New Trends and Technologies Impacting Design Review in AEC

A report on the latest technology trends for the Architecture, Engineering and Construction industry sectors by The Business Advantage Group Ltd.
Executive Summary

The Architecture, Engineering and Construction (AEC) industry is constantly looking for process improvements to better manage potential project delays and costs. These result from project complexity, size, uniqueness, and regulations, as well as the need for virtual team collaboration.

Design reviews are a critical part of this process and present some unique challenges. Key team members are often located in many locations, on diverse computing platforms, and face difficulties working on the entire project at once. It’s also often difficult for all stakeholders—especially owners, developers, and other non-AEC industry professionals—to easily understand design intent or visualize the proposed final solution. As a result, there are usually multiple discussion cycles and proposed design modifications that can delay decisions, push out project timetables, and increase costs.

The solution lies in advanced, scalable technologies that can bring efficiency to the project life cycle and deliver substantial savings in both time and costs.

**In this report, we’ll highlight:**
- Challenges related to the design review within the AEC workflow
- How new technologies are helping to manage these challenges
- Which new technologies are being adopted by leading AEC companies
- The quantifiable benefits brought about by these technologies
- Three use case studies on leading AEC companies

The research findings are based on in-depth telephone interviews with more than 30 AEC professionals (please see background section for more details).

"Let’s just say we used to spend triple the time on a project than we do now... especially the design review part was the most time consuming.” (Sun, Senior Architect, Dalian Jinguang Construction Group Co Ltd, China)

Design Review of Hospital Services in the FULmax CUBE VR system, Fulcro Ltd.
AEC Workflow and Design Review Challenges

Design review is one of the most critical phases of the AEC workflow for ensuring that the final building meets expectations. This consists of both formal design reviews that include the client(s) and almost continuous informal design reviews in which design teams discuss and iterate improvements. 85% of the companies agree with the statement “Design reviews are a time-consuming aspect of the AEC workflow and often result in delays in moving the project forward...”. This is most often due to business challenges, lower workplace efficiency, and the resulting economic, and financial impact.

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<thead>
<tr>
<th>Business Challenges</th>
<th>Workplace Efficiency</th>
<th>Economic Impact</th>
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<tbody>
<tr>
<td>Business challenges related to the AEC design review process result in slow decision-making, leading to time-consuming iterative design improvements.</td>
<td>Technical issues result in lower workplace efficiency. Typical issues cited by AEC professionals include problems related to software, hardware, or both, as well as integration, interoperability, and security limitations.</td>
<td>Most professionals within the AEC space mentioned the need for higher productivity and improved efficiency as important success parameters for design review.</td>
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While design reviews are an essential part of the overall building design workflow, they’re especially critical during the conceptual design phase, followed by the client approval stage, architectural design stage, and bidding for projects and engineering design stages. A typical AEC workflow is shown below, along with key design review intervention points:

- **Increasing Design Team Size and Complexity**
  - The design review happens across all creative stages
  - Typically same 3D model is used across different stages (content density keeps increasing)
  - Rapid iteration is a norm

- **Stage 1**
  - Bidding
  - Requirement gathering

- **Stage 2**
  - Conceptual design or schematic design

- **Stage 3**
  - Architectural design development

- **Stage 4**
  - Technical design development

- **Stage 5**
  - Design approval stage/Construction document

- **Stage 6**
  - Client approval stage

- **Stage 7**
  - Construction stage

- **Stage 8**
  - Sub contracting stage

- **Stage 9**
  - Final design review

50% of AEC companies doing design review at each stage
Trends and Technologies Impacting AEC Design Review

New technologies are making tremendous improvements to the workflow processes, yielding better communication and increased productivity. Companies can now work smarter and save money with new capabilities like enabling collaboration on designs with team members anywhere, conducting design reviews in virtual reality, and rendering complex 3D models faster. The following is a primer on some of the most impactful technologies benefiting the design review process.

