

ACEC

AMERICAN COUNCIL OF ENGINEERING COMPANIES
TECHNOLOGY COMMITTEE

+ EGNYTE

The Future of Data in Engineering

LEVERAGING TECHNOLOGY FOR ENHANCED EFFICIENCY AND INNOVATION



In an era marked by rapid technological advancement and evolving workforce dynamics, the Architecture, Engineering, and Construction (AEC) industry is undergoing a significant transformation. This whitepaper, produced by the American Council of Engineering Companies (ACEC) Technology Committee in collaboration with Egnyte, explores how effective data management serves as a catalyst for technological productivity in engineering firms. It provides a comprehensive overview of current economic conditions, the growing role of data in AEC operations, and the challenges and opportunities associated with data management, including the integration of artificial intelligence and cloud storage solutions. By examining these critical factors, this whitepaper aims to equip engineering firms with the insights needed to leverage data effectively, enhance collaboration, and drive innovation in a competitive landscape.



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Introduction

In an era of unprecedented technological advancement and economic transformation, the Architecture, Engineering, and Construction (AEC) industry stands at a critical juncture. As we navigate record levels of infrastructure spending and peak employment, firms are experiencing a significant shift in how they operate, driven by the power of data and emerging technologies. This whitepaper, a collaborative effort between the American Council of Engineering Companies (ACEC) and Egnyte, explores the pivotal role of data as a catalyst for technological productivity in engineering.

		AI	Big Data	Digital Delivery	Cyber Security	Change Mgmt.	Value drivers:
I	Technology that helps run the firm						Talent Attraction and Retention
II	Technology that delivers projects						New Revenue Streams
III	Technology that solves client problems						Internal Productivity Increased Quality

Figure 1: ACEC Technology Committee Horizon Framework

The AEC industry faces unique challenges and opportunities in today's landscape. While infrastructure investment is at an all-time high, productivity gaps (compared to other sectors) make it difficult to take full advantage of the investment. Simultaneously, changing demands in the labor market are forcing a reshaping of the skill mix within firms, as we see a decline in traditional engineering degrees and a rise in computer science graduates, forcing firms to rethink how they apply their resources.

The need to improve productivity coupled with a changing workforce has afforded firms an opportunity to leverage technology to drive efficiency and innovation. The ACEC Technology Committee, through its work with thousands of firms, has identified three horizons for which technological solutions exist:

- ▶ Technology that helps run the firm
- ▶ Technology that delivers projects
- ▶ Technology that solves client problems

The ACEC Technology Committee Horizon Framework (See Figure 1) has identified several different domains, each with its specific skills and programs, that cut across the horizons and can help increase productivity. While each domain has unique capabilities and benefits, the one underpinning factor is that they all depend on efficient data management.

The increased need for, and dependence on, efficient data management results from data's emerging status as a critical asset. The implications are staggering. Our research reveals

that the average storage used by engineering firms has grown from 0.905 TB in 2018 to 8.375 TB in 2023. This exponential growth reflects the industry's increasing reliance on advanced technologies such as Building Information Modeling (BIM), real-time collaboration tools, and sophisticated simulations, which has created an explosion of data.

As we delve into the current state of the AEC industry, we'll examine how firms leverage data to drive efficiency, enhance decision-making, and foster innovation. We'll explore the adoption of cloud-based platforms, with engineering firms now using cloud solutions like Egnyte, and investigate how these technologies are reshaping workflows and collaboration.

This whitepaper aims to provide AEC professionals with insights into:

- ▶ The economic and business conditions shaping the industry
- ▶ The growing role of data in AEC firm operations
- ▶ Trends, challenges, and opportunities in data management
- ▶ Strategies for leveraging technology to enhance productivity
- ▶ Future projections for data-driven engineering practices

As we stand on the brink of a data-driven revolution in engineering, understanding and harnessing these trends will be crucial for firms aiming to thrive in an increasingly competitive and technologically advanced landscape.

Current Economic and Business Conditions

The AEC industry is experiencing significant growth and transformation, driven by record infrastructure spending, technological advancements, and evolving workforce dynamics. This section provides an overview of the current economic landscape and its implications for AEC firms.

