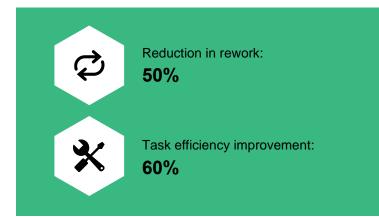# Mixed Reality Enhances Design Visualization And Project Outcomes For AEC Firms With Microsoft HoloLens 2

Architecture, engineering, and construction (AEC) firms must continue to embrace innovation and a digital-first mindset to optimize workflows, improve project certainty, and reduce inefficiencies to boost productivity and operational efficiency. From planning to design and construction, connected teams, data, and processes are integral to better project delivery across complex and often expensive building and infrastructure projects. While advances in building information modeling (BIM) have continued to spur innovation across project lifecycles, model visualization and stakeholder collaboration constraints present hurdles that must be overcome to optimize building and infrastructure design, accelerate workflows, and propel projects and businesses forward to new levels of growth.

Microsoft HoloLens 2 is an untethered, self-contained holographic headset that allows users to leverage enterprise-ready mixed reality (MR) applications while working "heads up" and "hands free". Microsoft boasts a vast ecosystem of applications and services from in addition to solutions from third-party partners that enable industry-specific use cases, such as clash detection, immersive model visualization, and issue documentation and tracking. AEC firms are empowered to overcome design, modelling, collaboration, and building site challenges to enhance project quality, decision-making, improve productivity, and improve bottom-and top-line business results.

To better understand the benefits, costs, and risks associated with mixed reality on the Microsoft HoloLens 2, Microsoft commissioned Forrester Consulting to interview 23 decision-makers from 21 organizations that are customers of Microsoft

Reduction in rework:
50%

Task efficiency improvement:
60%

HoloLens 2 and conduct a Total Economic Impact™ (TEI) study.[1]

This abstract will focus on the AEC industry's use of Microsoft HoloLens 2 to leverage mixed reality applications and its value to their organizations.

CHALLENGES

AEC firms face many challenges in their pursuit to improve project delivery and drive business growth. Innate building and infrastructure complexities, communication across diverse sets of project stakeholders, and shortcomings in traditional clash-detection approaches hold organizations back from achieving workflow efficiency across project lifecycles, cost optimization, and improved quality of service. Other challenges include an industrywide disparity between available jobs and skilled talent. Firms struggle with high staffing turnover and shortages, hindering the ability, speed, and cost of hiring and training enough workers to meet demand.

→ **READ THE FULL STUDY HERE**

Decision-makers within AEC investigated how mixed reality could solve key challenges, including:

- **Complex infrastructures and precision requirements.** Projects took place in facilities that were packed with existing infrastructure, which made it difficult to determine the correct installation paths for components and adhere to precise construction tolerances. Existing BIM solutions lacked the ability to consistently detect clashes between model components and infrastructure, leading to errors in fabrication and installation that caused downtime and rework.

- **Stakeholder collaboration and alignment during the design process.** Communication and decision-making across designers, construction workers, and customers was limited as models could not be accurately viewed in real space. This limitation increased the chances of stakeholders misinterpreting design intent, lengthening sales, planning, and design processes while also increasing the risk of costly design clashes, hazards, or other issues that could go unnoticed before fabrication or construction. The VP of design and engineering at one AEC firm shared: "There are many ways to say the same thing and to do things in different regions, different parts of the country, and at partner companies. Without everybody sitting in front a map speaking the same vernacular, you really don't know what you're getting."

- **Clash detection and design issues caused costly rework and downtime, impacting customer experiences.** Model clashes that weren't detected and corrected prior to construction or fabrication created downtime for field crews and project teams as well as high rework costs. In fact, a VP of design and engineering noted that the cost of rework was about three times the original cost of installation. Delays to project schedules and avoidable costs hurt customer experiences and operating margin.

OPPORTUNITIES

Decision-makers also investigated mixed reality to seize new opportunities, including:

- **Provide heads-up, hands-free instructions to improve worker speed, quality, and safety.** Interviewees looked to MR to enable workers to view task instructions, essential data, and model visualizations while working heads-up and hands-free.

- **Empower workers with self-guided learning.** Decision-makers sought to enable scalable, self-paced training that could reduce expert instruction time. Improving skill acquisition, retention, and training outcomes with training that could provide better visualization, hands-on experience, and repeatability was particularly critical given shortages of skilled workers across the AEC industry.

