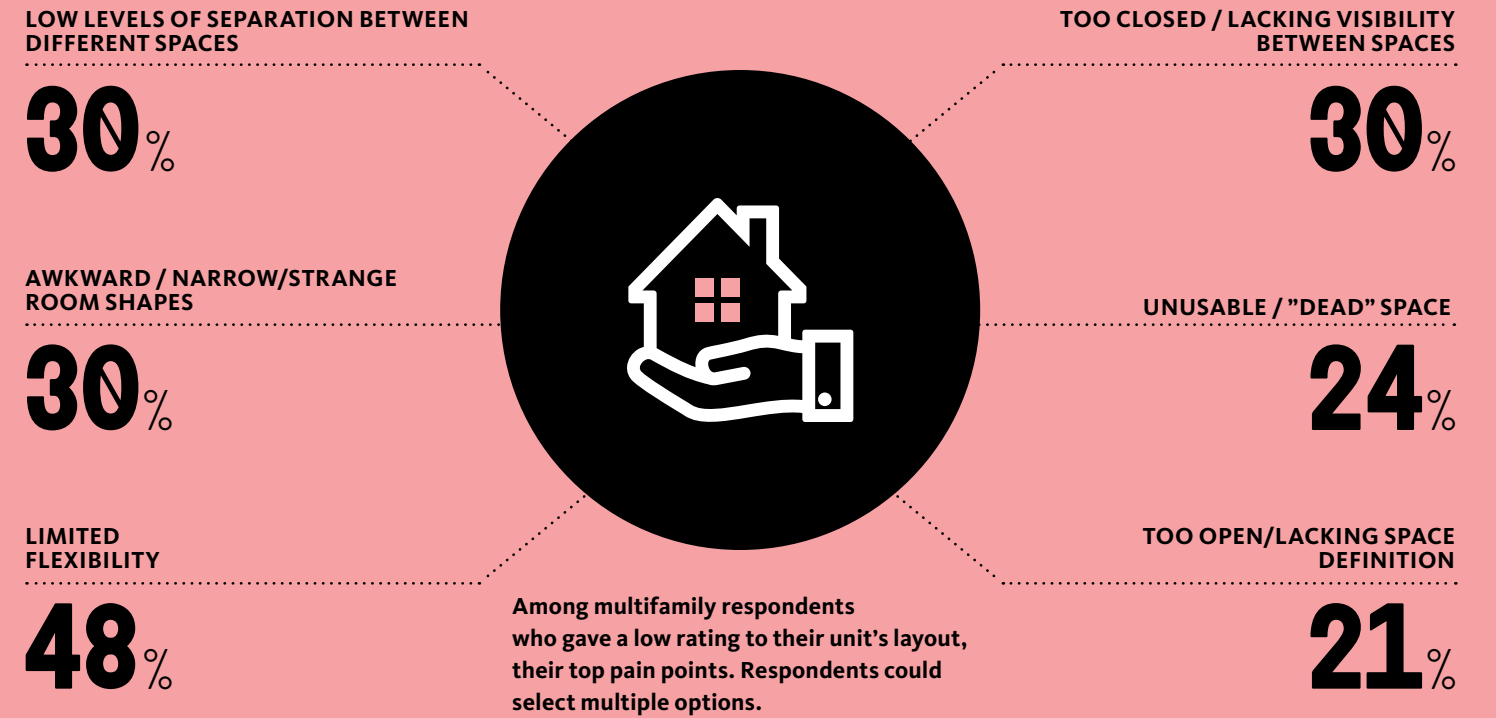
3 UNITS NEED TO SUPPORT WELL-BEING — AND WORKING FROM HOME

In creating homes that support well-being, developers will also support key needs of remote workers. Homes that support well-being are about more than just integrating the outdoors — those with higher unit safety and diverse establishments nearby are also considered optimal.

STRATEGIES & RESEARCH

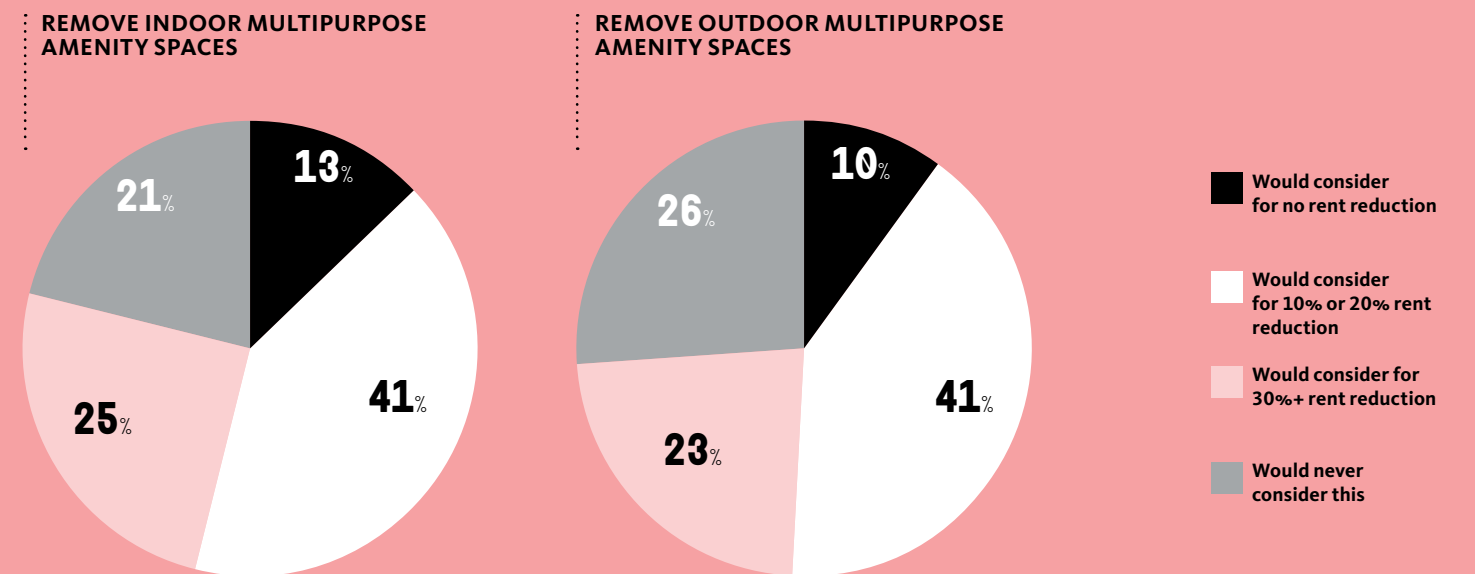
The design of residential units is ripe for innovation. Creative unit layouts could improve the resident experience when increased footprints are not feasible or affordable.

Source: Gensler Residential Experience Index 2021



The perceived value of common amenity areas is debatable.