Record Infrastructure Spending and Peak Employment

The AEC industry is currently witnessing unprecedented levels of infrastructure investment. This surge in spending has led to peak employment levels across the sector, fueling growth and intensifying competition for skilled labor. (See Figure 2)

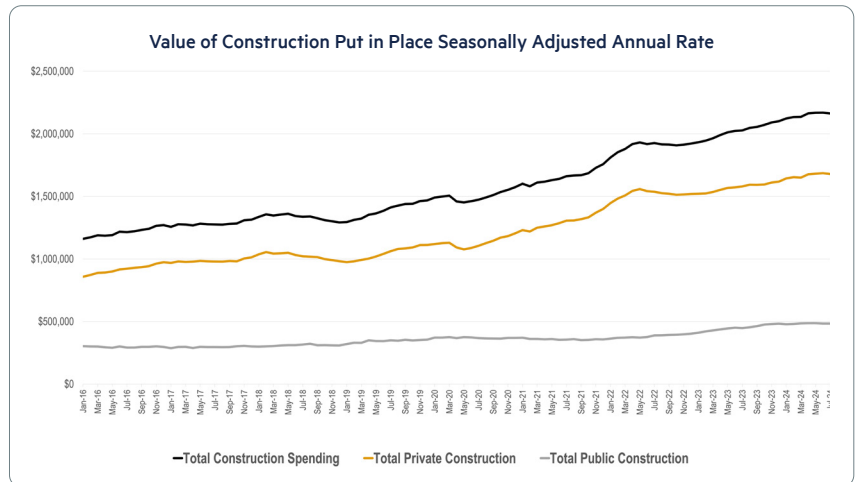


Figure 2: Source: US Census Value of Construction Put-in-Place Survey

Productivity Challenges

Despite the robust growth, the AEC industry faces notable productivity challenges:

- ▶ A significant productivity gap exists between the AEC industry and other sectors.
- ▶ Within the AEC industry, the engineering services sector demonstrates higher productivity than construction but still lags behind other sectors.

(See Figure 3)

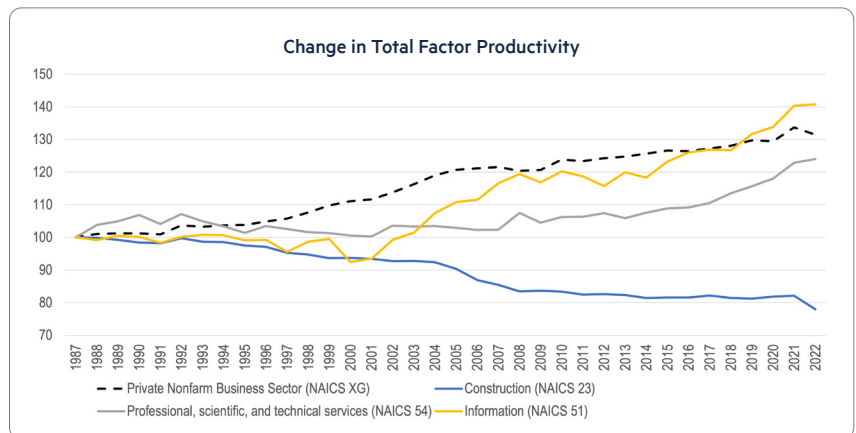


Figure 3: Source: Bureau of Labor Statistics, Major Sector Total Factor Productivity

This productivity disparity underscores the need for AEC firms to leverage technology and innovative practices to enhance efficiency and output.

Labor Market Dynamics

The architecture and engineering (A/E) workforces are undergoing significant changes, which will shape the direction of the industry.

The first is that current employment levels in the industry are reaching capacity, indicating a potential labor shortage. (See Figure 4)

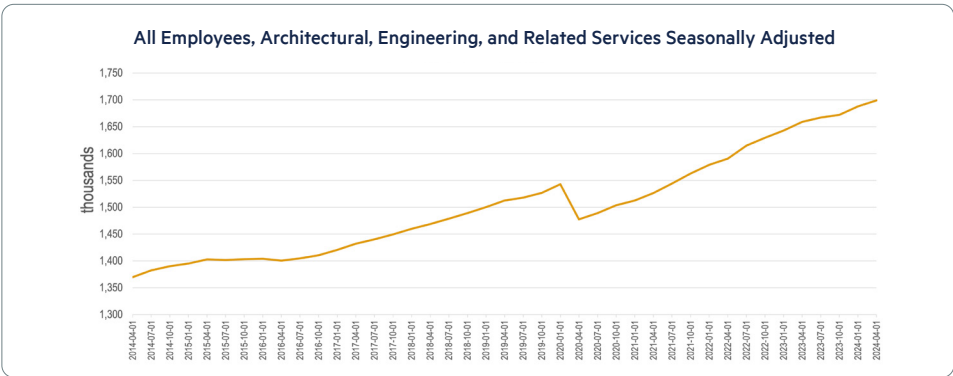


Figure 4: US Bureau of Labor Statistics, Employees on Nonfarm Payrolls by Industry Sector and Selected Industry Detail

