

A&D PLM Action Group Model-Based Systems Engineering Research

Report of Findings

General Availability Edition

Release 1.0

October 2025



Abstract

CIMdata, on behalf of the Aerospace & Defense PLM Action Group (AD PAG), conducted a collaborative research effort with multiple PLM solution providers to gain an understanding of needs and opportunities within the industry on the topic of model-based systems engineering (MBSE). The participants' shared objective was to align perspectives on the topic and have a meaningful impact on the providers' solution strategies and the AD PAG members' implementation roadmaps. CIMdata was responsible for project management and creation of project artifacts. The project used two methods to gather information: subject matter expert (a.k.a. domain expert) interviews and an online survey. The primary information source for analysis and reporting was the set of responses to the web-based survey. These responses represent a broad community and, as answers to a set of closed-ended questions, lend themselves to statistical analysis. The responses to each question are summarized in charts or graphs. The range of survey responses to each question are compared to the interview responses to that question and any significant differences are noted. At the end of the report, summary observations are offered.

Preface

The research reported in this document was commissioned by the Aerospace & Defense PLM Action Group (AD PAG) in collaboration with four PLM solution providers with a passionate commitment to the subject of model-based systems engineering (MBSE). The sponsors of the research are pleased to share these findings with the broader community of PLM professionals. Please note that this report's findings are based on information gathered a year ago. While the situation for some of the topics explored has evolved, the overall results and analysis remain valid and valuable. We encourage you to contact any AD PAG member, the solution provider partners, or CIMdata to share your thoughts on this report and the important topic of MBSE.

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Revision Record

Revision	Date	Description
1.0	October 2025	Initial Release of the <i>A&D PLM Action Group Model-Based Systems Engineering Research – Report of Findings General Availability Edition</i> , which is based on content in Release 1 (December 2024) of the <i>A&D PLM Action Group MBSE Research - Report of Findings</i>

A&D PLM Action Group Model-Based Systems Engineering Research Report

Executive Summary

This report presents the results, analysis, and initial observations from a research effort on the topic of model-based systems engineering (MBSE) conducted by CIMdata on behalf of the Aerospace & Defense PLM Action Group (AD PAG) member companies in collaboration with multiple PLM solution providers. For this research effort, CIMdata and the AD PAG partnered with Ansys, PTC, Siemens Digital Industries Software, and The Reuse Company, all solution providers committed to addressing the MBSE challenges of industrial companies.

The project used two methods to gather information: interviews with MBSE thought leaders and strategists and an online survey. Interviews were conducted by CIMdata with MBSE thought leaders from five communities, including the participating PLM solution providers, key A&D customers nominated by the participating solution providers, the AD PAG member companies, and prominent experts from industry and academia. To broaden the information base CIMdata reached out to prominent solution providers who had declined to sponsor this research, and several of these “providers of interest” agreed to be interviewed.

The second method of information gathering was through a web-based survey targeted toward a broader community of PLM practitioners in industry. The learnings from the interviews were applied to develop the line of inquiry in the web-based survey.

CIMdata conducted a total of 18 in depth interviews: four with the solution provider sponsors, four with the other “providers of interest,” two with key customers recommended by the solution provider sponsors, six with AD PAG members, and two with prominent experts from industry and academia. A total of 83 completed and validated survey responses were received and have been analyzed. The survey was open to all industries but was targeted toward, and most heavily promoted within, A&D; 60% of responses were from that industry. Review of the interviewees’ and survey respondents’ companies and the positions held confirms that the information received is representative of the most influential companies and leading thinkers within the A&D industry.

Significant Findings

The following key findings were derived from analyzing the interview and survey results.

Value Positioning

There is broad agreement across the industry and within the solution provider community that MBSE has risen dramatically in perceived value and importance over the last three to five years. Both communities agree that increasing complexity of products and services, of value chain collaboration, and of control over the lifecycle system engineering process are primary factors responsible for this change.

Most in industry see a strong connection between MBSE and digital engineering. Many in industry also see the Department of Defense's (DoD's) digital engineering strategy as a significant factor elevating the level of interest and investment in digital engineering and MBSE.

Despite a good deal of buzz, SysML 2.0 is not currently considered a factor elevating the level of interest or investment in MBSE. This finding must be tempered in consideration of the standard's newness. It is still too early to evaluate the impact the standard will have over the next three to five years.

Value Footprint Over Time

Industry investment in MBSE is concentrated in the Concept and Development stages. That said, significant examples exist within industry of current MBSE implementations in Production and Support. Interviewees offered the view that it is often more straightforward to define clear business use cases and quantitative return on investment (ROI) metrics in these downstream lifecycle areas.

MBSE solution providers believe their technology and services can be applied much more broadly than industry has deployed them to date.

Readiness Assessment

Broad agreement across industry and within the solution provider community is that MBSE is in its early days, and that the A&D industry is most advanced in applying systems engineering practices in general and in implementing some level of model-based best practices for MBSE.

Complexity of organizational impact and cultural resistance were cited as the most significant inhibitors to MBSE success. Executive commitment is viewed as the most critical success factor. Comments regarding the critical influence of middle management were particularly insightful.

- “Support from top management is a necessary-but-not-sufficient-condition for the successful deployment of MBSE in an organization. However, support from middle-management is crucial. They are responsible for the spreading and establishment of the corporate culture in an organization.”
- “The greatest resistance comes from program managers. Their evaluation by middle management is short term, but the payback from MBSE implementation is long term.”

Lack of data and system model interoperability was also cited as a major inhibitor by a large majority within industry but by a minority of solution providers.

Future Investment

The top “pain points” cited by industry interviewees related to interoperability. The “pain point” most frequently cited by industry survey respondents as a target for near-term investment was ease of use of the MBSE software tools. These results reflect a difference in perspective, where interoperability is more significant to deep experts and ease of use is more significant to a broader user community that includes engineers in other domains and lifecycle phases.

Value expansion opportunities most frequently cited by industry for near-term investment were what-if simulation and analysis, knowledge management and reuse, and product line engineering.

Industry's perspective on MBSE investment is shifting from emphasis on immediate return toward a balance between immediate return and strategic value.

Technology Considerations

Interoperability and data exchange were most frequently cited by industry as the most significant solution capability gaps. Ease of use was the third most frequently cited.

Industry interviewees offered the following general assessment of the current capability of commercial software solutions to meet the industry's requirements for MBSE.

- “Systems lifecycle management (SysLM) is a term coined to cover all perspectives of systems engineering through the full lifecycle for the systems of interest. SysLM solution suites are conceived as monolithic platforms. As such, they are oriented to carry out all the system lifecycle activities within the platform. Consequently, these platforms provide a lot of possibilities for importing information but do not provide any capabilities for exporting the information to other platforms.”
- “Current modeling tools are too complex, and the user experience can and must be improved significantly, even with customizations if necessary.”

The areas of greatest skepticism and concern within industry toward solution providers relate to their commitment to providing integrations with competitors' solutions and their commitment to openness.

Despite calling out significant gaps and concerns, a strong majority within industry indicated that their MBSE solution provider is a good partner, while only a small minority expressed a negative view. A substantial majority within industry consider their solution provider to be a thought leader in MBSE.

Introduction

CIMdata, on behalf of the Aerospace & Defense PLM Action Group (AD PAG), conducted a collaborative research effort with multiple PLM solution providers to gain an understanding of needs and opportunities within the industry on the topic of model-based systems engineering (MBSE). The shared objective of the participants was to align perspectives on the topic and have a meaningful impact on the providers' solution strategies and the AD PAG members' implementation roadmaps. CIMdata was responsible for project management and creation of the project artifacts.

Since its founding in 2014, the CIMdata-administered AD PAG has sponsored research and jointly staffed projects on topics such as Model-Based Definition (MBD), Multiple-View Bill of Materials (Multi-View BOM), PLM Technology Obsolescence Management, Global Collaboration, Model-Based Systems Engineering, and Digital Twin/Digital Thread. The members regularly interact with the principal PLM solution providers in project collaborations and executive-level strategic discussions. Current AD PAG membership includes Airbus, Boeing, Bombardier, Eaton, GE Aerospace, Gulfstream, Moog, Pratt & Whitney, Rolls-Royce, Safran, and Spirit AeroSystems.

In recent years, the AD PAG's leadership has expanded its reach into the PLM solution provider community to engage in collaborative research and dialogue about strategic topics. For this particular research effort, CIMdata and the AD PAG partnered with Ansys, PTC, Siemens, and The Reuse Company, all solution providers committed to addressing the MBSE challenges of industrial companies.

Information Gathering

The project used two methods to gather information: interviews with thought leaders and an online survey.

Interviews

Interviews were conducted by CIMdata with five communities, including the participating PLM solution providers, key A&D customers nominated by the participating solution providers, the AD PAG member companies, and prominent experts from industry and academia. To broaden the information base CIMdata reached out to other prominent solution providers who had declined to sponsor this research, and several of these "providers of interest" agreed to be interviewed.

All interviewees received a written questionnaire prior to the interview and were requested to return a completed copy before the scheduled call. Using this method, the interviewer could focus on asking questions of clarification and requesting additional details.

The planned sequence for the interviews was to query first the solution provider sponsors and the other "providers of interest," then the sponsors' recommended key clients, and lastly the AD PAG members and prominent experts from industry and academia. This sequence was intended to provide a layering of perspectives, giving heaviest weighting to the solution provider sponsors. This planned sequence was generally followed.

Web-Based Survey

The second method of information gathering was through a web-based survey targeted toward a broader community of PLM practitioners in industry. CIMdata developed the survey based on

initial findings from the thought leader interviews and promoted it through their usual channels (i.e., a press release, webinars, social media site posts and advertising, targeted emailings, etc.). Each research sponsor received a survey that duplicated the CIMdata survey questions for promotion within their communities of contacts using their own internal processes and methods. This was to help increase the number of industrial responses and ensure the data and results would be representative of the overall population of interest to the sponsors.

The learnings from the interviews were applied to develop the line of inquiry in the web-based survey. The line of questioning was similar, but whereas the interview questionnaire was open-ended, the web-based survey questions were converted to a closed-ended format with pick lists. The pick list choices were derived primarily from the interview responses. Though the richness of inquiry achieved in the interviews could not be replicated in the web-based survey, the survey provided a means to harvest useful insights into the current state and future trends across a broader industrial community.

Analysis and Reporting

The primary information source for analysis and reporting was the set of responses to the web-based survey. These responses represent a broad community and, as answers to a set of closed-ended questions, lend themselves to statistical analysis.

In this *Report of Findings*, the responses to each survey question are summarized and presented in charts or graphs. The range of survey responses to each question is compared to the interview responses to that question. Any significant differences and additional insights from the interviews are noted. Throughout this report, CIMdata provides commentary, and at the end of the report CIMdata offers summary observations for consideration.

Respondents' Demographics

This section presents a characterization of those who were interviewed and those who responded to the web-based survey. The pool of survey respondents is analyzed along several dimensions, including their position title and company's industry, position within the industry ecosystem, geography, and revenue.

Interviews

CIMdata conducted a total of 18 in-depth interviews:

- Four with solution provider sponsors – Ansys, PTC, Siemens, and The Reuse Company
- Four with providers of interest – Dassault Systèmes, HCLTech, IBM, and Tata Consultancy Services
- Two with key customers recommended by the solution provider sponsors – BAE Systems and Indra Sistemas
- Six with AD PAG members – Airbus, Boeing, GE Aerosystems, Gulfstream, Safran, and Spirit AeroSystems
- Two with prominent experts from industry and academia – Charles Wasson, INCOSE Fellow and Certified ESEP, Founder and Principal Consultant, Wasson Strategics, LLC and Claudio Zuccaro, Professor for Systems Engineering, University of Applied Sciences Munich

The eight industrial companies interviewed included six of the Top 20 and four of the Top 10 companies in the global A&D industry.

All interviewees completed a detailed questionnaire in advance, and all interviews were of high quality. Several interviews involved multiple subject matter experts (SMEs, or domain experts). The participants were very open during the discussion and provided valuable insights regarding the current state and future of MBSE from their personal experiences and from the perspective of their current roles. Many were also able to share more general views of the status and goals of companies across the industry who are investing in MBSE solutions.

Web-Based Survey

A total of 83 completed and validated web-based survey responses were received and analyzed.