Source: Gensler Residential Experience Index 2021



Among multifamily renter respondents, their willingness to consider removing amenity spaces they currently have in exchange for a rent reduction, calculated based on their disclosed monthly rent.

RETAIL

OVERVIEW

The retail industry has undergone profound upheavals over the past couple years, but many brands are emerging stronger than ever. Successful retail brands are embracing new opportunities to connect with their customers. Now, retailers are more aware of the need to readily adapt to new changes, and the most successful ones are always thinking of ways to improve their consumer experience through new mediums and methods of engagement.

TRENDS

01

New types of agility will be essential.

Retailers are accustomed to regularly changing layouts between seasons, holidays, or even weekly promotions. The pandemic reiterated how agility needs to be extended to new challenges like inflation, workforce shifts, or supply chain disruptions. The most effective retailers will design agility into their spaces through a test and learn process. The most effective designs can scale up quickly.



02

Retailers will provide shopping experiences in new worlds.

As new audiences grow in online video games and the still-nascent “metaverse,” retailers will design their in-store experience to meet customers in whichever “world” they live. This is more than an online shop — it’s a blending of physical retail with new, immersive virtual spaces to engage customers in ways that haven’t yet been fully imagined.

03

New types of connectivity will create a new baseline.

Customers expect retailers to be communicative and responsive through multiple channels. Stores will implement a new baseline of connectivity with social shopping, WhatsApp direct-message shopping, and livestreamed personal shopping as available services from their physical locations. This will expand retailers’ potential audiences in terms of geography and accessibility.

04

A variety of space types will cater to many different types of people.

Retailers are increasingly managing a wider portfolio of typologies to better serve consumers across a variety of needs. Each space has its own specific purpose, duration, and activations to offer a more “right-sized” and tailored experience. In the coming years, different typologies will range anywhere, from physical to mobile to virtual. The aim is to create an environment that is best suited for any given target audience.

“The world of retail has undergone a massive acceleration, and the shifts are unlikely to slow down.... Retailers that can adopt agile ways of working and fast decision-making will have better odds of thriving in the future.”

— McKinsey, “Why Retail Outperformers Are Pulling Ahead”

FEATURED PROJECTS

- A. Heritage Bank, Castle Hill, Australia
- B. JBL Store, New York



TOCA Social, London

Branded socializing experiences will begin to take over as the new anchors, as illustrated in this concept for TOCA Social. Gensler partnered with TOCA Social to create an interactive leisure and hospitality destination that invites visitors to experience the journey of a pro footballer through multisensory spaces immersed in the color and energy of the game.



FEATURED PROJECTS

C. Weltmeister West
Nanjing Road Experience
Center, Shanghai

D. Studio Three,
Chicago

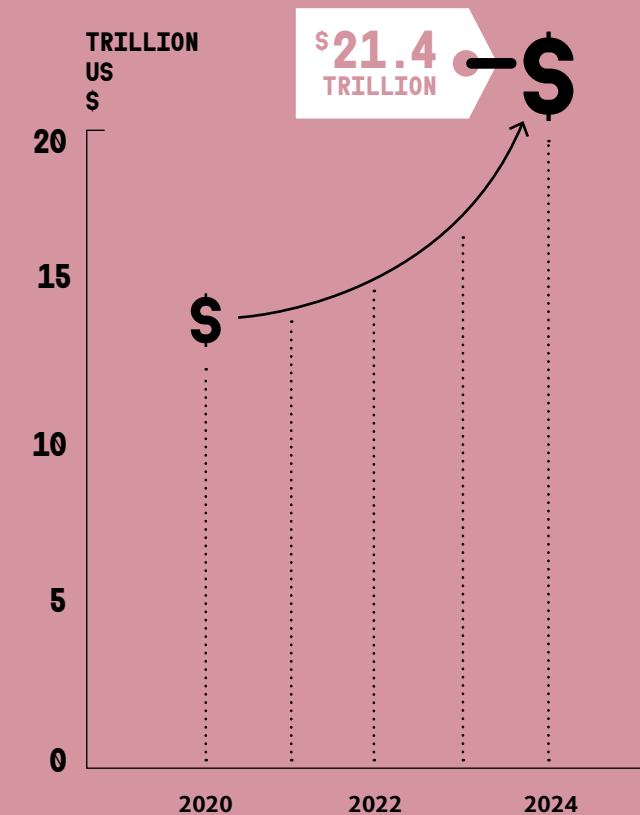
STRATEGIES & RESEARCH

“E-commerce is booming, but physical stores remain important. Forward-thinking companies have been using their stores to educate consumers, reinforce their brands’ positioning, and support e-commerce sales.”

Source: McKinsey, “Into the Fast Lane: How to Master the Omnichannel Supply Chain”

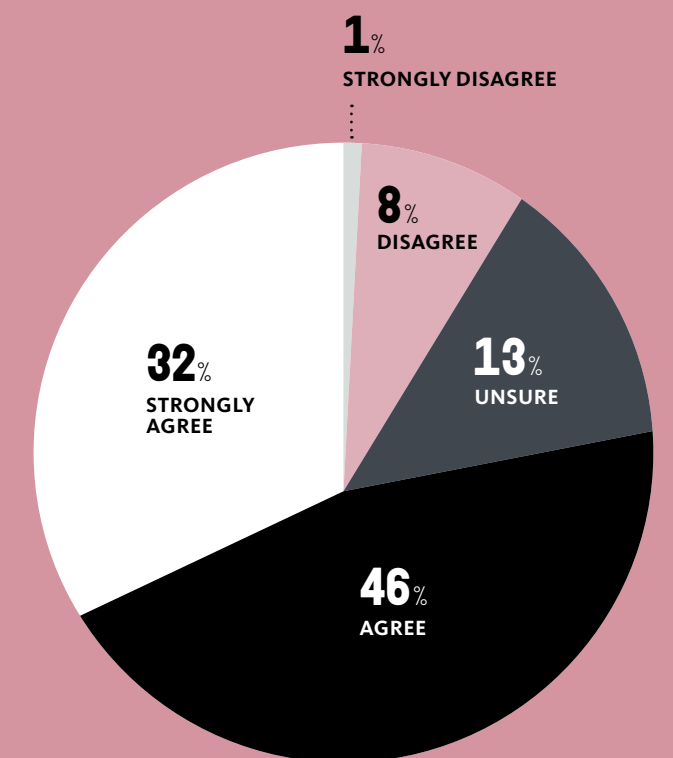
In-store sales are expected to reach \$21.4 trillion globally by 2024.

Source: Statista



COVID-19 accelerated the shakeout among retailers that likely would have occurred over the next few years anyway.

Source: PwC and ULI, Emerging Trends in Real Estate 2022



SPORTS

OVERVIEW

Experience is at the forefront of the business of sports. To that end, teams and organizations are in need of designs and renovations that can incorporate the latest changes in technology and social dynamics. Spectators, sponsors, athletes, and a stadium's surrounding community want meaningful and sustainable destinations.