The second is that there has been a notable decline in the number of traditional engineering degrees awarded while computer science degrees are rising. (See Figure 5)

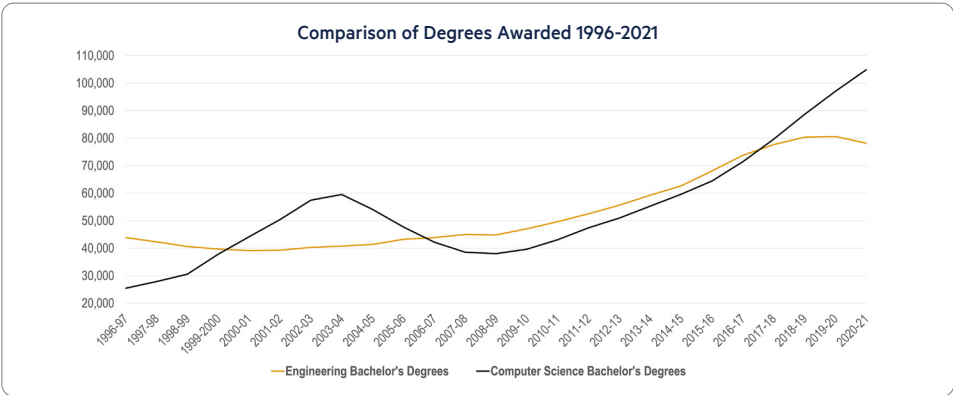


Figure 5: Source: National Center for Education Statistics, Digest of Education Statistics

The result is that A/E firms have been forced to shift by diversifying their workforce. Between 2012 and 2022, the number of unique occupation classifications in A/E firms increased by approximately 11%. (See Figure 6)

This has led to a host of new roles emerging in AEC firms, including:

- ▶ Software Developers
- ▶ Software Quality Assurance Analysts and Testers
- ▶ Data Scientists
- ▶ Web and Digital Interface Designers

This changing dynamic has forced the industry to evolve towards more technology-driven practices, leveraging these new skill sets to adapt to modern project demands.

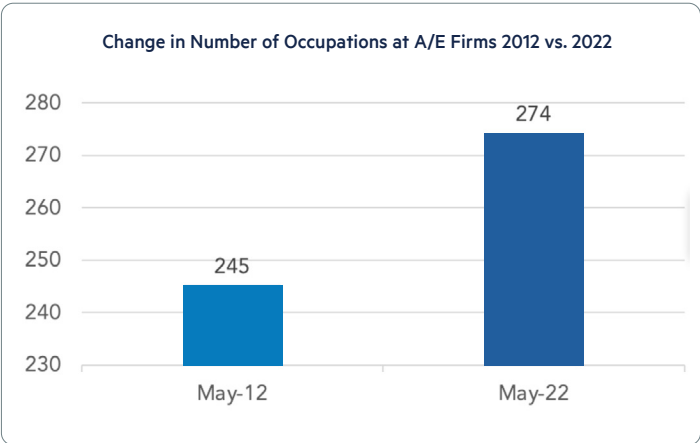


Figure 6: Source: Bureau of Labor Statistics, Occupational Employment and Wage Statistics

Implications for AEC Firms

Given these economic conditions and market trends, AEC firms must:

1. Develop strategies to attract and retain talent in a competitive labor market.
2. Invest in technologies and processes that can boost productivity and efficiency.
3. Adapt to changing skill requirements by upskilling existing employees and hiring for emerging roles.
4. Leverage data and advanced technologies to maintain a competitive edge in a rapidly evolving industry landscape.

By understanding and responding to these economic and business conditions, AEC firms can position themselves for success in an increasingly complex and technology-driven market.



The Growing Role of Data in Firm Operations

As firms look to implement new technologies to bridge the productivity gap, data has become the critical asset driving innovation, efficiency, and competitive advantage as the AEC industry evolves. This section explores the unprecedented growth in engineering data and its implications.