- **Demonstrate plans and models in 3D to customers to enable sales and improve service.** Interviewees sought tools to help project leaders, designers, engineers, and constructors better demonstrate, visualize, and review plans, models, or components with customers. They sought to improve alignment, enable co-creation, reduce rework, prevent delays, and boost sales and service.

- **Overlay designs on physical locations to identify issues and gain buy-in of onsite workers and key stakeholders.** Decision-makers needed a way to accurately visualize and communicate how models and components would align within existing infrastructure and reduce misinterpretation of design intent across project stakeholders. It was imperative to identify model clashes earlier in design, planning, and fabrication stages to mitigate late-stage design changes that could result in rework, budget overrun, and project delays.

> **"There is no technology on the market that can give you perspective like [mixed reality on] HoloLens can. There is nothing comparable that can give you that experience."**
>
> *Corporate controls manager, construction and engineering*

INVESTMENT OBJECTIVES

Decision-makers hoped to achieve the following goals with mixed reality, including:

- Reduce errors and rework.

- Accelerate design and planning phases.

- Protect health and safety.

- Accelerate task completion.

- Accelerate training and reduce training costs.

- Improve learning and knowledge retention.

- Improve alignment and buy-in for office teams, site workers, and customers.

- Improve quality of work.

- Reduce demand and stress on leaders and experts.

- Reduce pass-along costs for customers due to delays and rework.

- Improve customer experience (CX).

- Strengthen brand image.

- Increase customer retention, enrichment, and advocacy.

- Increase contracting win rates.

SOLUTION CRITERIA

After identifying challenges and opportunities, decision-makers evaluated many different technology categories and ultimately selected Microsoft HoloLens 2 devices based on the following criteria:

- **Heads-up, hands-free work and collaboration with robust capabilities and dependability.** HoloLens 2 enabled accurate real-world overlay of 3D models and instructions while leaving workers free to see the physical environment and use both hands. Precise presentations of designs and instructions eliminate room for misinterpretation across the project lifecycle.

- **Simplicity to embed within Microsoft's ecosystem, including Azure, Intune, Active Directory, Dynamics 365, Office, and Teams.** Decision-makers selected HoloLens 2 to accelerate time-to-value and reduce operational overhead with established ecosystems of Microsoft services, avoiding major customization, coding, or investment in other new tools.

- **Robust partner ecosystem of independent software vendors (ISVs) with expertise and offerings specialized for AEC use cases.** The large and growing selection of ISV applications for use of mixed reality within AEC enabled customers to accomplish a vast array of AEC-specific use cases while lowering risk, accelerating deployment, and reducing costs. Customers were drawn to partner solutions such as VisualLive and Trimble Connect MR, which enabled them to upload and visualize computer-aided design (CAD) and BIM models, interact with data, and execute workflows.

- **Availability of specialized devices designed to support work in safety-controlled environments.** HoloLens 2 Industrial Edition and hard-hat integration options such as the Trimble XR10 with HoloLens 2 enable users to leverage mixed reality while meeting safety requirements.

- **Successful proofs of concept (POCs).** During initial testing of concepts, AEC firms quickly realized value and opportunities for potential use cases and business growth, driving buy-in for the investment with decision-makers. Interviewees instantly saw opportunities for design changes within their projects that could improve efficiency and quality of work, driving home the value of the investment.

KEY BENEFITS FOR AEC ORGANIZATIONS

Through the adoption of HoloLens 2 devices, the interviewed AEC firms were able to address organizational challenges that had previously impacted project efficiency, operational cost, and business growth. Empowered by the robust capabilities of HoloLens 2, mixed reality services, and AEC-specific partner applications, organizations achieved several benefits, including:

Training efficiency. Self-guided mixed reality instructions leverage 3D models, simulations, and real-world overlays to enable workers to learn more quickly, better understand content, and practice skills, enabling AEC firms to reduce training time by 50% at an average savings of $22 per labor hour. AEC firms must teach company-specific skills and processes that are ripe for MR. Most firms have standard processes and preexisting 2D models and instructions to fast-track training creation. Learners can also observe and participate in remote demonstrations or be evaluated by viewers as they test their new skills.

Reduction in training time:

50%

Field task worker productivity. Using heads-up, hands-free instructions enhanced by immersive instructions, models, and remote assistance, organizations improved field task worker productivity.

- **Firms improved efficiency and reduced rework by 75%, saving $44 per hour.** Aided by design visualization and remote collaboration, field workers conducted design evaluations, installations, and inspections, improving project speed, cost savings, quality of work, and CX.

- **An AEC firm streamlined fieldwork using task lists, recording capabilities, and remote collaboration.** The company reduced the number of employees needing to travel on-site without negative repercussions, saving costs and protecting employee health and safety.