“Sports is about bringing people together: bringing people together on the field, that teamwork and that chemistry, and bringing the fan base together in and around a venue, the energy and excitement that creates.”

— Jonathan Emmett, design director, Gensler Sports

03

The return of live music presents an opportunity to deliver diverse, immersive experiences.

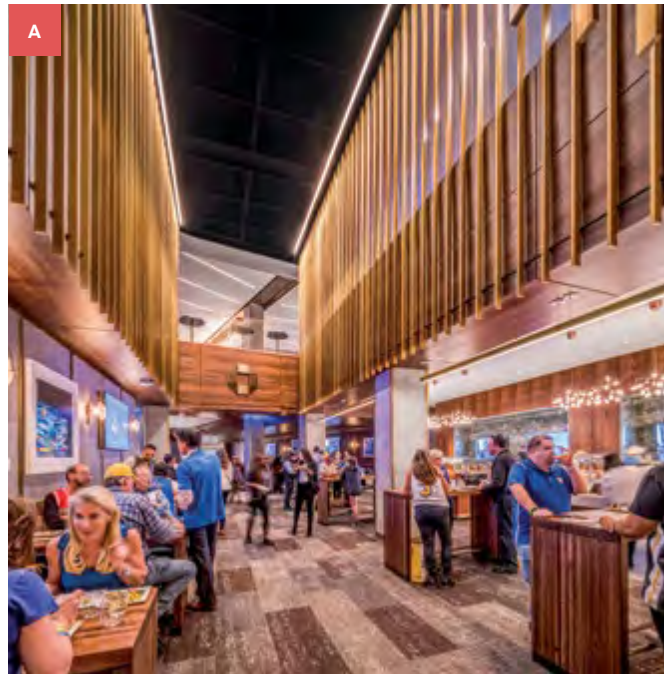
The absence of live music venues over past couple years has driven an immediate demand for fans to reclaim that essential experience. Our research suggests that venues providing expanded offerings, diverse seating options, immersive experiences, and advanced technology will have the most opportunity going forward. Venues that incorporate outdoor space will build in resilience and create opportunities for flexibility in the event of future disruptions.

TRENDS

01

The demand for unique experiences for a variety of fans will continue.

While a game or event may get fans to the venue, a range of event-day experiences keeps them coming back. Our core value for design centers around creating experiences for everyone who walks into the building. We achieve this by differentiating places in the building for a variety of premium product offerings — from clubs, to suites, to sponsor zones — that appeal to every level of guest.



02

Design for sports and entertainment venues must be informed by data.

The sports and entertainment industry is constantly evolving. Curating a more impactful design must be based in data-driven research. Research informs every facility we design — from player recovery technology, to food service automation, to financial models for premium seating products.

FEATURED PROJECTS

A. Chase Center, San Francisco

B. University of Texas at Austin, Moody Center Basketball Arena, Austin





C

“Today, the emphasis on pure physical training is transitioning into a more balanced approach that includes a player’s mental health and well-being.”

— Jonalyn Abraham, project architect, Gensler Sports

04

Training facilities and performance centers will need dedicated, healthy spaces.

The sports industry has shifted beyond pure training facilities to establish performance centers that take a more holistic approach to achieving “total performance” through dedicated spaces that support conditioning, treatment, recovery, and rehabilitation. Healthy environments take advantage of indoor-outdoor spaces and flexible environments to promote wellness, and balance individual and team success.



D



E

05

There is an ongoing need for public-private partnerships and sports-anchored districts.

From campuses to cities, sports and entertainment venues have become catalysts for economic and urban renewal. Sports- and entertainment-anchored districts have greater success at reactivating and engaging local communities. Public universities are relying more on public-private partnerships to expedite and achieve essential capital programs in the face of limited public funding.

FEATURED PROJECTS

C. Los Angeles
Chargers Training Facility,
El Segundo, Calif.

D. Austin FC St. David's
Performance Center,
Austin

E. Milwaukee Bucks
Entertainment Block,
Milwaukee



FEATURED PROJECT

F & G. Q2 Stadium,
Austin

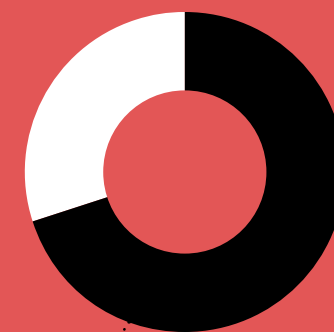
STRATEGIES & RESEARCH

“More than 60% of fans say a great ‘year-round experience’ would make them more likely to be more engaged with the team in the coming season, and 55% say it would make them more likely to purchase a ticket in the future.”

Source: Deloitte, "Sports marketing strategies to stay connected year-round"

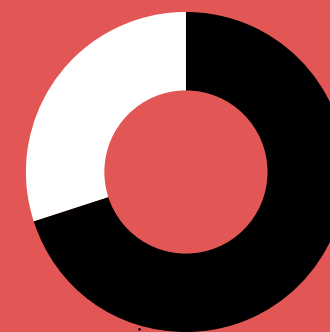
Sports fans want brands and rights holders to show support.

Source: World Economic Forum, "How the power of sport can bring us together and drive social justice"



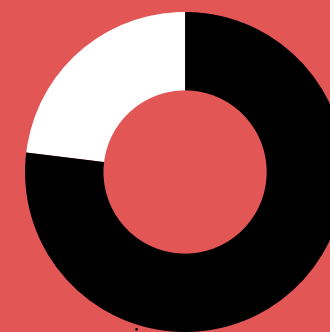
70%

indicate teams and leagues should support athlete protests and initiatives



70%

believe teams and leagues should create marketing campaigns to support diversity



77%

believe brands are more powerful when they partner with sports organizations to help influence social change



64%

have an increased interest in brands that join the fight against racial inequality

THE FUTURE OF HEALTH

DESIGNING A HEALTHIER HUMAN EXPERIENCE

Awareness of how the built environment impacts human health is at an all-time high. As humanity continues to face several formidable challenges directly related to health, this awareness gives us hope. Environments can be a tool with which to make people healthier, a fact that forward-thinking healthcare providers, science organizations, and mission-driven companies are recognizing.

In the coming years, wellness practices will grow to become the touchstones of successful cultures. Investment in resilient solutions will spike as organizations look to shore up operations against external shocks and accommodate new technologies to future-proof their operations. As digital and physical worlds blend, it will be crucial for design to emphasize our common humanity and shared purpose.

The context for these trends is one unignorable demographic shift: the aging of the population that will soon place unprecedented demands on all sectors to support a healthy and intergenerational future.