Growth in Engineering Data

The quantity of data generated and used by AEC firms has grown exponentially in recent years, with storage purchases surging from 3.34TB in 2018 to 25.64TB in 2023. (See Figure 7)

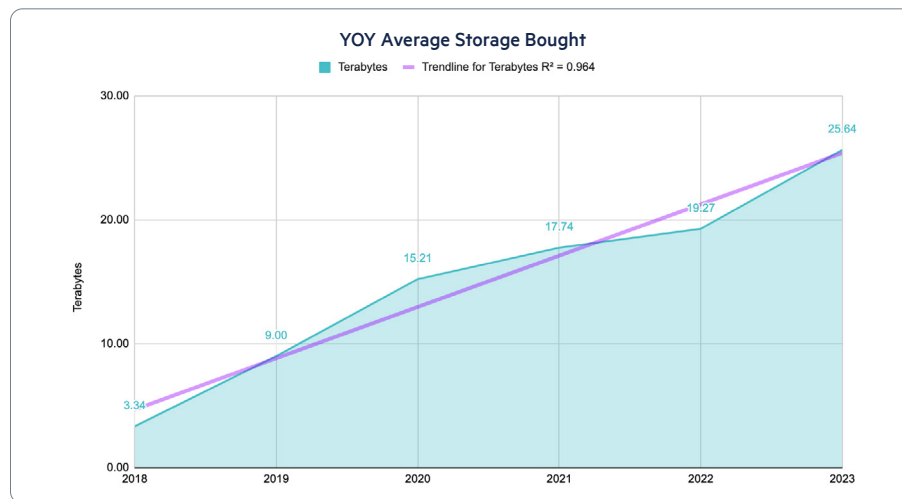


Figure 7: Source: Egnyte's AEC 2024 AEC Data Insights Report

For engineering firms, the average storage used has grown even faster than the AEC industry as a whole, increasing more than eightfold, from 0.905TB in 2018 to 8.375TB in 2023. (See Figure 8) This massive increase in storage is being driven by new data-driven technologies focused on increasing both efficiencies and accuracy, such as:

- ▶ Sophisticated simulations
- ▶ Detailed engineering models
- ▶ Complex data analytics

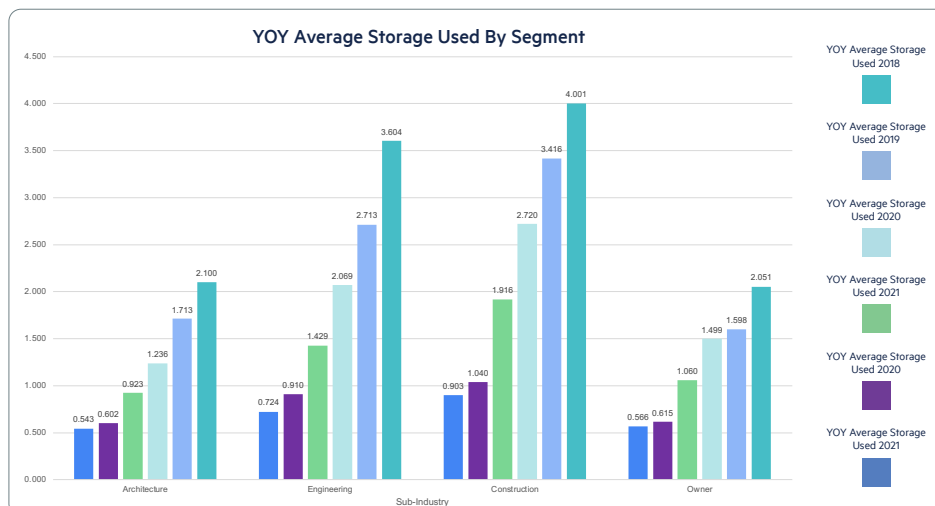


Figure 8: Source: Egnyte's AEC 2024 AEC Data Insights Report



Data Security: Ensuring Safety and Compliance

One downside of the explosion of data in engineering is that it has significantly expanded the cybersecurity threat landscape. This surge has contributed to a marked increase in cybersecurity-related incidents within the industry, ranging from ransomware attacks to insider threats and even human error. According to a 2023 Dodge Data study, **Data Resilience in Design and Construction: How Digital Discipline Builds Stronger Firms**, 59% of firms reported experiencing a cybersecurity threat in the past two years. This growing threat puts pressure on engineering firms in two critical areas: compliance and client trust.