The survey was intentionally designed to be a challenge for the respondent. Answering the questions required a deep understanding of the current state and investment plans for MBSE realization within the respondent’s company. The time required to complete the survey was approximately 30 minutes. Consequently, it is fair to assume that only those with a serious interest in the topic of MBSE would invest the time and effort needed to complete the survey. This hypothesis may be confirmed by reviewing the respondents’ self-selected role titles as shown in Figure 1 and by reviewing the respondents’ job titles, which were determined based on the names and email addresses provided.¹

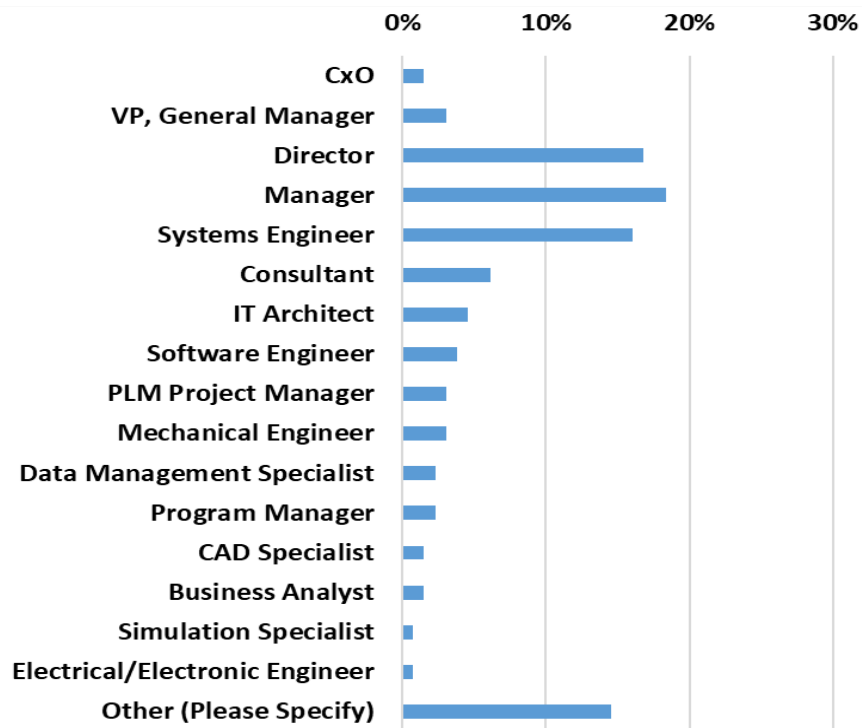


Figure 1 - Survey of Respondents' Role Titles (% of respondents)

¹ A partial list of respondents’ job titles is provided in the Appendix.

While the survey was open to all industries, it was targeted towards and most heavily promoted within A&D. Consequently, 62% of the responses were from that industry, as shown in Figure 2. Another 28% were from similar industries.

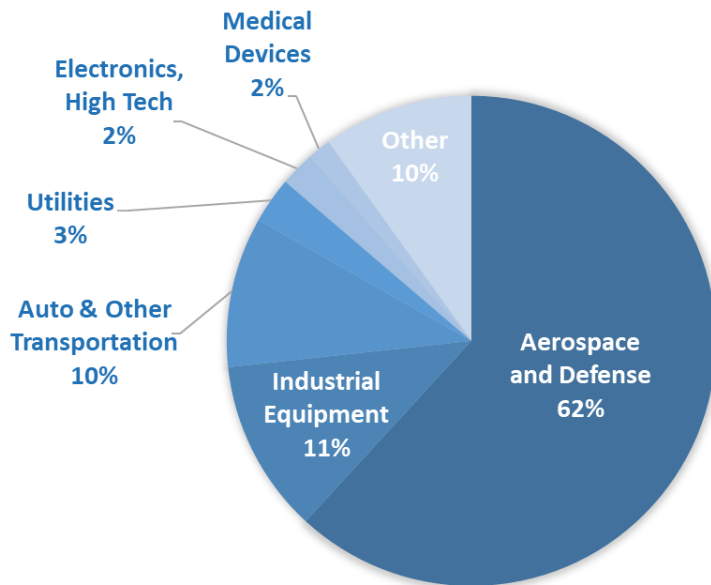


Figure 2 - Distribution of Survey Respondents by Industry

Respondents were also asked where their companies were positioned within their industry’s ecosystem. Results are shown in Figure 3.

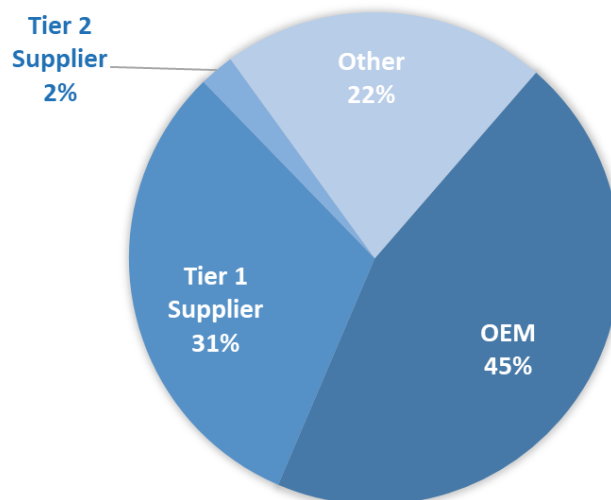


Figure 3 - Respondents’ Companies’ Position Within Their Industry’s Ecosystem (% of respondents)

Respondents were almost exclusively from North America and Europe, and evenly distributed across small, medium, and large revenue enterprises as shown in Figure 4 and Figure 5.

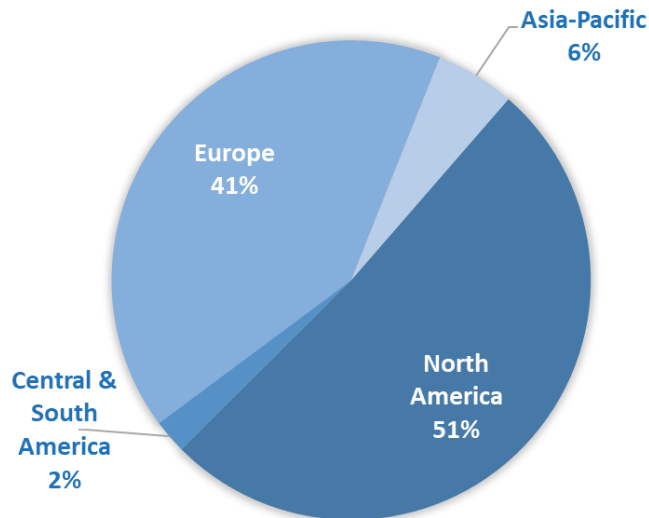


Figure 4 - Distribution of Survey Respondents by Geographic Region

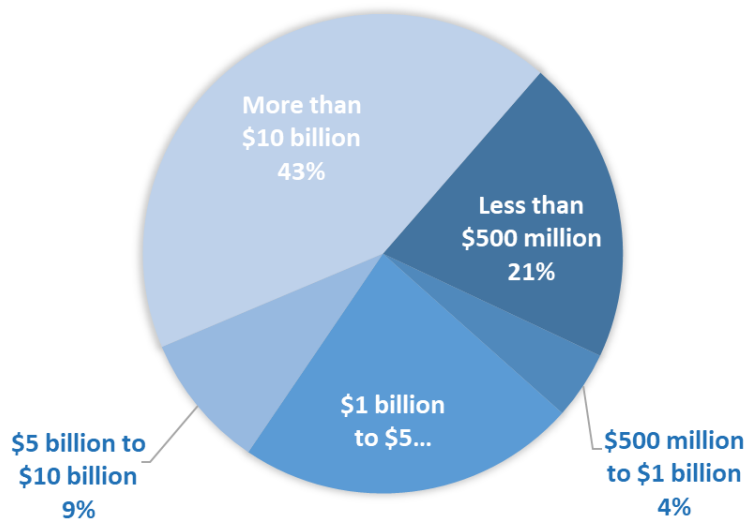


Figure 5 - Distribution of Survey Respondents by Company Revenue

Value Positioning

This section explores how MBSE is perceived and valued within industry.

Interviews

Each interview began with the question, “What is your definition of the MBSE?” The INCOSE definition was prominent in responses from both industry and solution provider thought leaders as shown in Figure 6.

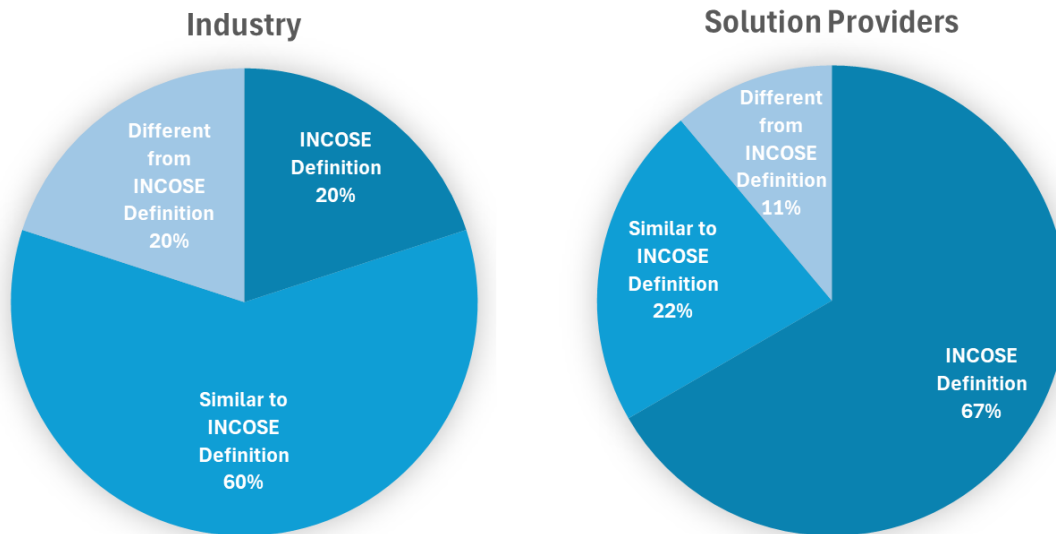


Figure 6 - Prevalence of References to INCOSE’s MBSE Definition by Industry and Solution Provider Interviewees (% of interviewees)

Nearly all solution providers accept INCOSE’s definition of MBSE. While widely accepted within industry, some thought leaders criticized INCOSE’s definition as being too vague and overemphasizing models without proper linkage to systems engineering fundamentals.

All interviewees agreed that the perception of value and level of investment in MBSE has increased significantly over the past three to five years. When asked why, industry and solution provider thought leaders were in reasonable agreement as shown in Figure 7.



Figure 7 - Changes Over the Last Three to Five Years That Have Elevated the Perception of Value and Level of Investment in MBSE (% of interviewees)

Both groups called out three factors related to “increased complexity” as major drivers. Thought leaders from both communities also called out “software revolutionizing products” as a major driver.

Interestingly, “US DoD digital engineering strategy” was number five for solution providers but failed to break the Top 10 for industry. As can be seen in Figure 12, when a larger community was asked specifically, a significant portion of industry (40%) responded that the DoD’s digital

engineering strategy is a major driver for investment. For interviewees involved in the US defense industry, the DoD digital engineering initiative is a major driver for change. On the other hand, interviewees who were not involved in the US defense industry felt it was not a driver for them. However, they did acknowledge the impact that the DoD is having on the overall awareness and adoption of an MBSE approach in the aerospace industry.

Another factor of current interest—the emerging SysML 2.0 standard—failed to break the Top 10 with either community. However, when interviewees were asked specifically about the significance of SysMLv2.0 and how it is impacting their MBSE solution strategy, both communities characterized it as important. Their responses are shown in Figure 8.