META TRENDS

Here are five key metatrends impacting the health sector, and how design is responding:

01

DESIGN FOR RESILIENCE AND DESIGN THAT ELEVATES HUMAN HEALTH ARE ONE AND THE SAME

Increases in extreme weather events due to climate change are already straining healthcare systems. Facilities must integrate resilient and sustainable strategies in order to expand crisis response capacity as they think about their overall environmental impact.

02

MORE OF THE POPULATION WILL BE OVER 65 THAN UNDER 18 FOR THE FIRST TIME IN HUMAN HISTORY — THIS CHANGES EVERYTHING

As lifespans increase, spaces must support active, meaningful lifestyles for older adults. Work, travel, hospitality, and housing will require designs that empower all individuals.

03

SCIENCE ORGANIZATIONS WILL SET THE TONE FOR HOW WE ACT ON CLIMATE CHANGE AND HEALTH

As organizations seek to create positive change, they will look to the sciences, brought front and center by the pandemic, for best practices and inspiration, both in how they support their workforces and maximize the impact of their space portfolios.

04

EXISTING, AGING BUILDING STOCK CANNOT BE IGNORED

These industries — health and sciences in particular — occupy a disproportionate share of the world's inventory. A solution to repurpose (rather than discard) this building stock is essential, and will create new potential sources of return on investment.

05

DESIGNING “TO THE EDGES” WILL CREATE MORE WELCOMING AND SUPPORTIVE ENVIRONMENTS

Inclusionary design that addresses the edges of society, embracing formerly ignored and misunderstood populations, will be a hallmark of organizations looking to match their missions to their real estate.

HEALTHCARE

OVERVIEW

The healthcare industry is creating new experiences and interactions between patients, caregivers, and technologies that will enable healthcare institutions to pursue design strategies that merge virtual and in-person care delivery. The use of data to track the performance of new delivery models will be key to evaluating their effects on local communities. The industry's most salient long-term challenge will be to successfully deliver care to communities as extreme weather events become more frequent.



TRENDS

01

The evolution of clinical technologies will decentralize care.

Healthcare providers, from academic medical centers to primary care providers, will further prioritize consumer access to care in the coming years. The increasing capabilities and operational simplicity of clinical technologies allow formerly complex procedures, such as hip replacements, to be delivered in outpatient settings. The resulting real estate trend will be to migrate clinical services, to the greatest extent possible, from hospitals to primary- and secondary-service areas in local communities.

02

Now is the time to build resilient systems to withstand climate change.

Healthcare providers across the U.S. and around the world are already seeing their ability to provide care impacted by major climate events. Sustainable real estate strategies will protect investments in health systems, reduce risk, and empower providers to support their communities in the immediate aftermath of such events. Such strategies will also reduce the healthcare industry's notoriously high energy usage and help address the climate crisis at its root cause.

FEATURED PROJECTS

A. Northwestern Medicine Lake Forest Hospital, Lake Forest, Ill.

B. Dallas Medical Research Park at Parkland, Dallas

C. Confidential Medical Center, Pembroke Pines, Fla.



“Digital-first hospitals and clinics will learn from retail and hospitality to create more seamless, personalized digital patient experiences — both remotely and in person.”

— Dialogue Blog by Scot Latimer and Richard Tyson, “Digital Transformation of Healthcare Design”

03

Research will drive changes in healthcare experience design.

The experiences of staff and patients are equally important, and healthcare providers are demanding data-driven real estate solutions that cater to both groups. On the provider side, investing in the wellness of workers will help address retention challenges, especially among nursing staff. On the consumer side, providers will need to offer more convenient and comprehensive care, so they don't lose market share to other organizations.

04

Telehealth is here to stay, but in-person interactions will define the industry's future.

Adoption of telehealth spiked during the pandemic's early stages, then plateaued. Though telehealth will continue to play a significant role for some forms of care such as psychiatry, in-person interactions that require access to specialized technology will continue to comprise the overwhelming majority of healthcare interactions.

05

The lines between physical and digital healthcare delivery will continue to blur, requiring flexible spaces.

Physical, in-person care delivery will continue to integrate with platforms designed for virtual consumer engagement and telemedicine. But this integration will be uneven over time, because healthcare technologies will emerge in a piecemeal fashion, meeting some needs before others. Healthcare facilities will therefore require planning and design that provides flexibility, enabling them to confidently build spaces and networks to support care teams and local communities well into the future.



Bill Richards Center for Healing at Aquilino Cancer Center, Rockville, Md.

This first-of-its-kind facility offers a purpose-built space for cancer patients to explore trial psychedelic therapies. A multidisciplinary team came together to understand the choreography of these therapies and how space can impact the outcome, creating a safe, supportive, and biophilic environment. The patient experience was designed to create the ideal setting for guided spiritual journeys.

4



Columbia Primary Care - Manhattan Valley, New York

Principles for designing digital-first healthcare

New digital platforms and health technologies are becoming an integral part of future-ready healthcare. Emerging digital solutions that are blended with physical spaces can help make care more personalized, responsive, and effective. By designing with digital in mind, we have an opportunity to reconsider care delivery through the lens of human experience.

We've identified four fundamental principles to ensure better outcomes for clients and their communities:

1

ANCHOR DESIGN IN THE PHYSICAL-DIGITAL JOURNEY

With digital and mobile technologies, people can engage with their health anywhere — whether they're commuting, working at home, or traveling. Understanding how the clinician's workflow and the patient journey coincide online and onsite will be critical.

3

MAKE DATA AND ANALYTICS PART OF THE DESIGN PROCESS

Applying data to support design decisions, model opportunities, and measure design performance is now essential. Advances in technology are not just transforming the clinical healthcare experience — these advancements are giving us much richer data and more powerful tools for applying analytics.

2

DESIGN SPACE, SERVICES, AND DIGITAL ENGAGEMENT TOGETHER

By using experience analytics, we can better understand the patient journey. Gensler is integrating advanced spatial analytics to support programming, design evaluation, and quantified journey-mapping to improve the effectiveness of future clinics and hospitals, and to establish new ways to evaluate healthcare facilities today.

4

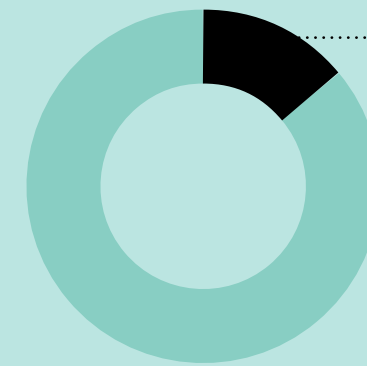
DIFFERENTIATE WITH PHYSICAL + DIGITAL EXPERIENCE

Focusing on the human journey with integrated design and advanced analytics has more advantages than just better design and performance — it also supports unique opportunities to differentiate from the competition, build brand equity, and develop powerful approaches to real estate strategy.