From a compliance standpoint, firms must focus on protecting sensitive data and retaining it for the legally required duration. This necessitates a strategic approach to content lifecycle management and the ability to quickly demonstrate compliance when needed. Additionally, contrary to the assertion by some engineering firms that “we don’t have sensitive data,” the reality is that most firms store thousands of files containing information that their clients and partners consider highly sensitive. Ensuring the protection of this data, both internally and externally, is essential for maintaining client trust.

Implications of Data Growth for AEC Firms

The growing role of data in AEC firm operations necessitates:

1. Investment in scalable and robust storage solutions
2. Adoption of advanced data management techniques
3. Implementation of stringent data security measures
4. Development of strategies to leverage data for improved project outcomes and decision-making

By embracing these data-driven approaches, AEC firms can position themselves at the forefront of industry innovation and efficiency, driving productivity gains and maintaining a competitive edge in an increasingly digital landscape.

Technology Adoptions and Integration

Engineering firms increasingly embrace technological solutions as the AEC industry evolves to enhance productivity, streamline workflows, and maintain a competitive edge. This section explores the current state of technology adoption and its integration into engineering practices.

Current State of Technology Adoption

Based on Egnyte's analysis, engineering firms show a higher level of technology adoption than the other segments in the AEC industry. This is due to several factors: (See Figure 9)

- ▶ 68.58% of Egnyte's engineering customers utilize Egnyte's Map Drive. This underscores their dependence on mapped network drives for more effective file management.
- ▶ Engineers demonstrate a higher affinity for web-based entry points (10.52%), indicating a growing preference for cloud-based platforms and their expanded feature sets compared to the other segments.
- ▶ The use of remote, onsite servers remains significant at 14.35%, demonstrating how engineering firms are beginning to leverage more complex hybrid approaches to data access and storage.

However, engineering firms still have a long way to go. The technologies mentioned above are the “now,” and even those have not seen universal adoption. The next set of technological advancements is right around the corner (and, in some cases, already here). How engineering firms position themselves to take advantage of those technologies will go a long way to ensuring their success.

Key Technological Advancements Reshaping Engineering

Even as most engineering firms are adopting current technologies, several new technological advancements are already transforming engineering practices:

1. Automation and AI Integration

- AI tools take over routine tasks, allowing engineers to focus on complex problem-solving and design activities.

- Predictive analytics forecasts project performance and identifies potential issues early.

2. Advanced Simulation and Digital Twins

- Sophisticated simulation software enhances design accuracy and optimizes project outcomes.
- Digital twins provide real-time modeling capabilities, reducing errors and rework.

3. Cloud-Based Collaboration Platforms

- These platforms enable seamless teamwork, ensuring all stakeholders have real-time access to up-to-date project data.
- They facilitate remote collaboration, which is essential in today's distributed work environments.

It is important to note two things: first, proper data management underpins all of these current and new technologies. Second, none of these new technologies are happening in a vacuum; rather, combining these new and existing technologies is driving the most significant gains in productivity.

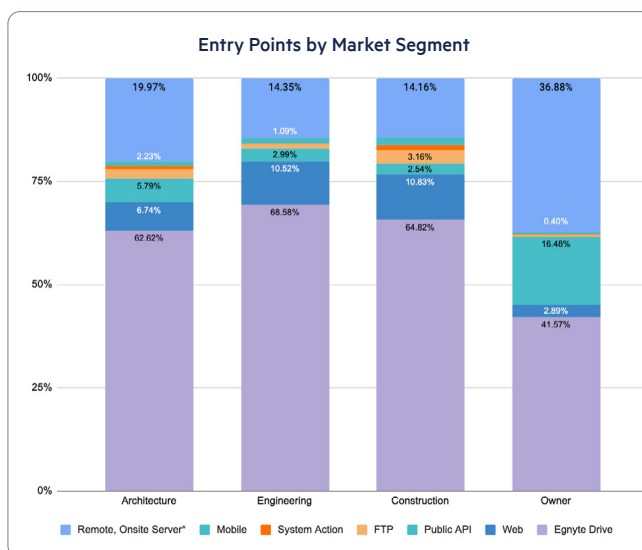


Figure 9: Egnyte's AEC 2024 AEC Data Insights Report, Entry Points by Market Segment

Integrations Driving Efficiency

This makes adopting integrated solutions and integrating existing and new solutions critical for maximizing productivity.