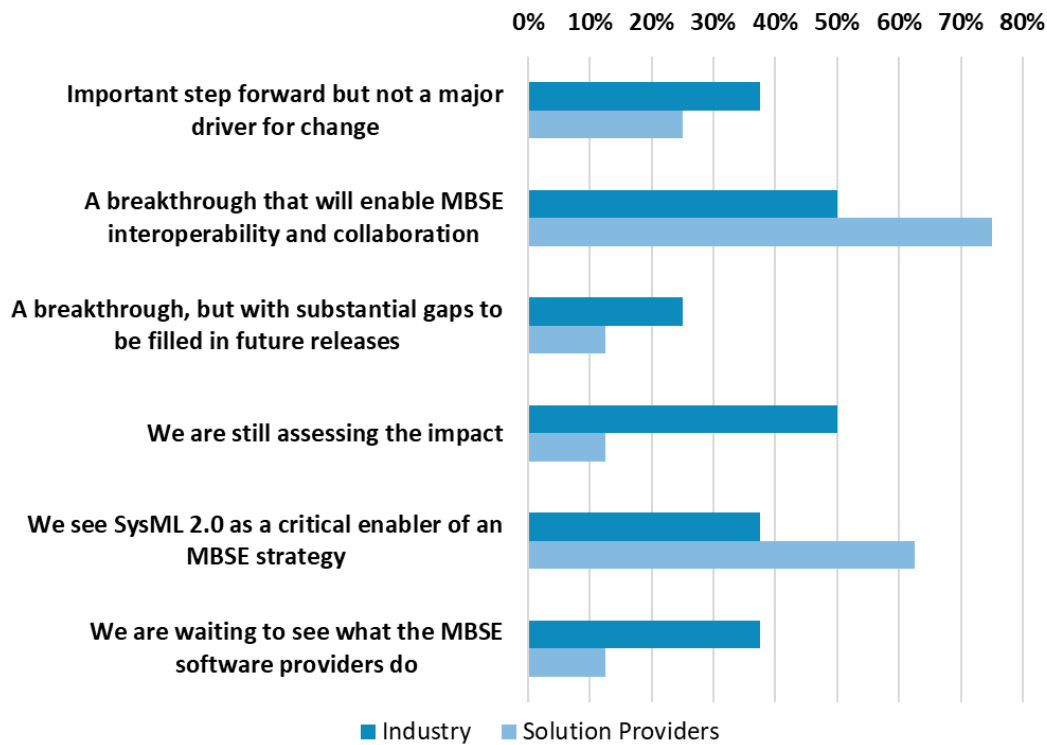


Figure 8 - Perceived Significance of the Emerging SysML 2.0 Standard and Its Impact (% of interviewees)

While solution providers are quite optimistic about the SysML standard’s impact, industrial users have not yet assessed the standard’s full capability and are less sure of the impact it will have. This is mainly because related tools are still under development, and industry needs time to evaluate and implement them.

Web-Based Survey

The first positioning question asked was, “How would you characterize the MBSE vision and strategy within your company?” Results are shown in Figure 9.

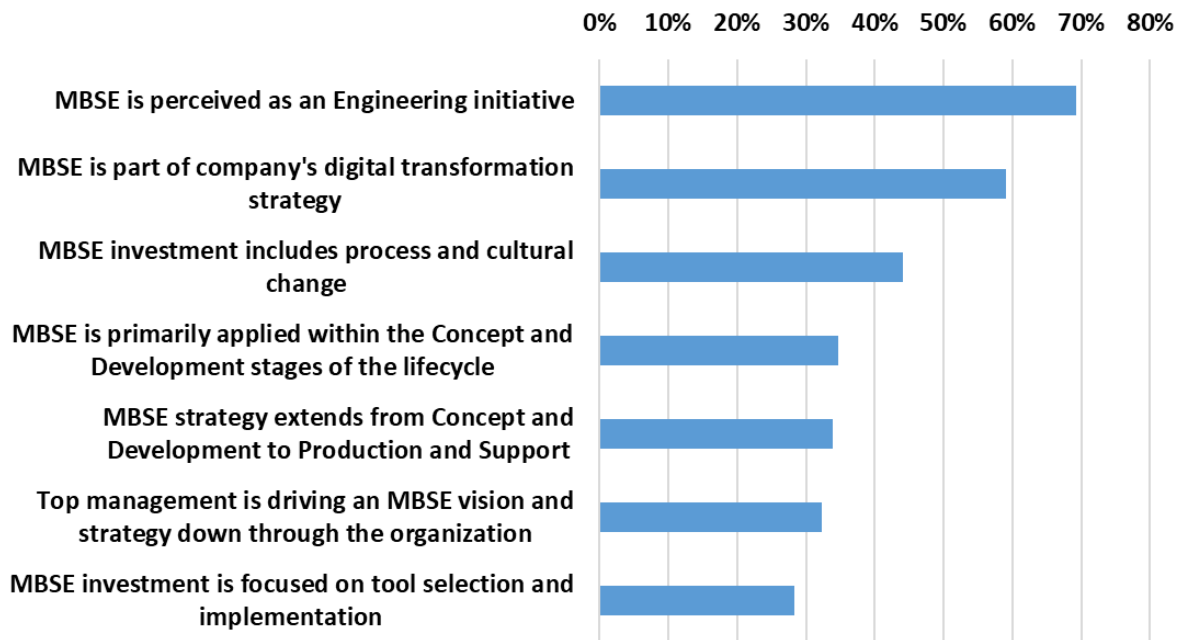


Figure 9 - Characterization of the MBSE Vision and Strategy Within the Respondents’ Companies (% of respondents)

As might be expected, MBSE is seen primarily as an initiative within engineering (i.e., product development). What is significant is the number of respondents who indicated that MBSE is now an integral element of their company’s digital transformation strategy and initiatives. There was generally strong agreement between the personal interview results and the broader set of results from the web-based survey with respect to the relative ranking and percentages for each of the aspects listed.

As noted above, there is broad agreement that MBSE has risen dramatically in prominence over the last three to five years. Respondents were asked what has changed over that period to elevate interest in MBSE within their company. Their selections are shown in Figure 10.

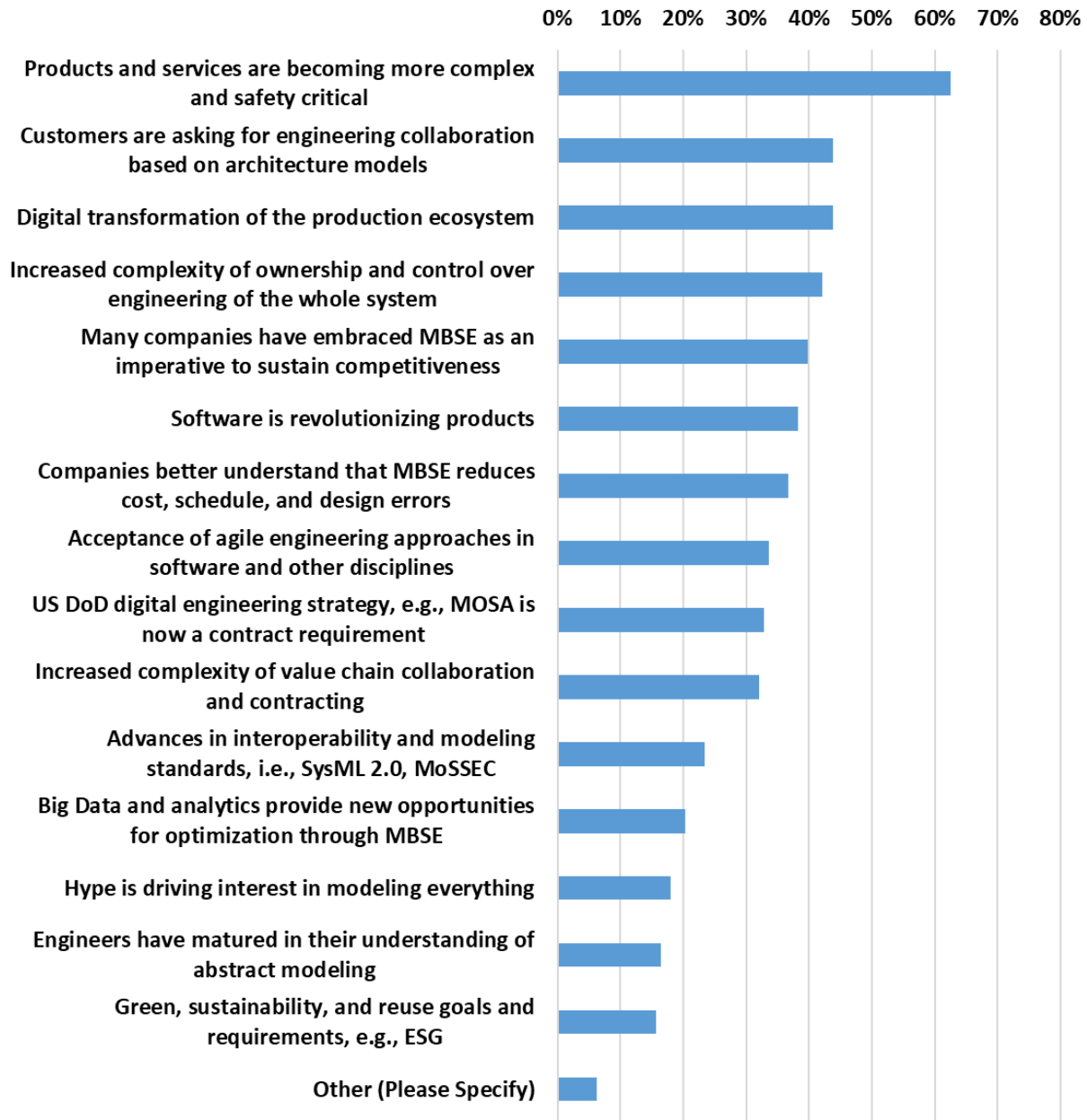


Figure 10 - Changes Over the Last Three to Five Years That Have Elevated Interest in MBSE (% of respondents)

While respondents cited a number of different factors, the two common themes driving increased interest in MBSE are:

1. Increased complexity of products and the value chains for their development, production, and service
2. Customer demands for collaborative participation in product development and, in response, companies embracing MBSE as the means to conform and sustain their competitive position

Respondents were then asked, “What do you see as the relationship between MBSE and PLM?” Their selections are shown in Figure 11.

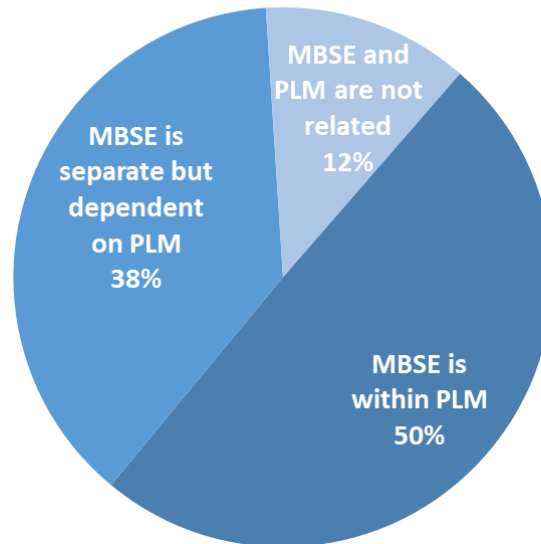


Figure 11 - Perceived Relationship Between MBSE and PLM (% of respondents)

Questions about PLM and where it fits in the landscape of digital engineering, digital transformation, and model-based X (MBx) always generate a mix of responses, which are dependent on the respondents’ backgrounds, experiences, and professional roles. Their perceptions range from equating PLM with commercially available software tools (e.g., Teamcenter, Windchill, 3D Experience) to recognizing PLM as the processes and applications for creation and consumption of product-related data through the product’s lifecycle from concept to retirement. Those perceptions are reflected in the responses to this question.

Next, insight into the impact of two recent events was requested. We asked for each respondent’s assessment of the significance of the DoD’s digital engineering strategy to the A&D industry and how it is impacting their company’s MBSE solution strategy. Results are shown in Figure 12.