Task worker productivity. HoloLens 2 enables users to see and manipulate advanced instructions, schematics, and other information overlaid on the real world, allowing AEC firms to achieve improved onsite task efficiency by 60% for onsite tasks, including clash detection, fabrication tasks, and installation work, and a by 50% reduction in rework, saving $44 per hour. Task workers at construction sites avoid back-and-forth referencing of instructions to improve efficiency and minimize safety risks, such as working on ladders or in risky environments. Workers can also use remote collaboration apps to quickly get support from peers or experts to reduce errors and rework.

Leader productivity. Mixed reality helped project leaders minimize instruction time, accelerate planning and design processes, and avoid errors and delays that could lead to excess time spent in remediation.

- **Firms improved productivity by 35% for leaders' planning, design, and instruction workloads, saving $55 per hour.** Empowered by better model visualization and communication, construction and engineering leaders shortened design phases, received faster buy-in, improved

sales and customer enablement, minimized instruction, and prevented errors and delays to avoid wasted labor.

- **One interviewed construction and engineering company used HoloLens 2 to align teams that were previously at odds.** The VP of design and engineering explained: "Mixed reality is the one thing that everybody can understand and translate instantly because it's visualized in real space. There's less confusion and rework, with more concise action to achieve the goal. We're more efficient with our clients' time, money, and effort."

Specialized expert productivity. Mixed reality helps specialized experts, including senior engineers and other employees or contractors with rare expertise to offload and improve the speed, quality, and effectiveness of their work, enabling AEC firms to reduce 1,040 annual hours of training and task work per expert by 35% and prevent 75% of monthly trips with 90% of labor per trip avoided, saving $92 per hour. A significant portion of AEC expert workloads are addressable with MR. MR helped experts offload mundane or repetitive work to task workers with virtual work instructions and training. Further, travel is a particularly large portion of their jobs; however, it can often be easily avoided with better task worker training, instructions, and remote guidance only when needed. Experts used MR remote support to avoid travel, boost capacity, and better address critical issues even when not physically present at job sites.

> **"HoloLens really flourishes when you have existing facilities or structures that you are adding to or modifying in some way."**
>
> *Corporate controls manager, construction and engineering*

OPERATIONAL COST SAVINGS

Reduced average expert and leader consumables for design, testing, and demonstration by **10%**

Reduced average trainee consumables by **80%**

Reduced average annual PPE costs by **50%**

Operational cost savings. Mixed reality helped AEC firms reduce operational expenses.

- **MR reduced net operational costs by improving quality, preventing errors and rework, and reducing downtime and delays.** By evaluating and revising designs early with MR, interviewees' organizations avoided rework and controlled costs**.** The corporate controls manager shared: "We went out to job sites, loaded models in the HoloLens , and let team members walk around. On every site, we saw opportunities to change designs and installation plans to be faster and better and found clashes and issues between model components and infrastructure. Every instance saves us several thousand dollars, and without this technology, we would not identify issues until actually installing work in the field. This is when the ROI hit home how valuable mixed reality is."

- **MR visualization enabled organizations to optimize training, design, and fabrication processes, significantly reducing operating costs and consumables.** Firms reduced: 1) average consumables costs by 80%, saving $800 per trainee; 2) average consumables costs for design, testing, and demonstration by 10%, saving $20,000 per expert and leader; 3) average

annual PPE costs by 50%, saving $134 per user; and 4) operating costs by 0.3%.

Travel and incidentals savings. Remote assistance and self-guided instructions reduced expert travel and associated costs for planning, rework, and follow-up visits. AEC firms saved an average of $2,000 per avoided expert trip and $50 per avoided field worker trip. Replacing expert travel with remote expertise and self-guided task worker instruction saves significant travel and incidentals costs (flights, cars, hotels, food and beverage, etc.) in addition to labor costs. Given the regional nature of their operations, AEC firms avoid regional field worker trips for rework and follow-up visits, which also generates minor cost savings for fuel and incidentals.

Business growth. Interviewed customers leveraged HoloLens 2 to improve customer experiences, enhance capacity, and bolster sales.

- **AEC firms increased revenue by up to 5% with mixed reality.** MR boosted sales by increasing productivity and reducing downtime through accelerating project timelines and enhancing work capacity. Firms increased customer interest and buy-in by using mixed reality to visualize plans and positioning themselves as experts that leverage leading-edge technology. MR accelerated customer deployments and enhanced support, boosting CX and therefore retention and enrichment. MR also strengthened brand image to recruit prospects and assisted salespeople in closing deals.