One indicator of how many integrations are being leveraged and how frequently is to look at file syncing. File syncing ensures that the file remains up-to-date and accessible in multiple systems, helping to ensure consistency. When files aren't synced, you tend to have people and information remaining in silos, with either limited or no access to data or, in the case where they do have access, working on older versions. As shown in Figure 10, engineering users are leading in syncing, indicating that 1) they need to work in different systems to accomplish their jobs and 2) they recognize the need to work from a single source of truth and have taken steps to ensure that they do.

Digging a little deeper, it is interesting to look at the types of integrations that Egnyte's AEC customers are leveraging. (See Figure 10)

While the Microsoft Suite is to be expected, the integrations with applications like Bluebeam and DocuSign are of greater importance. These indicate that mission-critical data is now being stored in multiple systems across the organization, a significant shift from several years ago.

As firms continue to embed technologies into their workflows, the need for additional integrations will emerge, and we expect the top ten integrations to shift to include many more industry-specific applications. (See Figure 11)

Strategies for Successful Technology Implementation

Through Egnyte's experience working with thousands of clients, they've identified several key strategies to maximize the benefits of technology adoption:

- 1. Invest in Comprehensive Employee Training**
Successful technology adoption requires significant financial investment, but the return depends heavily on how effectively the solution is utilized. Employees may struggle to leverage new tools without proper training, leading to underutilization and reduced ROI. Comprehensive training programs ensure your team can fully harness the technology's potential.
- 2. Prioritize Scalable, Industry-Specific Solutions**
As disciplines become more technically advanced, firms need solutions tailored to their specific workflows. Generic, off-the-shelf software quickly loses value and can become cumbersome when applied to specialized engineering tasks. Scalable, industry-specific solutions can

evolve with project demands, allowing your firm to grow without frequent and disruptive technology overhauls.

- 3. Foster a Culture of Continuous Innovation**
In a fast-evolving industry, adaptability and innovation are crucial for long-term success. Embracing new technologies, workflows, and skill sets positions firms to keep up with change and drive it. A culture of continuous improvement enables your firm to remain competitive and thrive in the face of industry shifts.

- 4. Implement Robust Data Management and Security Protocols**
Engineering firms handle vast amounts of sensitive data, from project designs and client information to regulatory compliance documents. Protecting this data is critical. By implementing strong data management and security protocols, firms can safeguard intellectual property, build client trust, and ensure compliance with industry regulations.

- 5. Regularly Assess and Update Technology Strategies**
Staying competitive requires more than adopting new technologies; it demands a proactive approach to continuously evaluating and updating your technology strategies. This includes anticipating industry trends, adjusting workflows, and embracing a data-driven approach to decision-making. Regular assessments ensure your technology keeps pace with industry developments and your firm's evolving needs.

By following these strategies, engineering firms can enhance productivity, improve project outcomes, and strengthen their competitive positioning in the ever-changing AEC landscape.

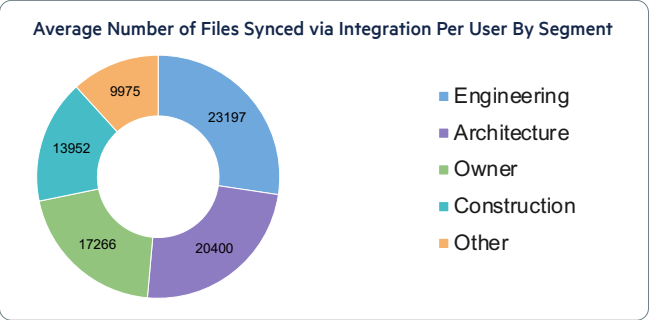


Figure 10: Source: Egnyte's 2024 AEC Data Insights Report

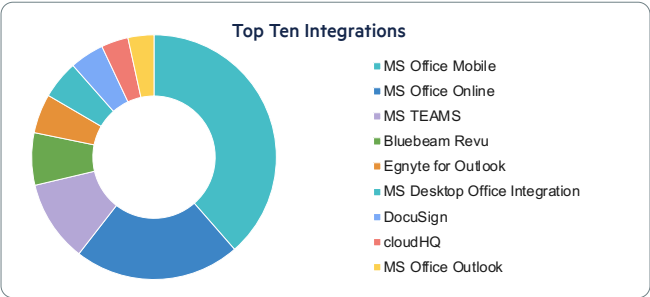


Figure 11: Source: Egnyte's 2024 AEC Data Insights Report

Creating an Intelligent Data Environment

As engineering firms navigate the challenges of increasing data volumes and complex project requirements, creating an intelligent data environment has become crucial for optimizing technology use and driving project success. The following is a condensed checklist on creating such an environment, the benefits for engineering firms, and strategies for successful implementation.