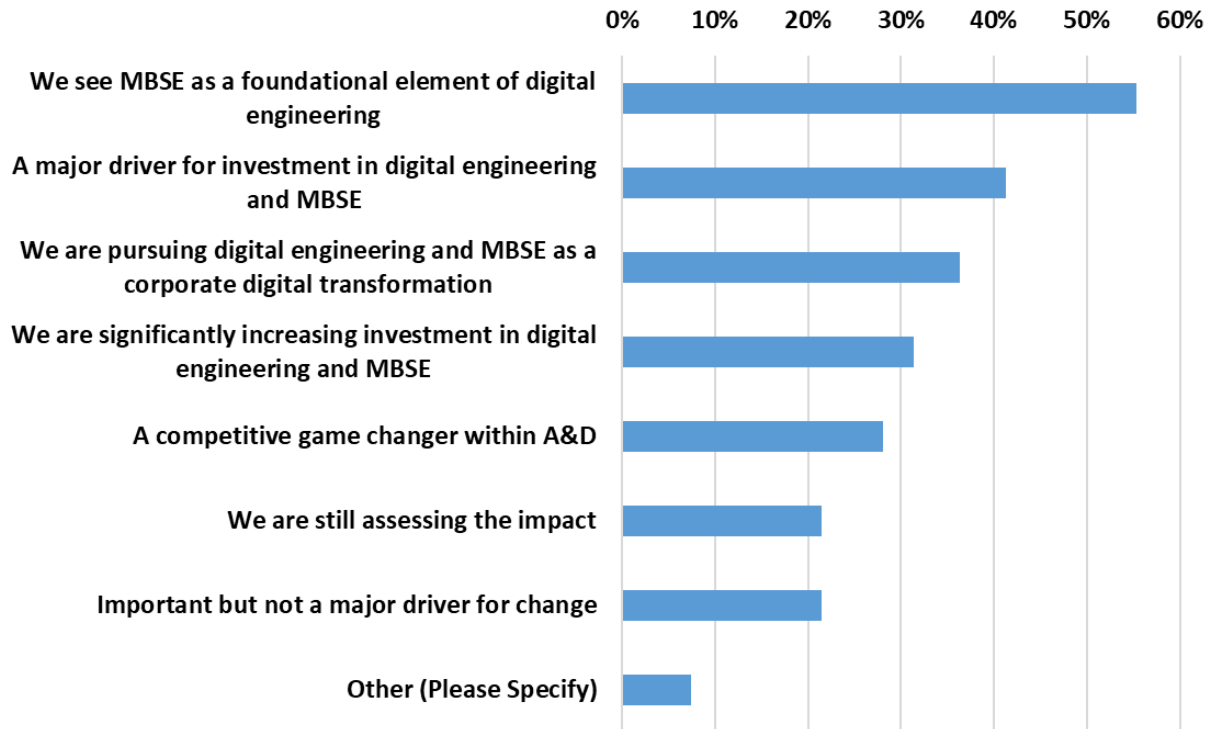


Figure 12 - Significance of the DoD’s Digital Engineering Strategy to the A&D Industry and Its Impact on Respondents’ Companies’ MBSE Solution Strategy (% of respondents)

There is little doubt that the DoD Digital Engineering Initiative driven through their Office of the Under Secretary of Defense for Research and Engineering has had a significant impact on the interest in and adoption of a digital engineering approach and associated model-based processes, such as MBSE and the software tools necessary to implement MBSE. These results are even more striking considering that fewer than a quarter of the respondents are active in the US Defense industry.

A similar question regarding the emerging SysML 2.0 standard was asked. Results are shown in Figure 13.

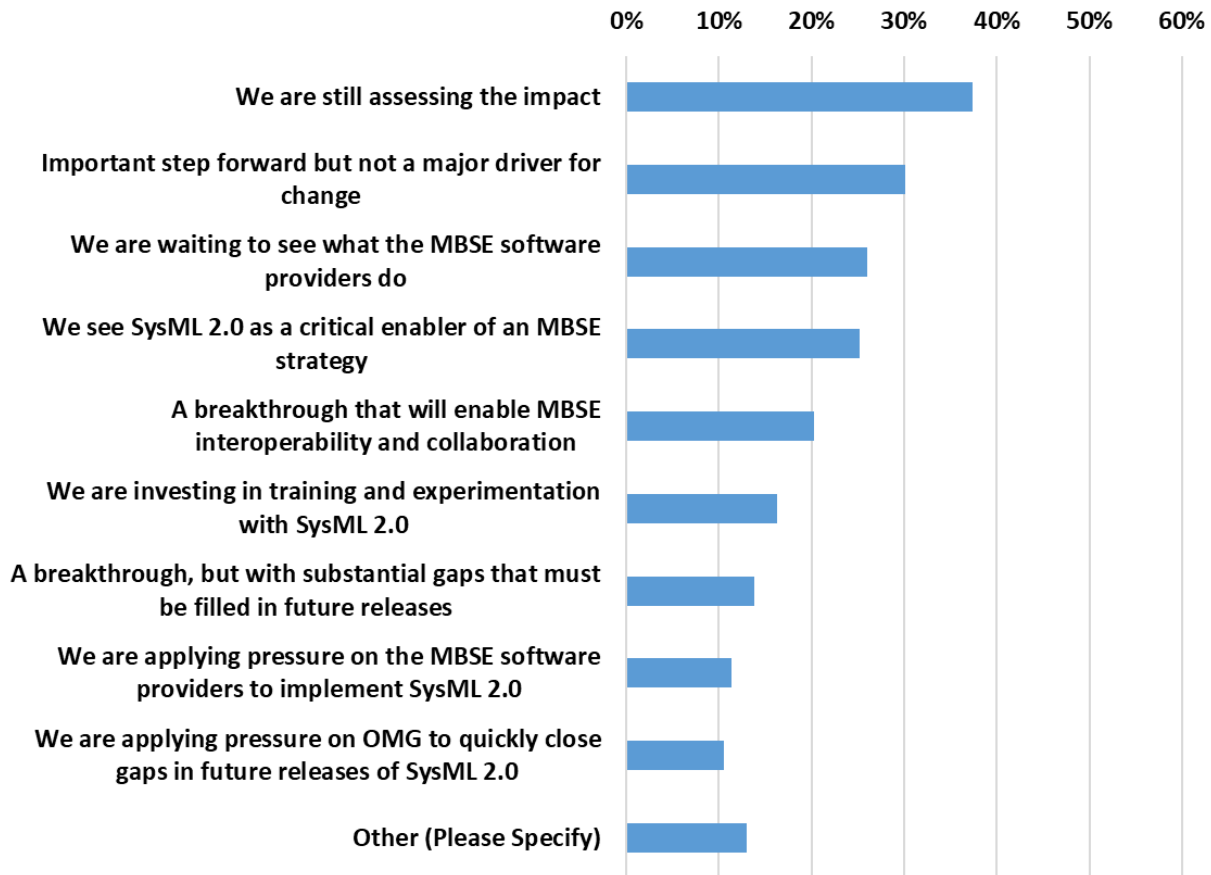


Figure 13 - Significance of the Emerging SysML 2.0 Standard to the A&D Industry and Its Impact on Respondents' Companies' MBSE Solution Strategy (% of respondents)

The responses indicate that the significance and timing of the impact of the emerging SysMLv2.0 standard is still unclear. While there is generally a positive perception and about a third of the community view the new standard as a major step forward from SysMLv.1.x, it is too early in the standard's lifecycle to assess its business impact on the A&D community.

Survey results indicate that some leaders in the industrial user community (~10%) are committed to evaluating and learning to use the new architecture modeling capabilities of SysMLv.2.0.

Finally, investment trends were addressed. Results are shown in Figure 14. Investment in MBSE appears to be healthy and accelerating going forward.

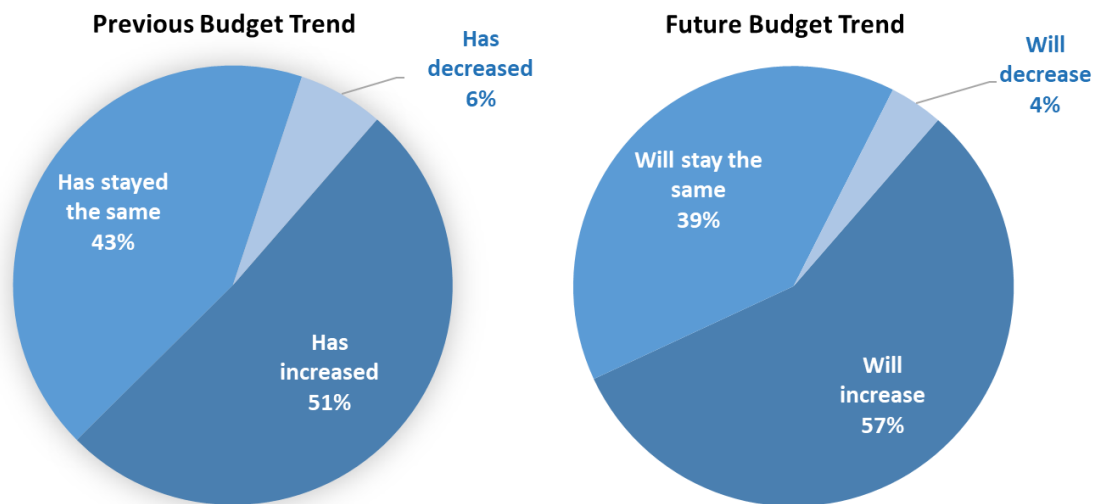


Figure 14 - MBSE Budget Trend Over the Past Two Years and Over the Next Two Years (% of respondents)

Value Footprint Over Time

This section addresses how thought leaders characterize the current value footprint of MBSE within industry and how that footprint will expand over time. The value footprint was explored and characterized in four dimensions: product lifecycle stages, use cases, processes, and data.

Interviews

MBSE is currently implemented across all stages of the product lifecycle, including Concept, Development, Production, Utilization, Support, and Retirement. Industry recognizes the value of MBSE as high during the Concept and Development stages, with growing importance and planned expansion in later stages such as Production, Utilization, and Support.

Solution providers believe their technology and services can be applied much more broadly than industry has deployed them to date. One solution provider commented, “We have seen new MBSE use cases that are now being applied on the industrial system, and more recently on the support/services system. The maturity of these topics is low in the industry, although the tools to perform them are available.”

To reinforce this point, more than one industry thought leader described current implementations in the areas of Production, Utilization, and Support with plans to expand in these areas over the next several years. These interviewees offered the view that it is often more straightforward to define clear business use cases and quantitative return on investment (ROI) metrics in these downstream lifecycle areas, which makes it easier to obtain senior management support and project funding in contrast to early-stage product development where the business benefits are more qualitative and harder to assess and measure in the near term.

Industry and solution providers are reasonably aligned in their opinions of the most promising use cases for MBSE. As shown in Figure 15, thought leaders from both communities include the same four use cases in their top five.

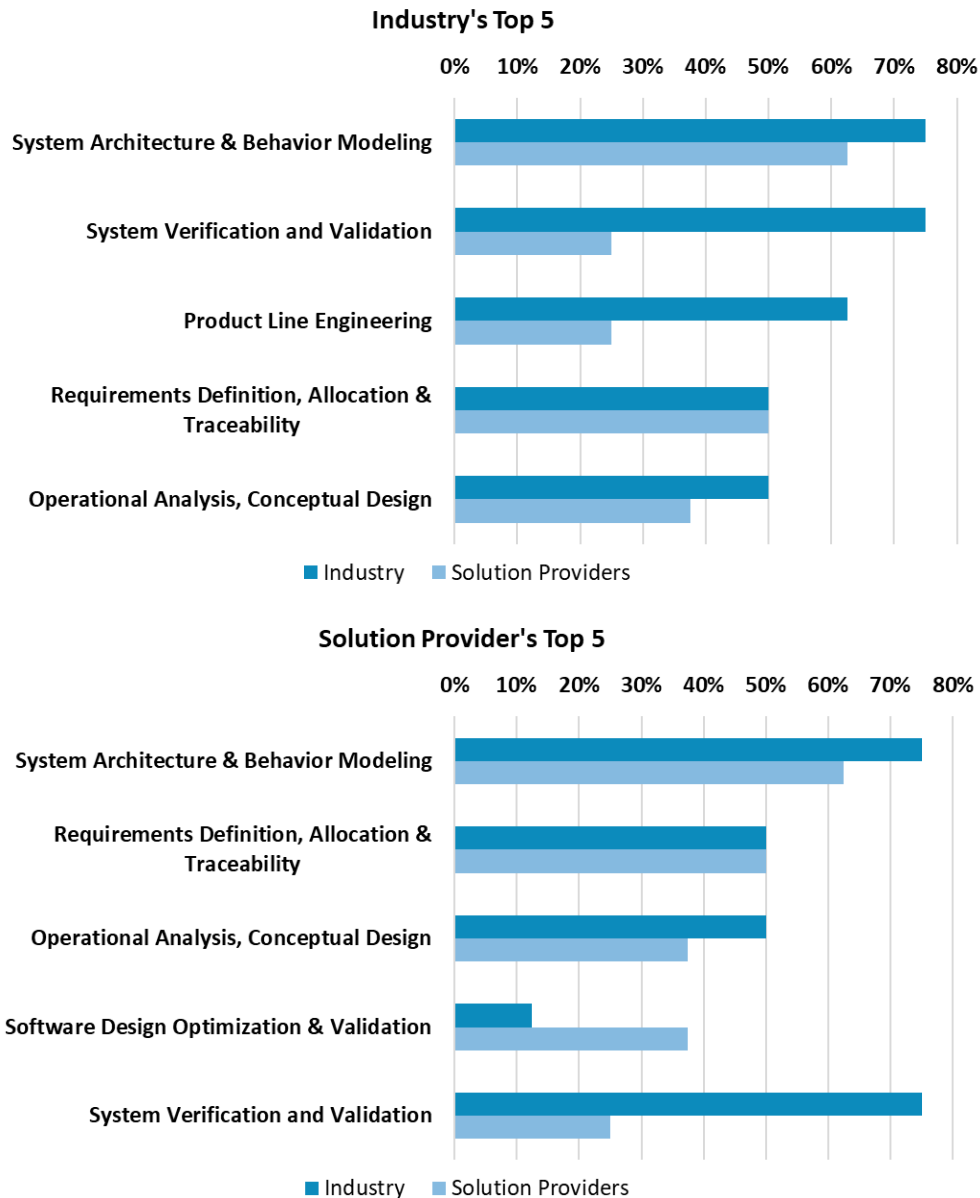


Figure 15 - Top Five Most Promising Use Cases Cited by Industry and Solution Provider Thought Leaders (% of interviewees)

Disparities in ranking are worth noting, in particular the ranking of System Verification and Validation. It is also interesting to note the importance assigned by industry to Product Line Engineering. It will be fascinating to see if the survey results confirm this ranking.