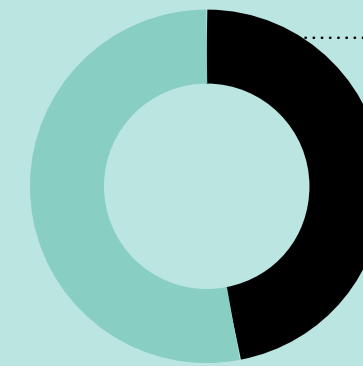
STRATEGIES & RESEARCH

Addressing issues of trust and quality is key to the future of outpatient care. Of patients in the U.S. who received outpatient healthcare:

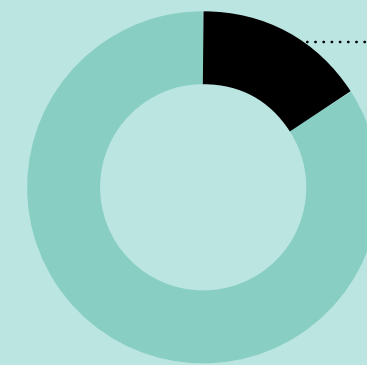
Source: Gensler Outpatient Healthcare Experience Index



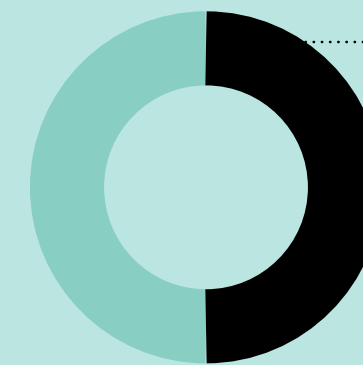
14%
had a virtual health visit between May and October 2020.



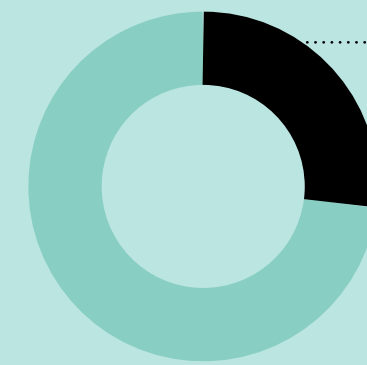
47%
who had a virtual health visit with a physician said that visit was as good as being in person.



16%
are highly engaged in their healthcare.



50%
rated the quality of their interaction with the physician positively.



27%
have low trust in the future of healthcare

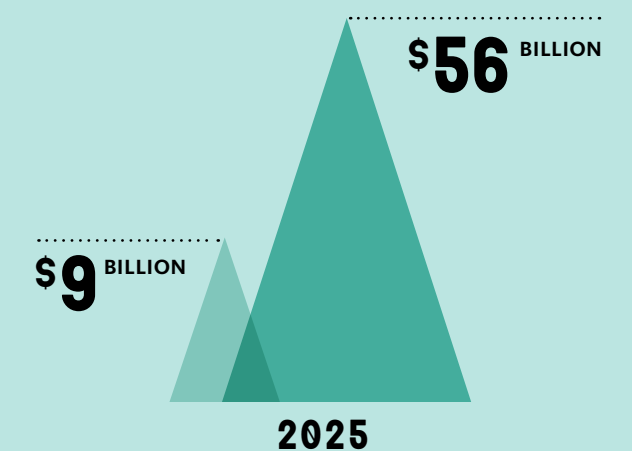


73%
felt comfortable during their most recent in-person outpatient visit.

Digital therapeutics such as mobile health apps and software will grow exponentially, shaking up the industry's space requirements.

Source: Insider Intelligence

In 2020, Insider Intelligence expected the digital therapeutics space to hit nearly \$9 billion by 2025, but its revised forecasts amid the pandemic put it closer to a \$56 billion global opportunity by 2025.



SCIENCES

OVERVIEW

Science organizations will continue to see rapid growth. Collaborations across research disciplines and geographies will lead to more rapid advances. To keep up with the pace of growth, clients are implementing lab and workplace solutions that can flex to meet demand, adapt to technology, and offer enhanced amenities to attract and retain talent.



03

Energy usage will drive innovation in lab development.

Science buildings consume between five and 10 times the energy of a normal office building. Given this high rate of energy use, even incremental improvements in performance yield substantial savings. In many regions, the need for innovative climate action has been accelerated as municipalities adopt requirements for net zero energy buildings.



TRENDS

01

Development for science clients will continue to attract attention.

There is tremendous interest in repositioning existing office buildings and expanding research-capable development in and near major science clusters. Industry leaders are thinking beyond the basics of functional, lab-ready space and differentiating their real estate through amenities and services that are dialed into science tenants' needs.

02

Science organizations are keeping their supply chain and manufacturing operations close.

As companies advance their innovations to production scale, the traditional hurdles of R&D-focused science clusters like high rents, logistics concerns, and nonindustrial zoning are being outweighed by the desire to maintain consistency and security of production and to promote more collaboration between manufacturing and research teams.

04

Scientists jobs are changing — so will their workplaces.

Changes in how scientists interact with and share data are unlocking new ways of advancing science. The ability of automation to collect more accurate scientific data at greater volume is leading to reductions in laboratory space. At the same time, scientists are interacting with data differently, using computational modeling, machine learning, and advanced collaboration and visualization tools. Cutting-edge science spaces will streamline interactions with data, while also facilitating person-to-person collaborations and connections.

05

Science organizations will keep growing into new markets.

Secondary markets are in growth mode along with neighborhoods at the periphery of major hubs like Boston, London, San Francisco, and Shanghai. Given that vacancy rates are below 5% in major hubs, emerging markets with strong university research presence offer more real estate options, reduced cost of living, and lower rents for earlier stage companies.

FEATURED PROJECTS

- A. Genmab
U.S. Headquarters,
Princeton, N.J.
- B. USF Research
Foundation Mixed Use,
Tampa, Fla.
- B. Organon,
Jersey City, N.J.



Lab Building of the Future Concept

This concept of the next generation of lab buildings prioritizes flexibility, well-being, and climate readiness. Mass timber framing and natural ventilation result in a building that uses 30% less energy, reduces up to 75% less construction waste, and saves up to 80% less carbon than a conventional lab building.



“The future for the industry is to blend a science lab with the collaborative elements of tech workplaces, which are masterful at creating synergies between people.”