- **A construction and engineering company used HoloLens 2 to enable sales by gaining buy-in with customers.** The VP of design and engineering shared: "We're seeing HoloLens as a good sales tool. It visualizes plans for people that aren't tech-savvy. It also reduces the costs of projects. Mixed reality has definitely translated into more work. I can't think of any client that we've utilized the HoloLens with that we've lost
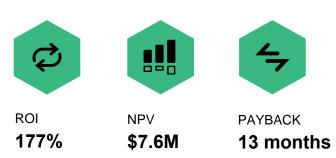
as a client. We only gained opportunities and ended up doing more and more work with them."

TOTAL ECONOMIC IMPACT RESULTS

Forrester aggregated customer data into a single industry-agnostic composite organization with a representative financial analysis.
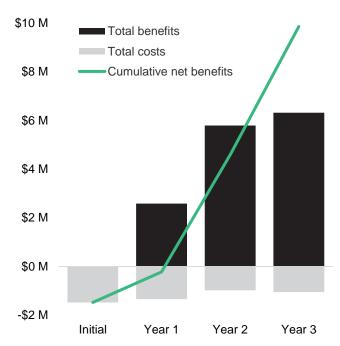
Composite description. The composite organization is a global for-profit business based in North America that sells complex services and supports customers globally. It earns at least $1 billion in total revenue per year and employs more than 5,000 FTEs globally.

Deployment characteristics. A team of nine technologists deploys 105 Microsoft HoloLens 2 with apps for instruction, visualization, and remote collaboration over a one-year period. These devices are used regularly by 200 users and are leveraged to train up to 1,000 additional general workers per year.

ROI	NPV	PAYBACK
177%	**$7.6M**	**13 months**

Results. Forrester's risk-adjusted financial analysis for a composite organization shows a three-year ROI of 177%, an NPV of $7.6 million, and a payback period of 13 months, with $11.9 million in total benefits versus $4.3 million in total costs.

Three-Year, Risk-Adjusted Cash Flows

Legend: Total benefits, Total costs, Cumulative net benefits. Y-axis ranges from -$2 M to $10 M. X-axis: Initial, Year 1, Year 2, Year 3.

Three-Year, Risk-Adjusted Total Benefits, By Category

$11.9 million total benefits

- Business growth 9%
- Training efficiency 17%
- Operational cost savings 25%
- Field task worker productivity 11%
- Travel and incidentals savings 9%
- Task worker productivity 12%
- Specialized expert productivity 13%
- Leader productivity 4%

MORE INFORMATION ABOUT THE TEI STUDY

For more information, download the full study conducted by Forrester Consulting on behalf of Microsoft: "The Total Economic Impact™ Of Mixed Reality Using Microsoft HoloLens 2," November 2021.

DATA COLLECTION FOR THE TEI STUDY

Forrester interviewed 23 decision-makers from 21 organizations representing diverse roles, industries, and regions that have deployed a range of mixed reality applications via Microsoft HoloLens 2 devices:

- Off-the-shelf applications from Microsoft, including Dynamics 365 Remote Assist and Guides.

- Off-the-shelf applications offered by partner ISVs.

- Custom-built or highly customized applications built by partner systems integrators (SIs).

- Custom-built applications by internal teams.

Forrester also interviewed leaders from 13 ISVs and eight SIs that offer mixed reality solutions for HoloLens 2, along with Microsoft stakeholders representing HoloLens 2, Azure, and Dynamics 365. Forrester enhanced and validated the analysis using analyst expertise, Forrester research, third-party research, and public market data.

Data Demographics

Interviews conducted by Forrester:

- Interviews with 23 decision-makers from 21 organizations using Microsoft HoloLens 2
- Interviews with 13 leaders from mixed reality ISVs and eight leaders from mixed reality SIs

Primary industries:

- Manufacturing
- Architecture, engineering, and construction
- Healthcare
- Education

Organization sizes:
Enterprises with between $500 million and $100 billion in annual revenue

Regions:
Organizations with global operations based in North America, Europe, and Asia

Mixed reality deployment size:
Deployments ranged from five to 400 Microsoft HoloLens 1 and 2 devices, with between 10 and 3,000 mixed reality users

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[1] Total Economic Impact is a methodology developed by Forrester Research that enhances a company's technology decision-making processes and assists vendors in communicating the value proposition of their products and services to clients. The TEI methodology helps companies demonstrate, justify, and realize the tangible value of IT initiatives to both senior management and other key business stakeholders.