No significant insight was gained from the discussion of process and data scope. Process and data scope of current implementations and future implementation plans followed the same pattern as for product lifecycle stage implementations.

Web-Based Survey

Survey respondents were first asked where in the product lifecycle is MBSE currently implemented in their companies, and how will those MBSE implementations expand within and across lifecycle stages over time. Results are shown in Figure 16.

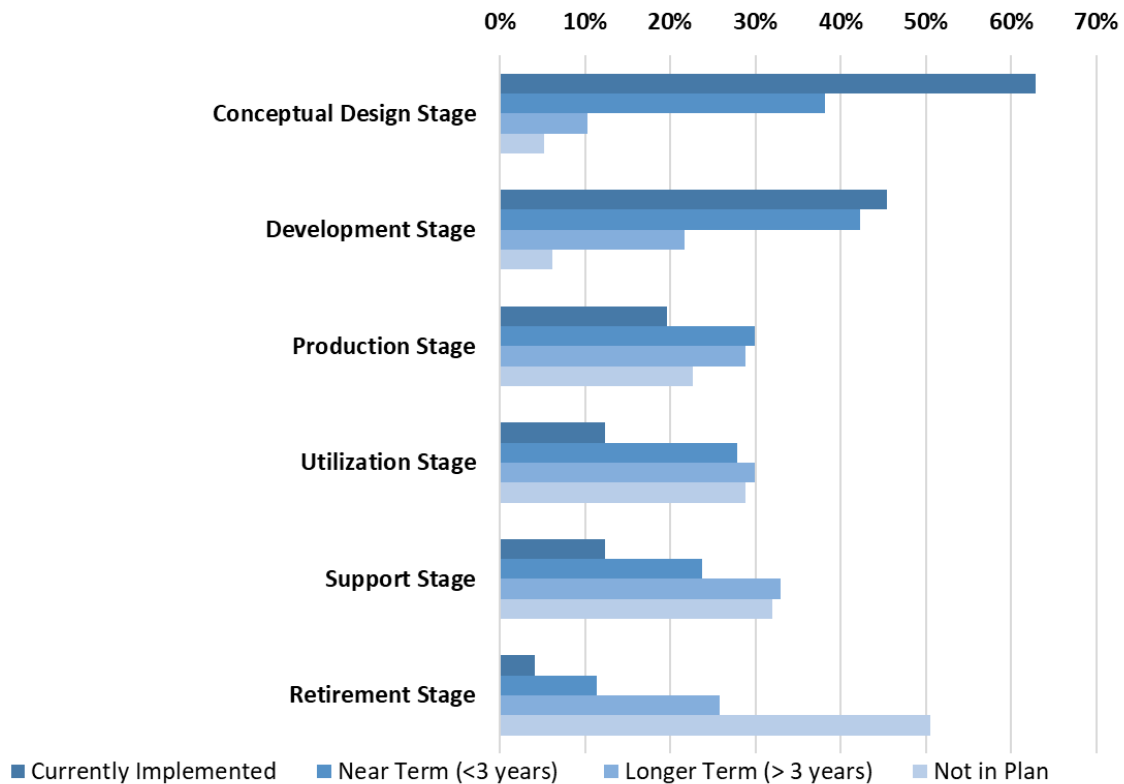


Figure 16 - Prevalence of MBSE Implementations Within Various Lifecycle Stages and Planned Expansion of MBSE Implementations Within and Across Lifecycle Stages Over Time (% of respondents)

The vast majority of MBSE focus and implementation activities today are in the Conceptual Design and Development stages (i.e., the left side of the engineering “V”). This is not surprising since traditional systems engineering is the start of product design and development processes beginning with end user requirements capture, system level product requirements definition, and requirements allocation to the various engineering disciplines involved.

Respondents were asked what they saw as the most promising use cases for MBSE solutions within their companies and how that value portfolio will change over time. Results are shown in Figure 17.

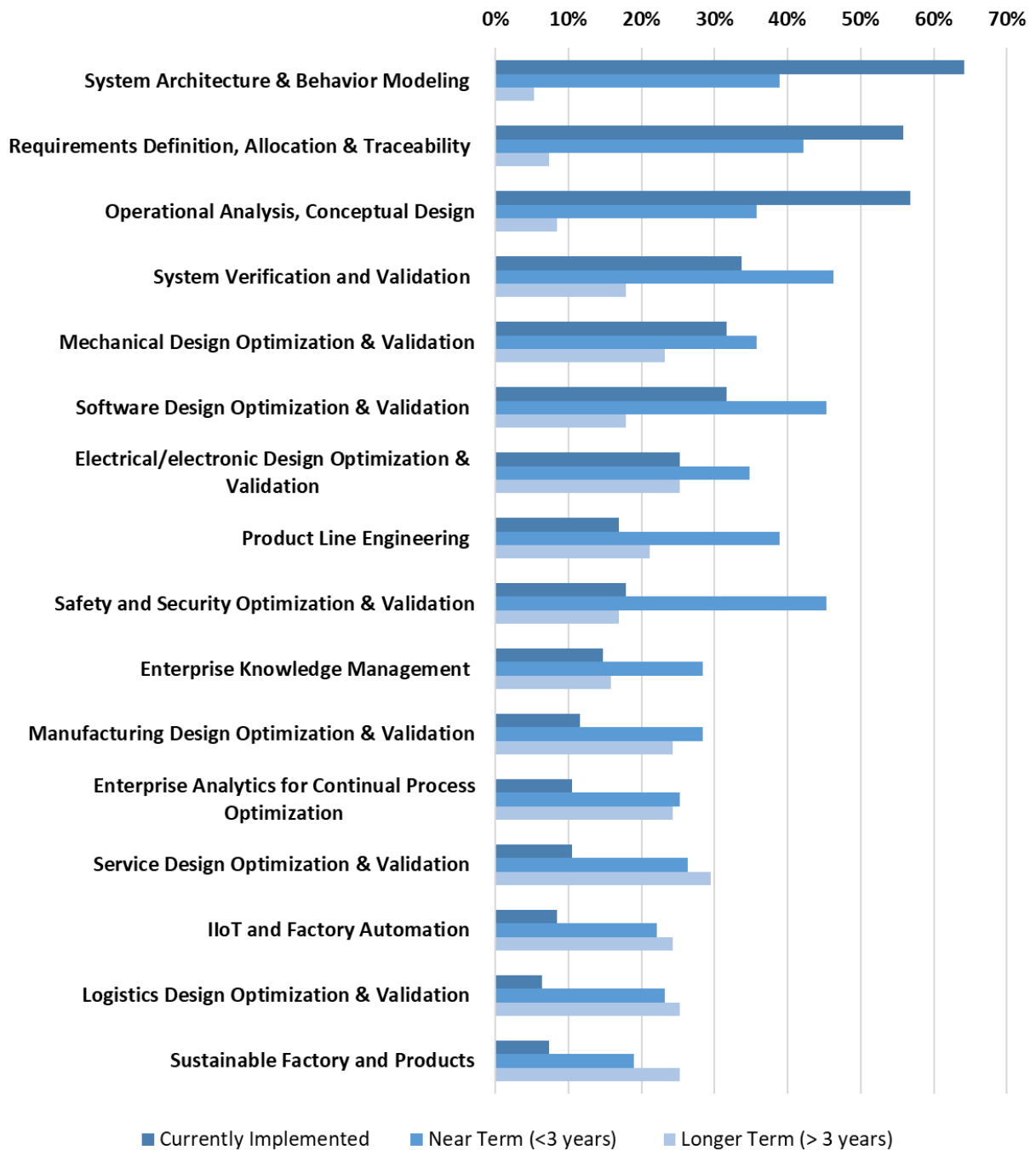


Figure 17 - Prevalence of MBSE Use Case Implementations and Planned Expansion of MBSE Use Case Implementations Over Time (% of respondents)

Consistent with the high-level lifecycle stage responses in the previous survey question, the identification of the most promising current MBSE use cases is heavily weighted towards the

traditional mainstream system engineering activities of requirements definition and allocation, system architecture definition and logical/functional analysis, and design verification and validation.

It is noteworthy that four of the top five use cases from the survey responses match the top five use cases from the industry interviews.

Looking to the future, respondents predict a significant increase in the near term (one to three years) in other emerging and non-traditional systems engineering use cases, such as software design, product line engineering, and design for safety and security. Respondents predict that in the longer term (greater than three years) use cases will emerge more prominently in other enterprise disciplines such as production and factory automation, supply chain and planning, and in-service operations. These results are in line with the emergence of Internet of Things (IoT), Industrial Internet of Things (IIoT), and digital twin technologies that can now be effectively applied in these domains.

Respondents were asked what systems engineering processes are currently supported by MBSE solutions within their companies and how the scope of supported systems engineering processes will change over time. Results are shown in Figure 18.

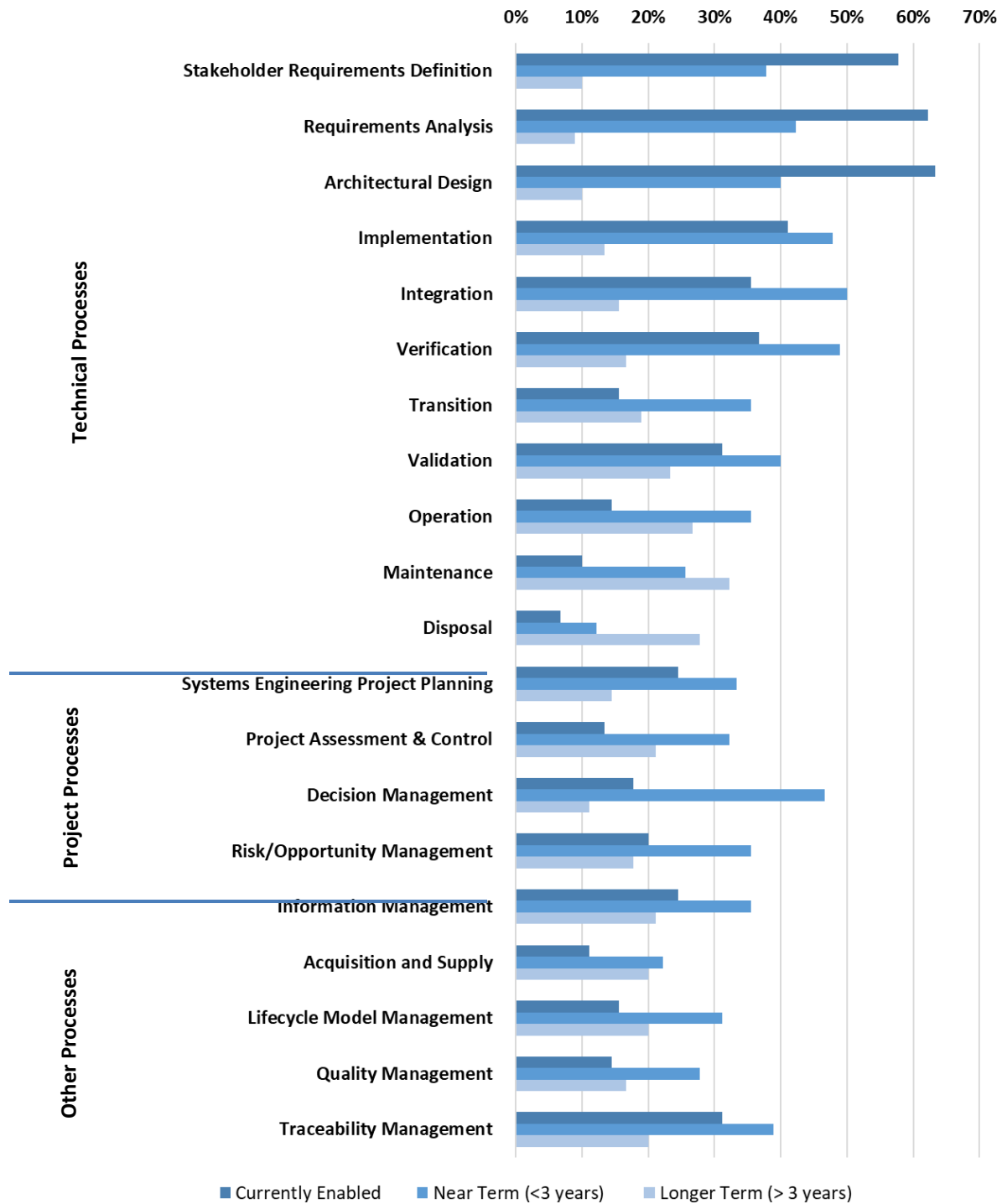


Figure 18 - Prevalence of Systems Engineering Processes Currently Supported by MBSE Implementations and Planned Expansion of Systems Engineering Process Support Over Time (% of respondents)

The results of this survey question are quite broad and difficult to assess due to the nature of the question, which required the respondents to not only indicate what MBSE processes their tools support today but identify what they expect the tools to support in the future. In essence, the respondents are providing a ranked “wish list” of desired future capabilities for their MBSE tool suppliers.