— Dialogue Blog by Chad Yoshinobu, “The New Hybrid Sciences Office Will Blend Tech Workplace, Hospitality, Brand Design, and Storytelling”



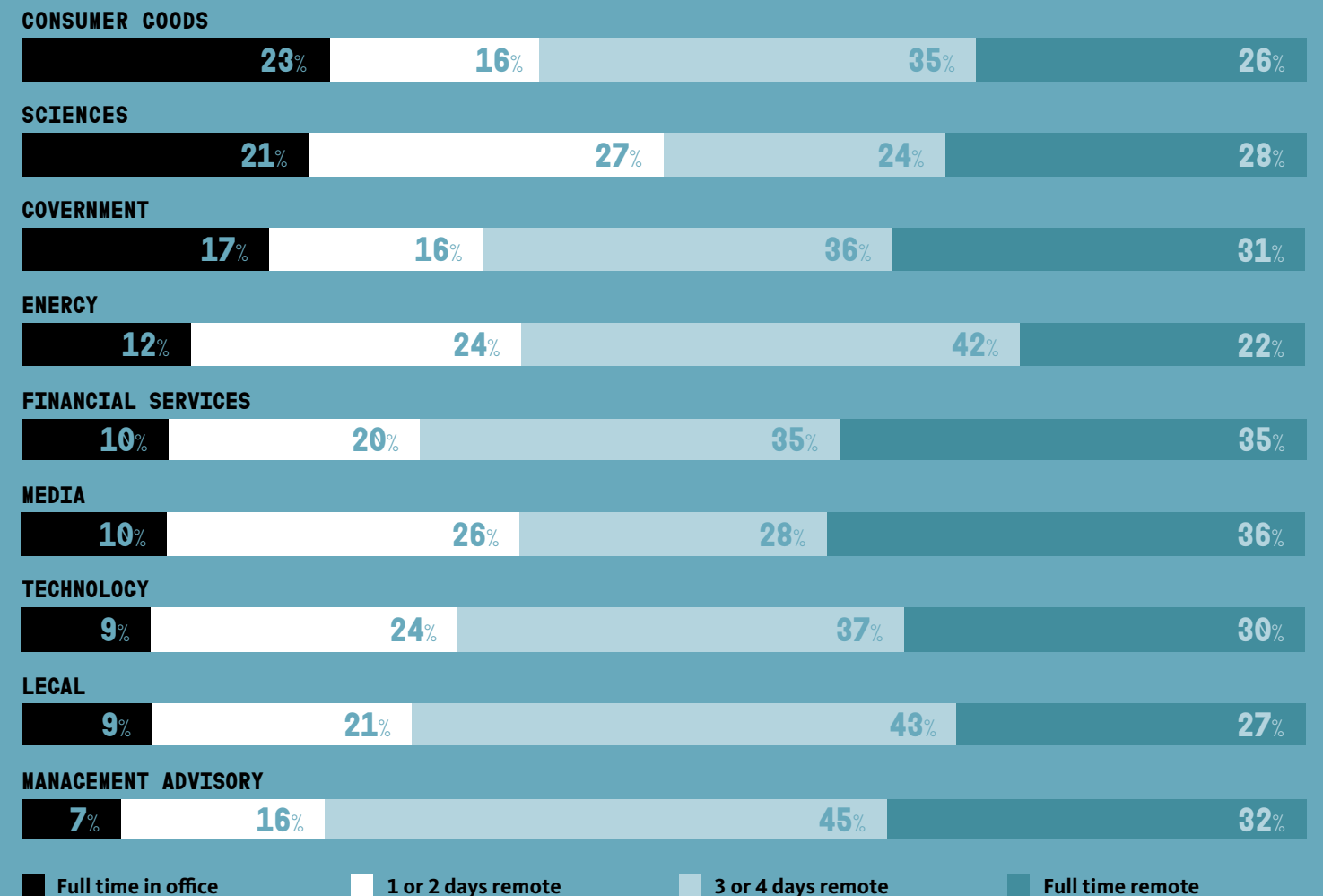
FEATURED PROJECT

D & E. JPL FEIF Building, Pasadena, Calif.

STRATEGIES & RESEARCH

Sciences show a preference for more in-person work than most industries.

Source: Gensler U.S. Workplace Survey Summer 2021



Life sciences growth now surpasses tech.

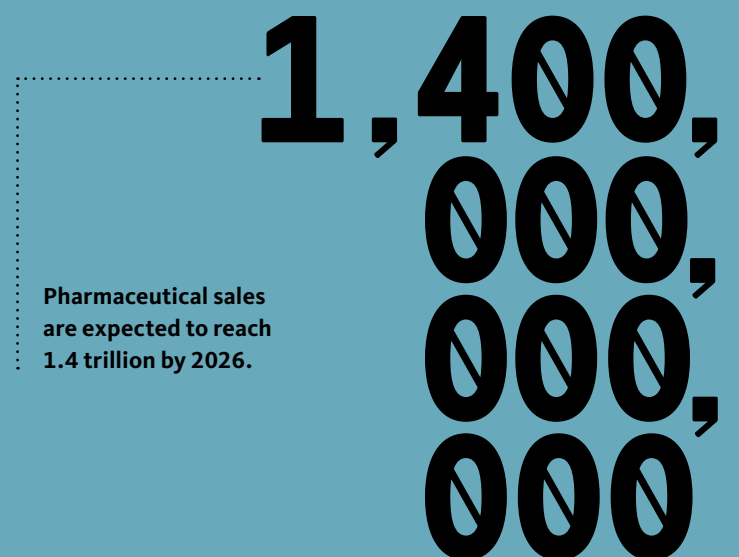
Source: U.S. Life Sciences Mid-Year Report 2021, CBRE

16%

“Life sciences employment reached a record high in March 2021, driven by biotechnology and other industry advancements. The industry’s 16% total job growth since April 2017 when CBRE first produced this annual report has surpassed that of the technology sector.”

Biotechnology-driven therapeutics are experiencing exponential growth.

Source: JLL



SENIOR LIVING

OVERVIEW

The number of people age 65 or older will double in the next 20 years, while average lifespans also increase. As we think about creating spaces for older adults, we must consider the fact that our communities will become more multigenerational, and the places we design for the oldest members of the community must emphasize holistic wellness, purpose, and activity in order to foster greater connections across our urban and social fabrics.



TRENDS

01

Housing for older adults can foster meaningful connections to urban life.

According to the Gensler Residential Experience Index, 69% of older adults want to stay in their current home, and many also want to live in urban areas, which can offer active and social resources that allow residents to thrive. A growing number of projects are focused on allowing older adults to age in place and continue to live in the cities they love.

FEATURED PROJECTS

A & B. Bosque House, San José, Costa Rica

C. Fountainview at Gonda Westside, Playa Vista, Calif.

D. Willow Valley Mosaic, Lancaster, Pa.



02

Mixed-use, mixed-income, and multigenerational lifestyle developments are emerging as new models.

Flexible residential units that can reconfigure to connect an adjacent unit for a live-in caretaker is a boon for someone who wishes to stay in their home later in life. But they can also attract all walks of life, such as a couple starting a family, or a group of friends looking to share an apartment after college. As the costs of senior living facilities continue to rise, so will demand for affordable alternatives that enable people to age in place.

03

Designing elevated experiences for caregivers is a big opportunity.

With the overwhelming majority of assisted living facilities reporting staff shortages, the senior living industry is at a turning point. The caregiver experience has seldom been a primary design driver for senior living in the past, but that will change as facilities explore new retention strategies. To this end, the industry can adopt lessons from across healthcare, hospitality, and other industries to create great places to work.