Centralize Engineering Data

One of the key aspects of an intelligent data environment is to centralize all of the engineering data to serve three purposes:

1. **Improve access to information** by enabling quicker retrieval and data sharing across project teams.
2. **Streamline collaboration** by ensuring everyone works from the same data set, which reduces discrepancies and improves decision-making.
3. **Strengthened data security** by leveraging the more robust security features available on a centralized platform, which helps prevent unauthorized access and breaches.

Maintain Data Integrity in Engineering Projects

An intelligent data environment helps maintain data integrity by implementing and enforcing:

1. **Rigorous access controls** ensure that only authorized engineers can modify critical data, helping maintain project information's accuracy and reliability.
2. **Automated data validation processes** help validate data integrity to ensure consistency and prevent errors across projects.
3. **Comprehensive audit trails** that monitor data access and modifications to provide transparency and accountability.

Leverage AI for Advanced Data Analysis

Artificial Intelligence plays a crucial role in extracting actionable insights through:

1. **Identifying patterns and offering predictive insights** to improve project decision-making with AI copilot technologies.
2. **Optimizing engineering processes** by automating routine engineering tasks and optimizing workflows to reduce project timelines and increase overall project efficiency.

Benefits of an Intelligent Data Environment

If implemented properly, an intelligent data environment can significantly improve project efficiency and delivery through:

1. **Streamlined collaboration**, which facilitates seamless data sharing and real-time updates across teams.
2. **Enhanced decision-making** by providing access to accurate, up-to-date information to power informed choices.
3. **Shorter cycle times** through streamlined processes and reduced time spent on data management tasks.
4. **Improved risk management** is due to improved data security and integrity, which reduces project risks.
5. **Greater innovation** by leveraging AI-driven insights to spark new ideas and solutions to engineering challenges.

Five Steps for Successful Implementation

As with all technology implementations, having an organized, well-thought-out approach is critical to success. We recommend you include all of these steps in your plan:

- ▶ **Assess Current Data Infrastructure:** Evaluate existing systems and identify areas for improvement.
- ▶ **Develop a Phased Approach:** Implement changes gradually to minimize disruption.
- ▶ **Invest in Training:** Ensure team members are proficient in using new data management tools.
- ▶ **Establish Data Governance Policies:** Create clear guidelines for data handling and security.
- ▶ **Regularly Review and Optimize:** Continuously assess the effectiveness of the data environment and make necessary adjustments.

By creating an intelligent data environment, engineering firms can harness the full potential of their data, leading to improved project outcomes, increased productivity, and a stronger competitive position in the marketplace.



Future Trends and Projections

As the AEC industry continues to evolve, several key trends are shaping the future of engineering firms and their approach to data management and technology adoption.

Centralized Cloud Platforms as the Core of Data-Driven Engineering

The adoption of centralized cloud platforms within the engineering sector is accelerating, with further growth anticipated in the coming years. Engineering firms are increasingly moving from traditional on-premises solutions to cloud-based systems, driven by the need for enhanced scalability, improved accessibility, and collaborative efficiencies. This shift reflects the broader industry trend towards cloud technology, allowing firms to handle modern engineering projects' complexities and maintain a competitive edge in a rapidly changing landscape.

Advanced Analytics for Predictive Insights and Project Optimization

Big data analytics will become a cornerstone of the engineering practice, enabling firms to derive actionable insights from vast project data. Real-time analytics dashboards will soon be standard, providing project teams with instant access to critical data for monitoring progress, optimizing resources, and making informed decisions. And data-driven decision-making will enhance project outcomes, streamline operations, and solidify analytics as a vital tool for modern engineering.