Of note is the significant near-term growth in the following areas:

1. Model integration and verification and validation in the Technical Processes domain
2. Management of systems engineering project processes across the board with particular emphasis on decision management and risk/opportunity management
3. MBSE Information Management across the board with particular emphasis on intellectual property (IP), model traceability, quality, and lifecycle model management

Respondents were asked what product lifecycle data are within the scope of the MBSE solutions within their companies, and how that data scope will expand over time. Results are shown in Figure 19.

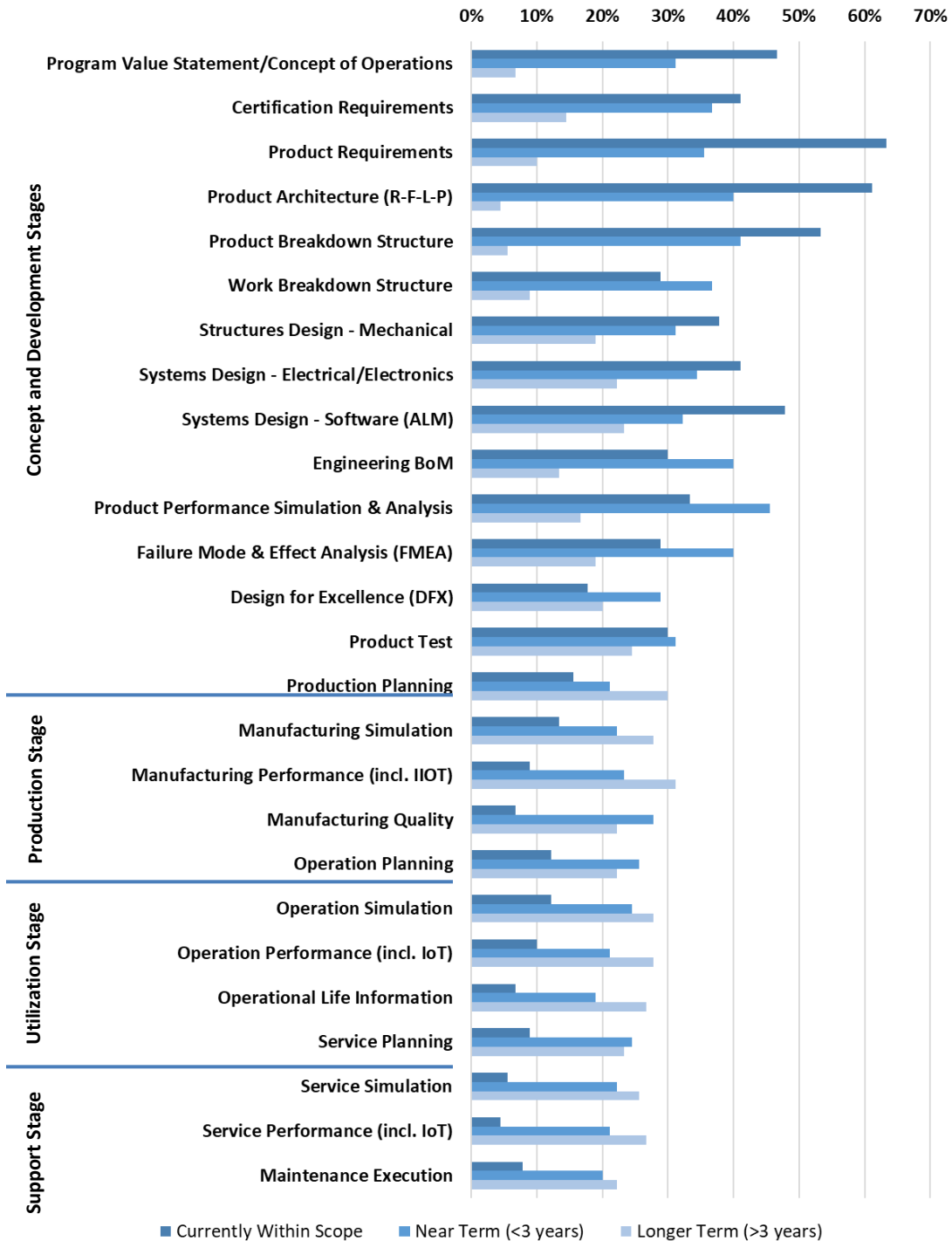


Figure 19 - Prevalence of Product Lifecycle Data Within the Scope of Current MBSE Implementations and Planned Expansion of Product Lifecycle Data Scope Within MBSE Implementations Over Time (% of respondents)

As with the previous question, there is much to consider when looking at the scope of the product data requirements and the predicted growth within each of the application areas. Predicted growth is greatest in the Conceptual Design and Development stages, encompassing a broad range of data categories, the most prominent of which is product performance simulation and analysis (S&A) data.

Consistent with results of an earlier survey question, the respondents are predicting significant long-term growth of MBSE applications in the Production, Utilization, and Support stages

Readiness Assessment

In this section the readiness of industry to successfully define and implement an MBSE vision is considered. Through a series of questions, thought leaders were asked to assess their positioning for successful pursuit of a MBSE strategy.

Interviews

The discussion of maturity within industry was highly subjective. Those interviewed agree that MBSE within industry is generally in its early days, and the A&D industry is the most advanced in application of MBSE. Notable comments offered by those interviewed include the following:

- “MBSE is in its infancy. We all individually feel we are behind but find that everyone is roughly in the same early phase of MBSE adoption and rollout.”
- “The industry, from our perspective, seems to be in transition. Practices are not yet completely adopted, nor standardized.”
- “The maturity of MBSE implementations within the A&D industry is approaching "repeatable." Most companies are half a step behind. Companies who are committed to a platform, commercial or built by themselves, are ahead.”
- “Comparing MBSE [maturity] to [the progression of] CAD (from emergence in the 80s to the fully parametric CAD now), we are in the mid-90s.”

Interviewees were generally reluctant to share use cases due to competition sensitivities. There was even greater reluctance to reveal benefits and metrics. However, some interviewees were forthcoming and offered valuable insights. They shared benefits from currently implemented use cases, including the following:

- Reduction in total engineering costs prior to product release to manufacturing
- Faster time to full-scale production from project initiation
- Improvement in product quality
- Reduction in physical prototype iterations
- Reduction in engineering change orders
- More innovative products/unique product features

Some interviewees shared metrics, including

- # Issues-raised
- # Issues-closed
- Time to resolution

- Improvement in communication
- Improved delivery of projects
- Reduced business risk
- More effective extended enterprise teams
- Team integration and improved mobility

Interviewees hold strong opinions regarding inhibitors to formulation and execution of an MBSE strategy within industry. This is a topic with significant divergence of views between industrial users and solution providers. As can be seen in Figure 20, 75% of industry and solution provider interviewees agree that *complexity of organizational impact and cultural resistance* is a principal inhibitor.

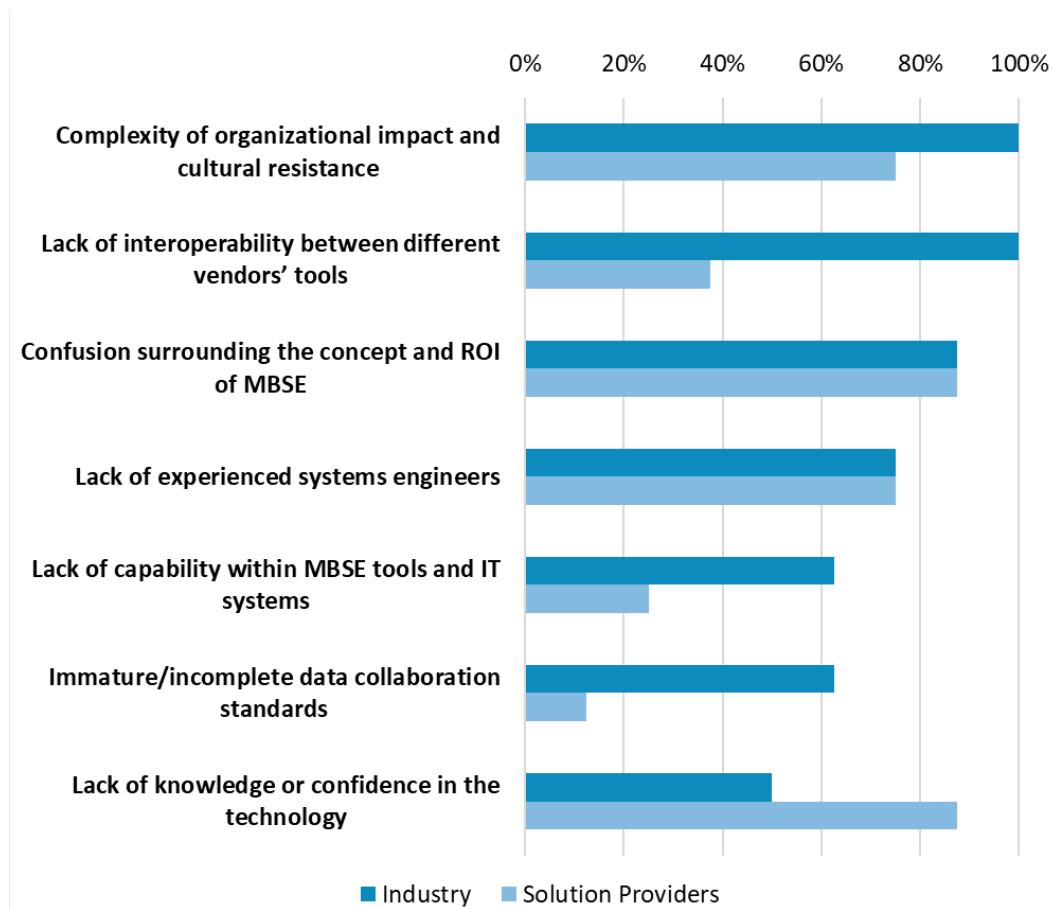


Figure 20 - Principal Inhibitors to Formulating and Executing an MBSE Strategy (% of interviewees)

However, 60% to 100% of industry interviewees consider interoperability, tool capability, and collaboration standards to be principal inhibitors, while only 15% to 40% of solution provider interviewees share their view.

Thought leaders from industry offered the following comments regarding inhibitors to a successful MBSE strategy:

- “The term MBSE has been overloaded and confused in the industry due to the generic nature of the definition. For example, if I consider my legacy spreadsheet of calculations the “model,” then I am doing model-based system engineering. As a result, companies have struggled to measure the ROI on MBSE.”
- “Engineers will not adapt if it is difficult without managers telling them to do it. For that to happen the benefit i.e., ROI must be clear.”
- “Lack of interoperability between different vendors’ tools and collaboration platforms is the Most Significant Inhibitor to executing an MBSE strategy. The appropriate mitigation is to promote the importance and then to demand interoperability.”

When interviewees were asked what critical factors must be in place within a company to ensure successful formulation and execution of an MBSE strategy, industry and solution provider thought leaders were well aligned as shown in Figure 21.