GRAPHICS PROCESSING UNIT (GPU)

AEC firms rely on professional GPUs to let their architects, engineers, and designers work effectively with all their CAD software tools. Companies can select from a broad range of desktop and mobile GPUs to match diverse user requirements in their organizations. Unlike gaming GPUs, professional GPUs are tested and certified by leading CAD ISVs and workstation OEMs, so design teams get the best possible experience from their IT investment.

Learn more

GPU-ACCELERATED RENDERING

GPUs are transforming rendering and the entire design process. Combining a high-end workstation with GPU-accelerated physically based rendering and physically based materials enables fast, accurate design iteration on predictable models. Architects and designers can make changes on the fly and quickly iterate on concepts while remaining in the creative flow.

Learn more
**VIRTUAL REALITY (VR)**

VR is revolutionizing AEC workflows with technology that makes it possible to work at scale. VR provides the ability to walk through entire virtual buildings during the design review process, run virtual construction rehearsals, and conduct maintenance and safety training—all in an immersive and collaborative experience. By using professional VR Ready GPUs, companies can be certain users will enjoy unsurpassed performance with the high level of graphics power needed for VR.

> “NVIDIA allowed for better productivity... we now use [VR] to sit down with clients and go through the building, so it provides a quicker and a faster method to signing off design.” (Stephen Yates, Information Technology Director, TP Bennett, UK)

**GRAPHICS VIRTUALIZATION**

With GPU virtualization, engineers, architects, and designers can access the applications they need from anywhere, on any device, while mission-critical designs remain securely in the data center. Users get the same responsive experience in a virtualized environment as they would from a physical workstation, with the added benefit of improved collaboration and version control.

> “NVIDIA Quadro Virtual Data Center Workstation [Quadro vDWS] enables 3D rendering on virtual desktops running in our data center. A lot of standard applications need [NVIDIA virtual GPU technology] for performance, even Windows 10 itself. When you get into using Revit or other high-end design tools, you absolutely need Quadro vDWS. Without it, performance will not be like a local desktop. With Quadro vDWS you can give someone less or more hardware resources based on what they need.” (Leslie Balazs, Technical Analyst, Clark Builders, Canada)
### The Benefits of Adopting New Technologies

Below is a summary of key benefits achieved by AEC companies through the adoption of new technologies:

<table>
<thead>
<tr>
<th>Time and resource optimization</th>
<th>Higher quality output and better comprehension of visualizations</th>
<th>Positive impact on the business</th>
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<tbody>
<tr>
<td>• Faster renderings</td>
<td>• Improved quality of visualization</td>
<td>• Higher client satisfaction</td>
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<tr>
<td>• Faster project delivery (time savings)</td>
<td>• Higher efficiency in the designing and rendering process resulting in improved productivity</td>
<td>through shorter rendering time</td>
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<td>• Workforce mobility</td>
<td>• More accurate comprehension of designs by end clients</td>
<td>• Improved client retention</td>
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<td>through improved quality of visualization</td>
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<td></td>
<td>• Better visualization of client work to share with prospects</td>
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<td>• Repeat client business</td>
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“The whole process, especially the rendering process, got shortened. Before NVIDIA, we needed 2 to 3 days to render big images. Now we can render 4-8 images within one day. The impact is big considering labor cost, electricity bills, and so on.” (Zhan, CEO, Sichuan Chaoyu Group Architect Design Co, China)

“One of the big financial benefits is that we have been able to explore more design options, quicker. We’ve produced more interesting designs which has gotten attention and new inquiries for our design talent.” (Kyle Kernozek, Associate, Bower, Lewis and Thrower, USA)
More specifically, these benefits relate to hardware capabilities, improved efficiency, and BIM related factors. The use of new technologies has been cited by AEC professionals to help manage several risks associated with a typical AEC project lifecycle. These include a combination of intrinsic factors such as higher staff morale as well as extrinsic factors, like being adequately innovative to combat competitive pressures. Here are a few key benefits for the industry:

**More immersive experiences**
Virtual Reality (VR) and Augmented Reality (AR) are specifically helping the AEC design review workflow, taking advantage of the fastest hardware for graphics acceleration and rendering. The result is faster design iteration and real-time (or near real-time) rendering for higher-quality visualization. In addition, with growing adoption of 4K displays for design workflows, working with large BIM models requires even more graphics horsepower to maintain a smooth CAD user experience.