“Advancements in health and medicine mean that age 100 will become more common. If people still retire around age 65, as many will, that could leave 40 years of life for which to design.”

— Dialogue Blog by Tama Duffy Day, “Charting a Better Course for Senior Living”

04

Gerontechnology will extend aging-in-place.

As people age, the use of technology to maintain and regain independence is critical. Gerontechnology integrates technology for health, housing, communication, leisure, and work for older adults. More older adults have embraced digital technologies than ever before, from telemedicine, to sensory aids, to assistive technologies. These advancements have the potential to enhance people’s lives, facilitate caregiving, and extend independent living and aging-in-place.

05

Wellness models for active adults are replacing one-size-fits-all care models.

Unlike one-size-fits all care models for older adults, wellness community models for active older adults allow residents to focus on their interests and needs. By focusing on the seven dimensions of wellness — intellectual, physical, social, spiritual, vocational, and emotional — this model offers a holistic, comprehensive approach.



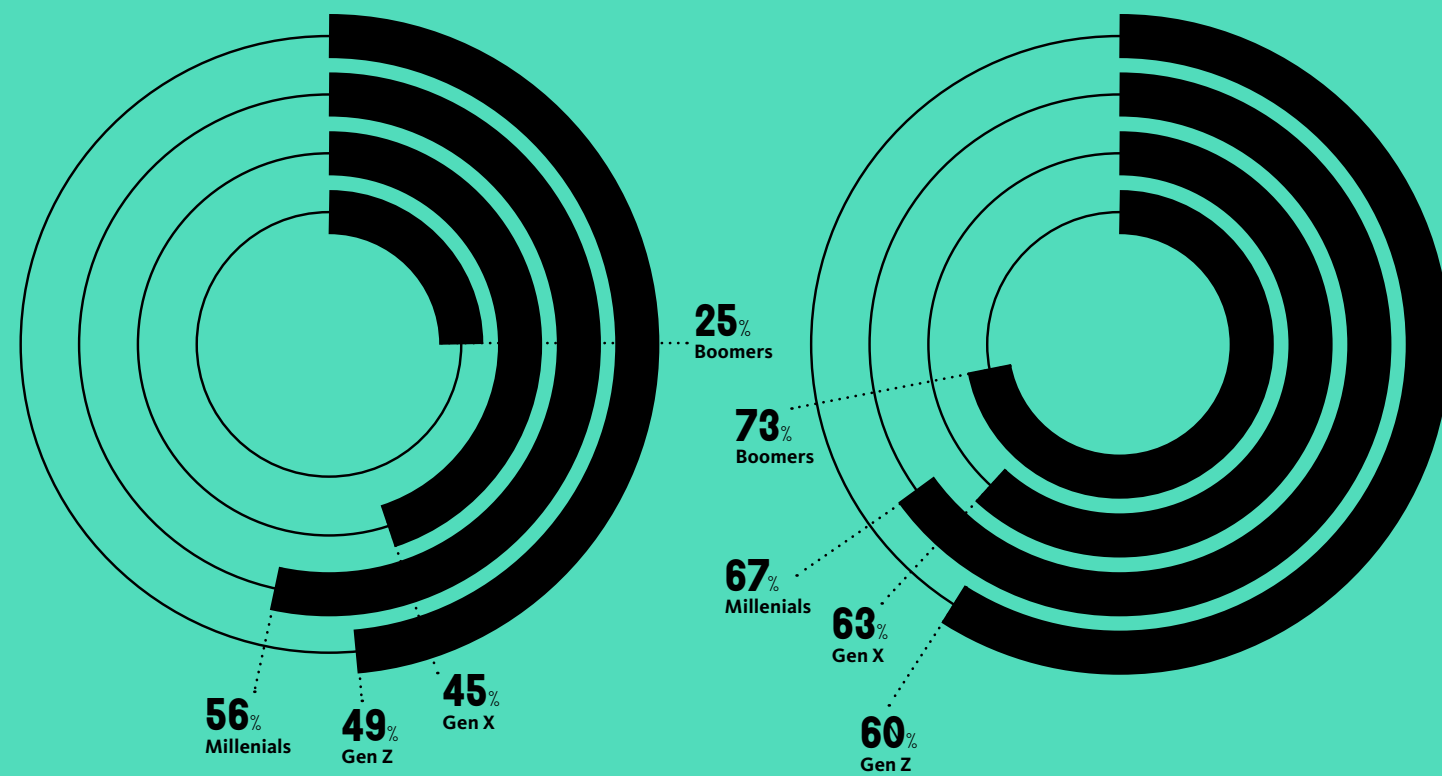
FEATURED PROJECT

E. Willow Valley
Mosaic, Lancaster, Pa.

Baby boomers are the generation that reports the highest level of satisfaction with their current living situation (73%), and the lowest interest in leaving the city where they live as a result of the ability to work remotely (25%).

More than any other generation, baby boomers want to stay in the cities where they live.

Source: Gensler City Pulse Survey Fall 2021

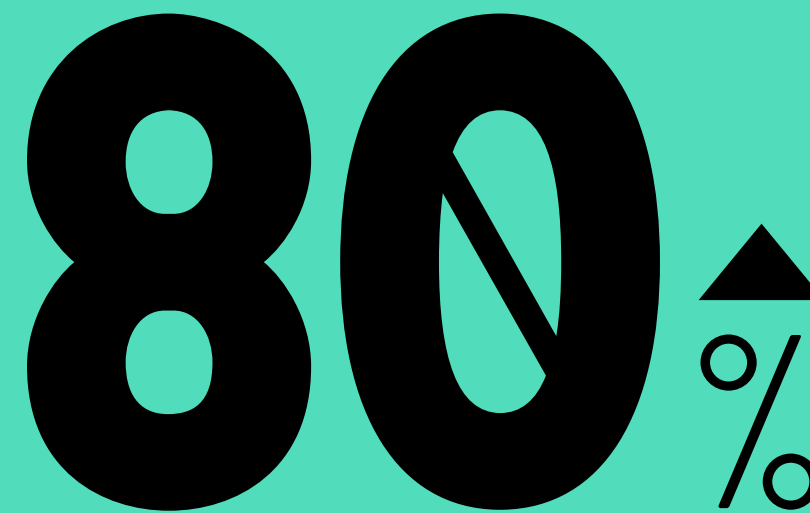


Percentage of respondents who say the ability to work remotely has made them think about moving, by generation

Percentage of respondents who are satisfied with their current living situation, by generation