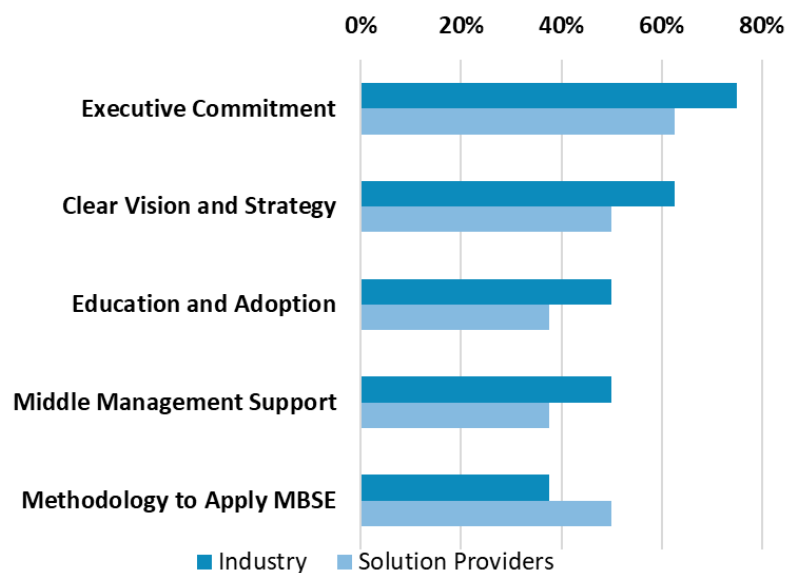


Figure 21 - Top Five Critical Success Factors (% of interviewees)

As is common with most new methodologies and technologies, executive commitment is crucial for the successful adoption of MBSE. Companies need strong leadership from the top down to drive the transition from document-centric to model-based approaches.

Thought leaders from industry offered the following comments regarding the critical influence of middle management:

- “Support from top management is a necessary-but-not-sufficient-condition for the successful deployment of MBSE in an organization. However, support from middle-management is crucial. They are responsible for the spreading and establishment of the corporate culture in an organization.”
- “The greatest resistance comes from program managers. Their evaluation by middle management is short term, but the payback is long term.”

Other critical success factors mentioned by thought leaders included MBSE Expertise, Collaborative IT Infrastructure, Project Governance, Tool Selection, Tool Integration and Standards, and Security Management.

Web-Based Survey

Survey respondents were asked to assess the maturity of the MBSE strategy realization within their companies. Results are shown in Figure 22.

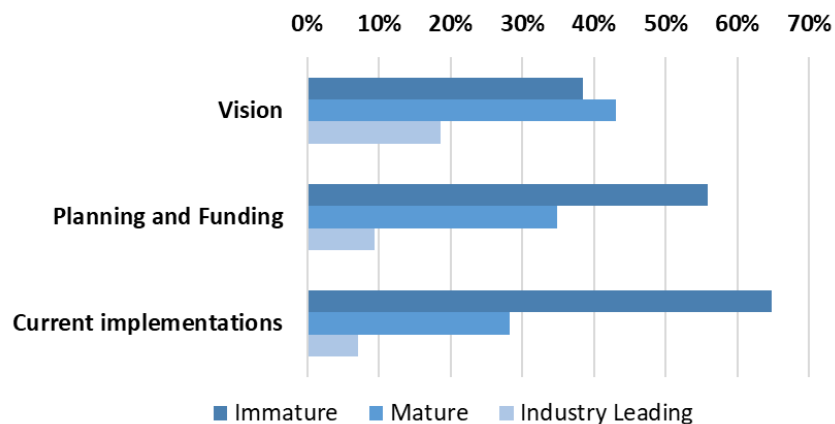


Figure 22 - Self-Assessment of MBSE Maturity Within Respondents' Companies (% of respondents)

Despite the fact that MBSE has emerged as a formally recognized area of desired industry best practice over the past decade, especially within A&D, industry as a whole is still in the early stages of adoption. Implementation maturity varies widely within the major original equipment manufacturers (OEMs), within their supply chain partners, and even from program to program and across divisions and business units within the same OEM.

This assessment aligns with a comment from one of the industry thought leaders interviewed:

- “MBSE is in its infancy. We all individually feel we are behind but find that everyone is roughly in the same early phase of MBSE adoption and rollout.”

A handful of industry leaders are at a reasonably proficient level of maturity on a program-by-program basis, but even those leaders believe a great deal is yet to be done to achieve the required consistent level of MBSE maturity throughout their global organizations.

Respondents were then asked which, if any, expected benefits have been defined to justify the investment in MBSE by their companies. Results are shown in Figure 23.

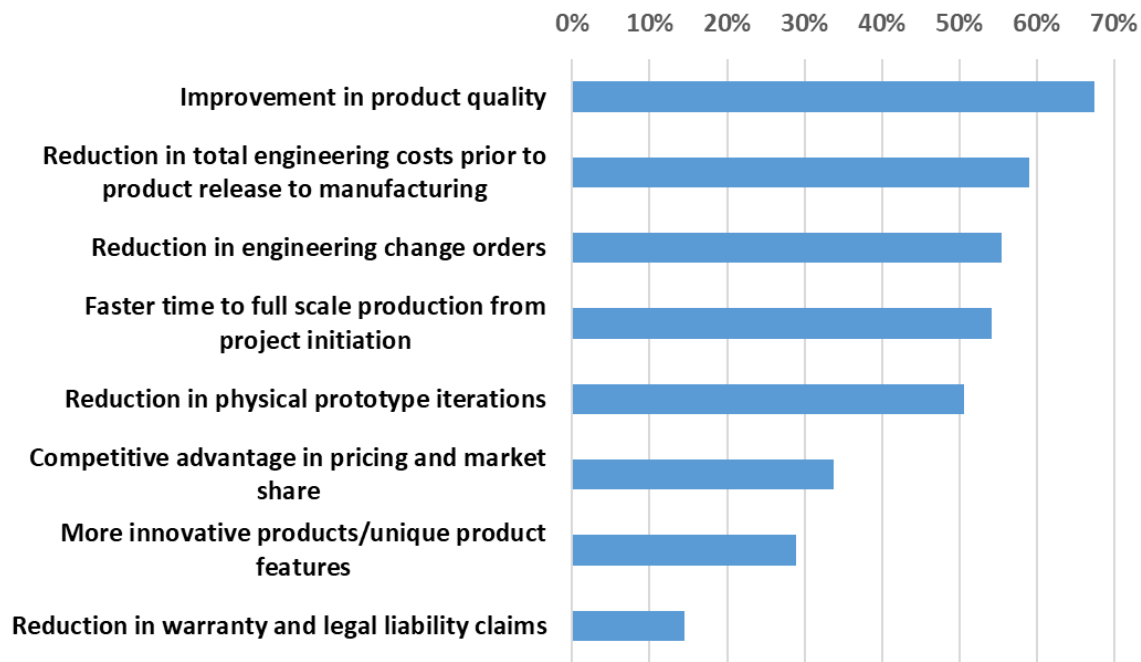


Figure 23 - Benefits Defined to Justify Companies' Investment in MBSE (% of respondents)

All survey pick list benefit options were derived from the thought leader interviews. Survey respondents had the option to add other benefits. Their submissions included product modularization, increased traceability, and reuse of knowledge. Several respondents selected "other" and entered "none."

All options were variations of cost, quality, time to market, and product innovation. It is interesting that improving quality ranks higher than reducing cost.

As a follow on, each respondent was asked which, if any, metrics are in place to track the effectiveness of their company's MBSE strategy. Results are shown in Figure 24.

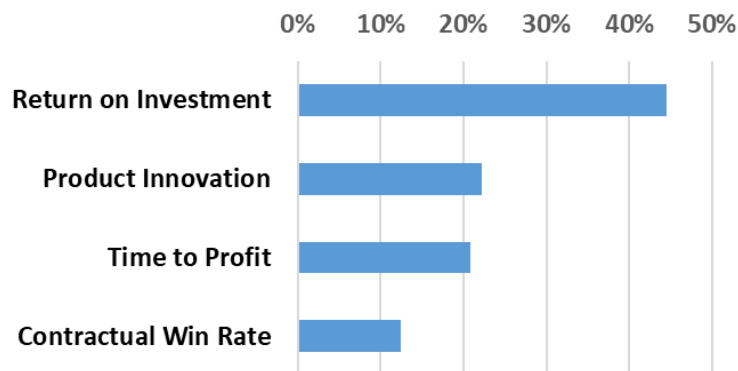


Figure 24 - Metrics in Place to Track the Effectiveness of a Company's MBSE Strategy (% of respondents)

Again, survey respondents had the option to add other choices to the list. Submissions included systems engineering hours, the number of defects found early in the design phase, and user and project feedback. Once again, several respondents selected “other” and entered “none.”

Respondents were asked to list the principal inhibitors to successful formulation and execution of an MBSE strategy within their companies. Results are shown in Figure 25. Inhibitors are listed in order of decreasing significance.

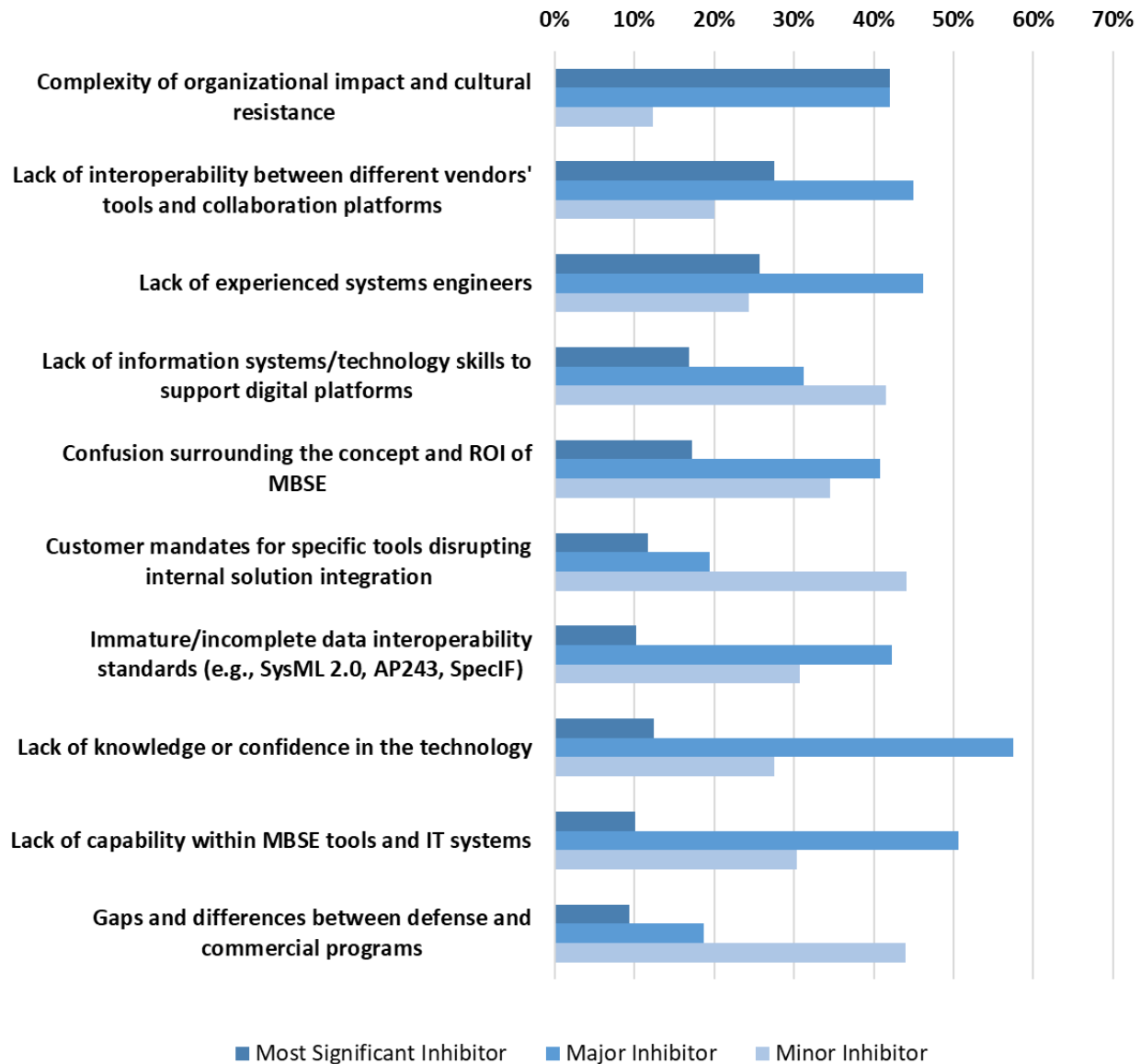


Figure 25 - Principal Inhibitors to Formulating and Executing a Successful MBSE Strategy (% of respondents)

The one factor that clearly stands out as the most significant inhibitor is the complexity of organizational impact and cultural resistance.