**Improved productivity**
New technologies are having a two-pronged impact on improving productivity and efficiency. First, they’re enabling designers to iterate designs faster, resulting in time savings, reduced labor cost, and shorter project duration. Second, technologies like GPU virtualization drive better collaboration, especially for remote teams collaborating on a shared model, accessed from a secure data center.

**Better management of BIM models**
As more companies are embracing Building Information Modeling (BIM)—and the massive 3D models that come with it—there is a growing need for much higher graphics capability to ensure a smooth design and model-development experience. The use of new technology in BIM simplifies design reviews and introduces time savings and efficiency into the project life-cycle. It reduces re-work, minimizes conflicts, accelerates changes, effectively controls error rates, and increases overall productivity. It also makes it easy to update and retrieve relevant information specific to a model.

“Quadro GPUs makes it significantly easier to manage the use of multiple applications simultaneously to present good design materials.” (Cori Moran, Visualization and Virtual Reality Specialist, SLR Consulting, UK)

“[There are] two main challenges. First, is finding the best way to help clients visualize space and materials through compelling renderings. Second is figuring out what tools will allow us to visualize more quickly, so that we can iterate more and better ideas.” (Chris Hinton, Architect, and Graphic Designer, Lord Aeck Sargent, USA)
Customer Spotlights

Zaha Hadid Architects, United Kingdom

Challenge

In order to convey Zaha Hadid Architect’s design solutions to its clients, stakeholders and the general public, ZHVR Group introduced real-time VR technology starting three years ago. Being able to present the practice’s work to viewers in fully immersive and atmospheric detail and adding interactive components, such as loadable design options, requires the use of game engines running on powerful hardware solutions.

Solution

The application of NVIDIA high spec graphic cards allowed ZHVR Group to advance beyond limitations. NVIDIA GPU products and dedicated VR assets enabled the team to build experiences and run simulations without artistic compromise while maintaining high framerates and GPU acceleration. With the help of NVIDIA, ZHVR Group also introduced real-time VR into the practice’s design workflow - to optimise design evaluation and offer an entirely new, 3D toolkit for their designers.

Impact

Armed with NVIDIA products, ZHVR Group has joined several highly acclaimed exhibitions showing the practice’s work – such as the Danjiang Bridge project - to the public. Such VR experiences have also become the mainstay of the firm’s commercial presentations – reducing decision-making time and enabling clients with a new level of insight and presence. Within the practice’s wide range of international projects, numerous teams are designing with the use of VR - benefitting from the immediacy of the new interface and from the enhancement of the dialogue amongst multinational teams.

“VR is the new digital platform of today in which we want to show – and connect to – our architectural ideas.” (Helmut Kinzler, Senior Associate and Head of ZH VR Group)

3D Rendering of Danjiang Bridge in Taipei, Design and Architecture by Zaha Hadid Architects, Rendering by MIR and VisualArch
**Fulcro Ltd, United Kingdom**

**Challenge**

Fulcro is an innovative, creative engineering team using CAD heavy applications on a daily basis. They wanted to ensure that they had improved graphics capabilities for these applications. Their technicians were experiencing significant loss of productivity over the course of a project due to slow graphics performance each time they manipulated a CAD model on their computer displays.

**Solution**

NVIDIA graphic cards facilitated fast rendering and reduced downtime. It enabled a much higher clarity of graphics, quicker model manipulation when rendering and the ability to do virtual reality (VR) within the construction sector. This helped reduce delays when working with clients by removing misunderstandings of designs compared to when presented in 2D.