The Economic Impact of Age Discrimination

Source: AARP

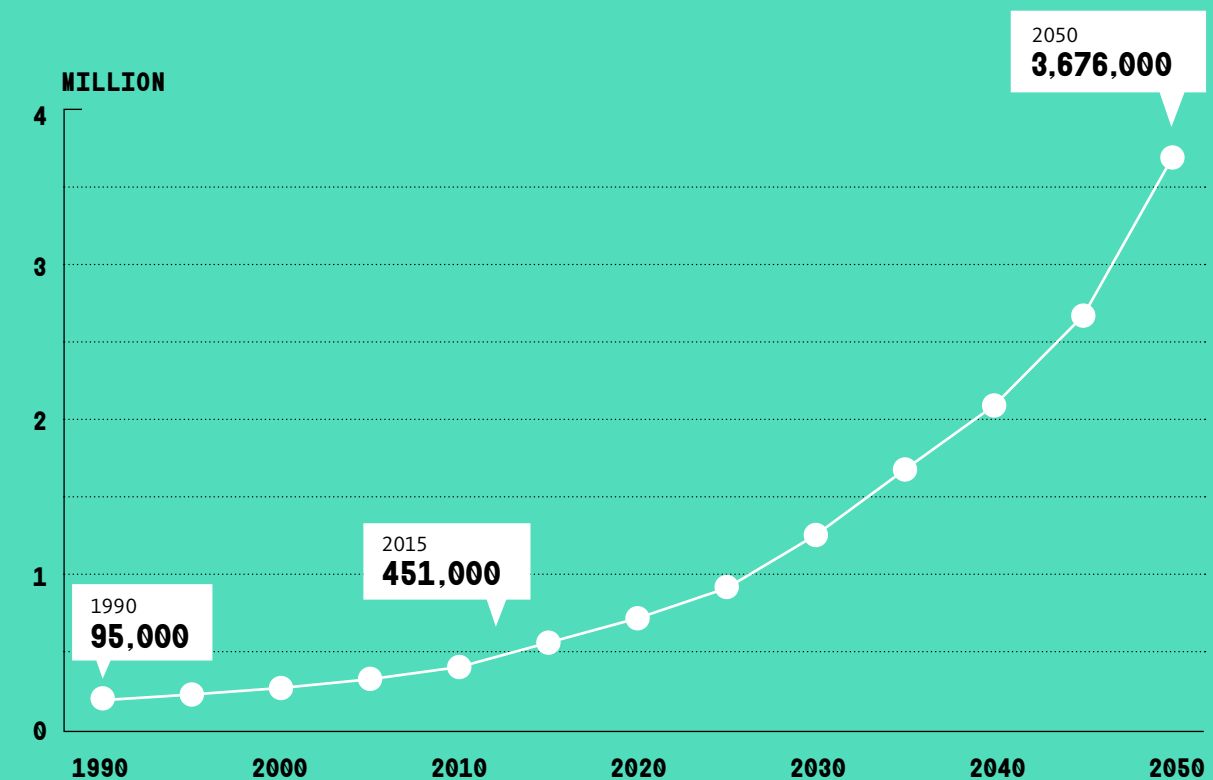


“The number of workers age 50-plus has increased by 80% over the past 20 years, more than four times faster than overall workforce growth.”

Moreover, “Among those age 65-plus who are currently employed, over 40% intend to work for at least five more years.”

The world’s centenarian population is projected to grow rapidly.

Source: United Nations/Pew Research Center



The United Nations estimates that there were about 95,000 centenarians in 1990 and more than 450,000 in 2015. At the current rate of increase, by 2100, there will be 25 million.

WELLNESS

OVERVIEW

The combined impacts of climate change, the pandemic, economic instability, and increased mental health issues have caused a seismic shift in how employers understand wellness. Far from being an optional amenity, wellness is now a cultural necessity — and therefore, one of the fastest growing industries across the globe. The conversation is no longer about whether wellness is good for business. We know it is. Now is the time to put wellness-based design strategies into action.

TRENDS

01

Successful organizations will foster a deeper sense of wellness through belonging.

Hybrid work modes threaten to undermine our ability to connect and create relationships, and a company's ability to build culture. In the near future, companies will look to grow culture virtually, while finding new ways to support their people's professional and personal growth, and to provide them with a healthy sense of belonging.

02

Designing for the edges takes center stage.

The variety of identities, affiliations, characteristics, and abilities that used to be pushed to the edges is now becoming part of the mainstream. This is driving more inclusionary design. Central building entries, for example, will create more seamless experiences for people of all physical abilities; new designs for neurodiversity will lean heavily on recent scientific findings. Where gaps and shortcomings exist in local code requirements, it will be incumbent upon designers and their clients to go beyond the minimum.

03

Finding individual agency: owning your personal wellness.

The ongoing health impacts of COVID have prompted many to take control over their own wellness. It's important to recognize that 'wellness' is a personal definition also based on circumstances. In the coming years, it will be up to organizations to find new ways to support their employees, whether that's through new types of amenities at the office or by giving people the space and time they need to rest, spend time with their families, eat healthily, or exercise.



04

Businesses are shifting to a mixed-use model.

Hyper-amenities are the new baseline. Wellness has evolved beyond the juice bar and the yoga mat. People require variety. That means providing choice, opportunity, scale, and variety in programming.

“The cost of poor health to employers is greater than the combined revenues of Apple, Amazon, Microsoft, Netflix, eBay, and Adobe.”

— Thomas Parry, Integrated Benefits Institute senior advisor

FEATURED PROJECTS

A. LinkedIn, Chicago

B. 545wyn, Miami

C. OhioHealth Neuroscience Wellness Center, Columbus, Ohio

“For many, wellness in the workplace now includes sustainable and healthy buildings, as well as environments that promote diversity, equity, and inclusion. One way landlords and employers are taking action on these priorities is by investing in ESG goals.”

Source: Dialogue Blog by Cindy Coleman and Stacey Olson, “An 8-Step Model for ESG and Wellness in the Workplace”

Demand for healthy buildings is at an all-time high — and will continue to grow.

Source: 2021 Fitwel report, “A New Investor Consensus: The Rising Demand for Healthy Buildings”

\$ INVESTING IN HEALTHY BUILDINGS

89.5%

of respondents plan to enhance their company's health and wellness strategy in the coming year.

Wellness Gap Analysis

Source: Gensler

DESIGNING FOR WELLNESS STARTS WITH AN ANALYSIS OF A SPACE TO SEE HOW IT STACKS UP AGAINST 8 KEY CHARACTERISTICS OF WELLNESS.





CREDITS

The entire Design Forecast team would like to give a special thank you to the many clients and Practice Area leaders at Gensler for their contributions in developing the trends and content featured in this publication.

CONTRIBUTORS

Oversight: Andy Cohen, Diane Hoskins, Leslie Taylor

Team: Joshua Barthel, Nick Bryan, Clay Kessack, Sam Martin, Kendra Mayfield, Jason Murphy, Mia Park, Rika Putri, Jonathan Skolnick, Zoe Zellers, Adam Zurbruegg

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