AI and Machine Learning for Automating and Enhancing Engineering Workflows

AI and machine learning are poised to revolutionize engineering firms' data management and operational

workflows. Predictive analytics powered by AI will enable more accurate project planning and risk assessment, while machine learning algorithms will optimize design and automate routine tasks. Both these advancements will improve project efficiency and precision and reduce time and resource expenditures, leading to a significant competitive advantage.

IoT-Driven Engineering Projects

The integration of IoT devices into engineering projects is set to rise, offering enhanced real-time data collection and monitoring capabilities. By leveraging IoT, firms can make more informed decisions based on live data streams, empowering proactive project management. IoT will also enable predictive maintenance in infrastructure projects, improving efficiency and reducing downtime. As IoT adoption increases, engineering projects will become more data-driven, responsive, and resilient.

Strengthened Cybersecurity Protocols for Safeguarding Engineering Data

As the volume of engineering data grows, so does the need for advanced cybersecurity solutions. Firms are expected to invest heavily in AI-driven threat detection and prevention systems, offering sophisticated and proactive defenses against evolving cyber threats. Strengthening cybersecurity protocols will be critical for protecting sensitive project data and maintaining client trust as digital-first operations become the norm across the industry.

Virtual and Augmented Reality to Redefine Design and Collaboration

Virtual reality (VR) and augmented reality (AR) technologies are transforming how engineering firms approach design and collaboration. These immersive tools enable stakeholders to experience and interact with designs in real time, enhancing client communication and accelerating decision-making. By facilitating a more intuitive and interactive design review process, VR and AR will improve project efficiency and reduce errors, driving faster and more accurate project delivery.

Blockchain to Ensure Secure, Transparent Data Exchange

Blockchain technology is poised to transform engineering by providing secure, transparent data sharing among project stakeholders. By enabling tamper-proof records and streamlining contract management, blockchain enhances trust, reduces disputes, and improves collaboration across the project lifecycle.

Sustainable Engineering Through Data-Driven Technologies

Sustainability is increasingly becoming a core focus of engineering. Integrating data-driven technologies will be instrumental in optimizing resource use, enhancing energy

efficiency, and minimizing environmental impact. Advanced analytics will enable firms to design more sustainable infrastructure, align with regulatory requirements, and contribute to a greener future, making sustainability an aspiration and an achievable, data-backed reality.

Adapting the Engineering Workforce Toward a Data-Driven Future

The engineering workforce is evolving to meet the demands of a data-centric industry. As AI, data analytics, and digital tools become integral to engineering processes, firms must invest in upskilling and continuous learning for their teams. Professionals with expertise in data science, AI, and digital engineering will be in high demand, and firms that foster these skills within their workforce will be better positioned to drive innovation and deliver superior project outcomes.

Efficient Data Storage Management for High-Volume Engineering Projects

As engineering projects become more data-intensive, efficient storage management will be essential for maintaining productivity. AI and machine learning will be critical in optimizing data storage, automating data lifecycle management, and ensuring that resources are used effectively. By embracing these trends, firms can reduce costs, improve performance, and ensure that their data infrastructure scales with project demands, maintaining a technological edge in a data-driven future.





Conclusion

As the AEC industry navigates an era of unprecedented technological advancement and data proliferation, engineering firms stand at the forefront of a digital revolution. The insights presented in this whitepaper underscore the critical role that effective data management and technology adoption play in driving productivity and maintaining a competitive edge in today's rapidly evolving landscape.

Key takeaways include:

1. 68.58% of Egnyte's engineering firm customers use Egnyte's Map Drive, emphasizing the crucial role of mapped network drives in engineers' daily workflows for effective file management.
2. The growing importance of intelligent data environments, which centralize information, maintain data integrity, and leverage AI for advanced analysis, is reshaping how engineering projects are conceived and executed.
3. Integrating automation, AI, and advanced simulation tools enables engineers to focus on complex problem-solving while enhancing the accuracy and efficiency of design processes.
4. The need for a strategic approach to workforce development, combining upskilling initiatives with targeted hiring of data science and AI specialists, is crucial for firms to capitalize on technological advancements fully.
5. The future of engineering lies in the continued growth of centralized cloud data platforms and the increasing application of AI and machine learning in data management and project optimization.

As we look to the future, the challenges of labor shortages and increasingly complex projects can be effectively addressed by strategically implementing advanced technologies and robust data management practices. There will be winners and losers, and the engineering firms that embrace these technological trends and prioritize data-driven decision-making will be best positioned to thrive.

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