**Impact**

Before adopting Quadro, Fulcro technicians experienced a few seconds of delay every time they manipulated a CAD model. Fulcro estimates that each user made 5% time savings, which across the entire organization translated into significant productivity gains.

“People are able to view more of a model at once, giving better visibility of a project complexity and to see the bigger picture. Using a newer graphics card reduces rendering time, increases efficiency, and reduces the stress of our employees because they are not constantly waiting for things.” (Dr. Max Mallia-Parfitt, Director of Applied Technologies, Fulcro Ltd, UK)

![3D Rendering of Dudley College’s Advance II Building, Fulcro Ltd.](image-url)
### Challenge
Clark Builders, partner of the Turner Construction Company, is among the top ten general contractors in Canada and serves the industrial, private and commercial sectors. Clark Builders has been listed on Deloitte’s Best Managed Companies list for the last ten years thus earning Platinum status, as well as being named as one of Aon’s Best Employers. Clark Builders uses Virtual Desktop Infrastructure (VDI) across the organization and wanted to boost the performance of software applications across virtual workstations.

### Solution
Most projects are site based, this means collaboration, connectivity and performance are important when working on projects remotely. Clark Builders invested heavily in NVIDIA Quadro vDWS to manage these requirements. With NVIDIA Quadro vDWS, employees can remotely render 3D models on virtual workstations and experience the same performance as provided by a physical workstation.

### Impact
Virtual GPU technology has made an impact. Clark Builders claim that NVIDIA Quadro vDWS powered workstations are ‘about as fast as you can get’ which means performance and mobility are now very easy to accomplish.

“...NVIDIA Quadro vDWS made our applications run a lot faster. We had our team render a 4K video on a regular low-end virtual machine and it would take about 4 hours. With NVIDIA Quadro vDWS this can now be achieved in 20 minutes.” (Leslie Balazs, Technical Analyst, Clark Builders, Canada)
Background Information

Although sponsored by NVIDIA, the research was conducted and analyzed wholly independently by Business Advantage (BA). BA interviewed design and IT professionals working in a variety of AEC companies in the USA, UK, and China. The goal was to understand the new technology trends driving improved efficiency of large project design reviews. In-depth telephone interviews averaging 60 minutes in duration were held with over 30 AEC design organizations. The discussions focused on the critical challenges they face in design reviews and what they’re doing to address them. The interviews were transcribed, translated to English, and comprehensively analyzed and captured in this report to share key insights and trends. NVIDIA is a strategic player in the AEC industry, not only providing the computer graphics performance needed for 3D CAD design and visualization, but also powering advances in leading-edge technology like VR, photorealistic rendering, and emerging generative design software. They also drive deep learning-enabled video safety monitoring and compliance software and autonomous vehicles on construction sites.

* Please note that the quotes have been edited for brevity and clarity.

Companies which participated in this research:
- Atkins China Ltd, China
- BLT Architects, USA
- China Architectural Design Consulting Company, China
- CITYSCAPE DIGITAL, UK
- Clark Builders, Canada
- Dalian Jinguang Construction Group Co Ltd, China
- DLR Group, USA
- EYP Inc, USA
- Fentress Architects, USA
- Fulcro Ltd, UK
- HGA incorporated, USA
- Jennings Design Associates Ltd, UK
- Kleinfelder Inc, USA
- Kohn Pedersen Fox Associates, UK
- LHB, USA
- Lord Aeck Sargent, USA
- Murphy Surveys, UK
- Perkins+Will, USA
- Platt Byard Dovell White, USA
- PLP Architecture, UK
- Sichuan Chaoyu Group Architect Design Co Ltd, China
- Skidmore, Owings & Merrill LLP, USA
- SLR Consulting Ltd, UK
- SmithGroupJJR, USA
- Stephenson Halliday Ltd, UK
- TP Bennett, UK
- Woods Bagot, UK
- WSP (London), UK
- Yu City Architectural Design Co Ltd, China
- Zaha Hadid Architects, UK