Respondents were asked to list the critical factors that must be in place within a company to ensure successful formulation and execution of an MBSE strategy. Results are shown in Figure 26.

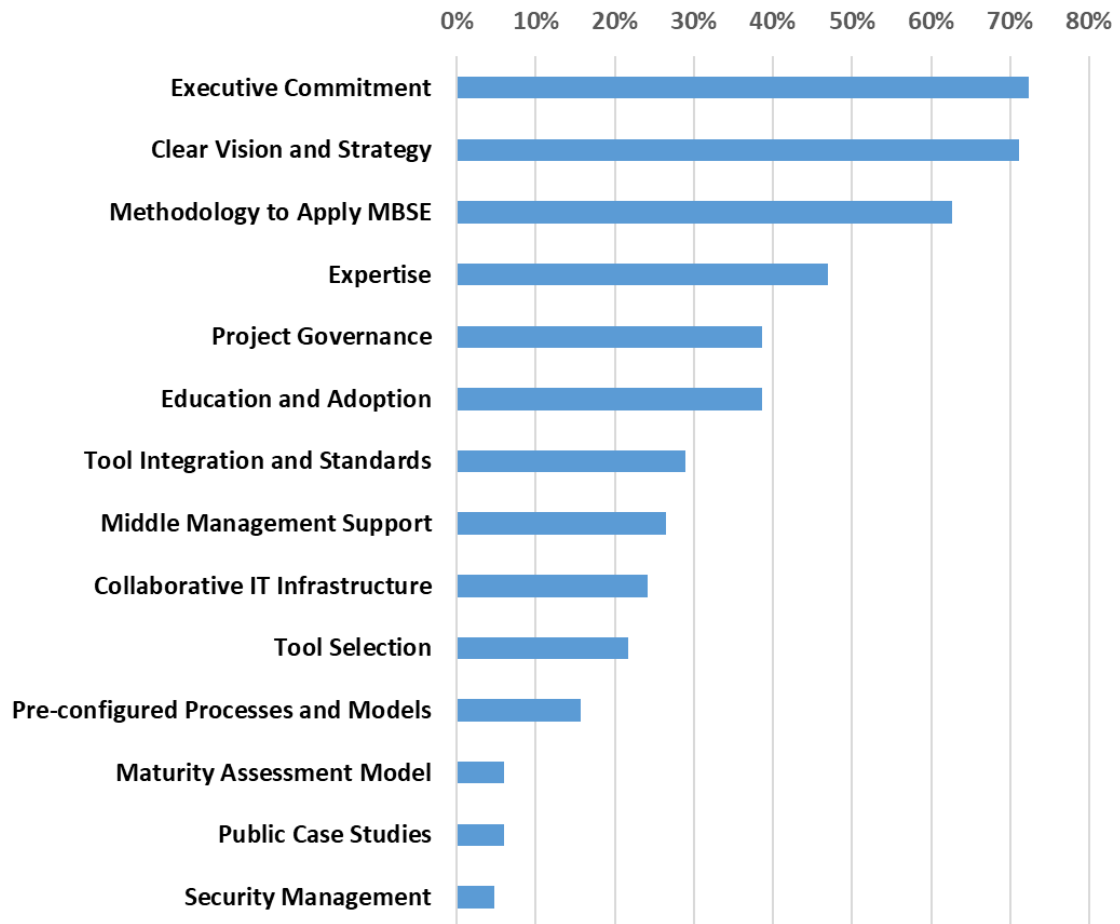


Figure 26 - Critical Factors That Must Be in Place to Ensure Successful Formulation and Execution of an MBSE Strategy (% of respondents)

These survey results correlate closely with the learnings from the thought leader interviews.

Assertion of the critical need for a well-defined MBSE vision and strategy that has strong and consistent commitment from executive management is not surprising. It is understandable that these factors are assessed to be the most critical prerequisites for success.

The logical follow on to this question was to ask respondents to what degree are these critical success factors in place within their companies and, by extension, within their industry? The responses to that question are presented in Figure 27.

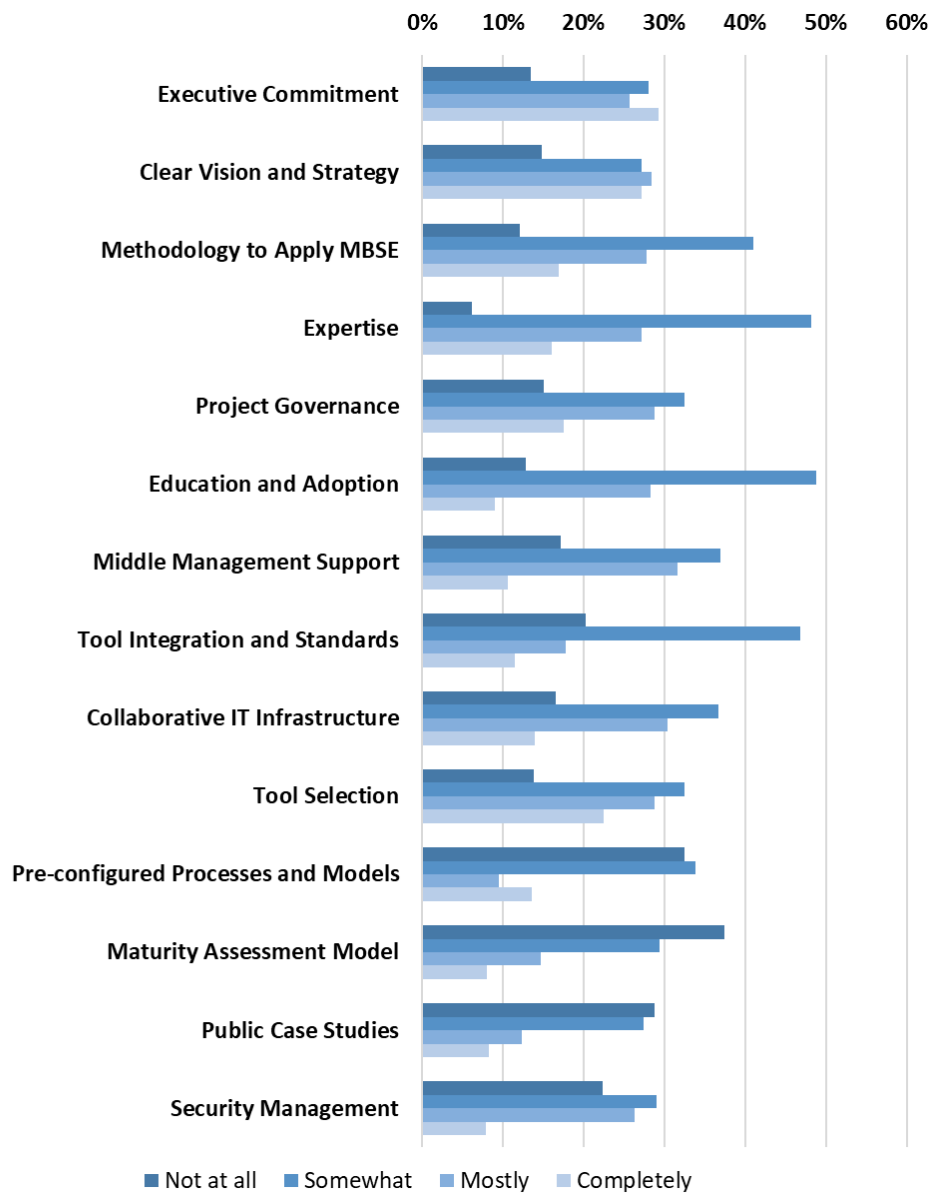


Figure 27 - Degree to Which Critical Success Factors are in Place Within Respondents' Companies (% of respondents)

The two most critical factors of Clear Vision and Strategy and Executive Commitment are Completely or Mostly in place in just under 60% of respondents' companies. This is troubling but may not be the most significant concern. Perhaps the more concerning factors are those that are ranked high but are not in place at all or only somewhat. Those critical success factors include Methodology to Apply MBSE, MBSE Expertise, Education and Adoption, Middle Management Support, and Tool Integration and Standards.

Future Investment

In this section elements of future MBSE investment planning are explored. These include “pain points” and opportunities being targeted, investment drives, and the balance between tactical and strategic perspectives applied to investment decisions.

Interviews

“Pain points” are the points of friction in the current information flow and way of working. Typically, a major focus for ongoing investment in a company’s MBSE implementation is to address and relieve “pain points.” Perspectives of the industry and solution provider thought leaders are presented in Figure 28.

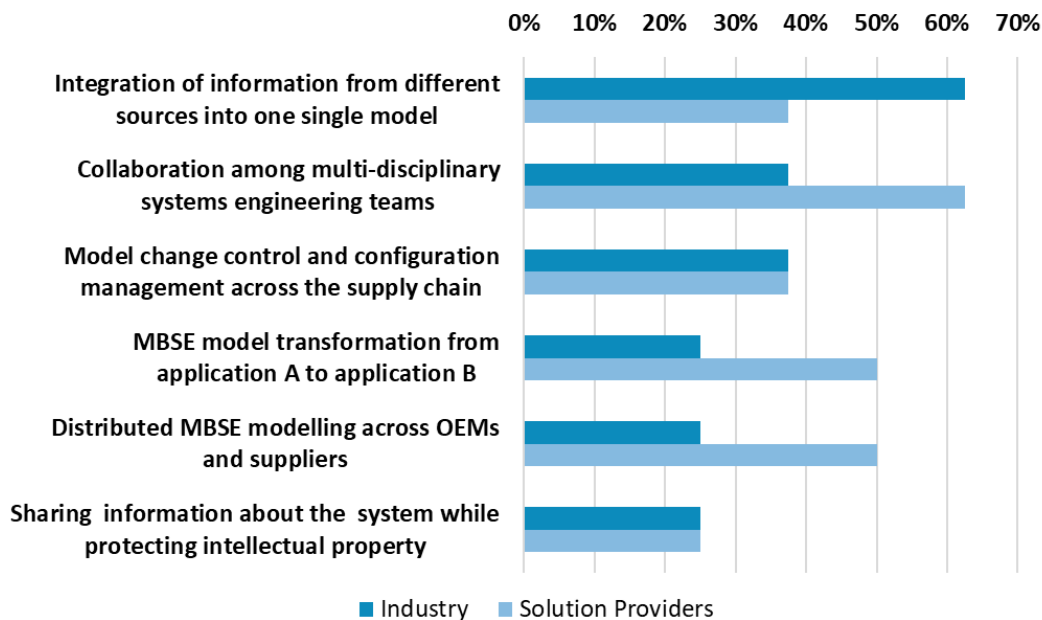


Figure 28 - Top “Pain Points” Being Targeted in Future MBSE Enhancements (% of interviewees)

Several top pain points relate to interoperability. Others relate to collaboration across disciplines and across the supply chain. These are two aspects of successful digital thread implementations, which is foundational to MBSE.

Thought leaders from industry offered the following comments regarding pain points.

- “Being a Tier 1 requires us to align with the production systems of multiple OEMs. This causes us to take an agnostic approach to PLM that requires coordination and agreement on model sharing.”
- “The digital thread is really important. It is astonishing that this topic is not sufficiently emphasized in industry.”

Opportunities are new capabilities or new business areas for potential expansion of the value footprint of an MBSE implementation. Industry and solution provider interviewees provided a wide-ranging list of more than 20 opportunities in their future investment portfolios. Some

opportunities discussed could, by their nature, significantly extend or alter MBSE practices. An industry thought leader offered the following comment:

- “MBSE solution capabilities and processes will need to change to capitalize on new product or technical opportunities. For Tier 1 suppliers, the elements we control will not need to change much. What will change will be in response to external direction from OEMs. They may have new MBSE methods that we will need to adopt.”

Discussion of business drivers for future investment planning yielded a diverse list of more than a dozen items that reflect external business demands and constraints.

Web-Based Survey

Respondents were asked what “pain points” they will be targeting for future MBSE implementations within their companies. Results are shown in Figure 29.

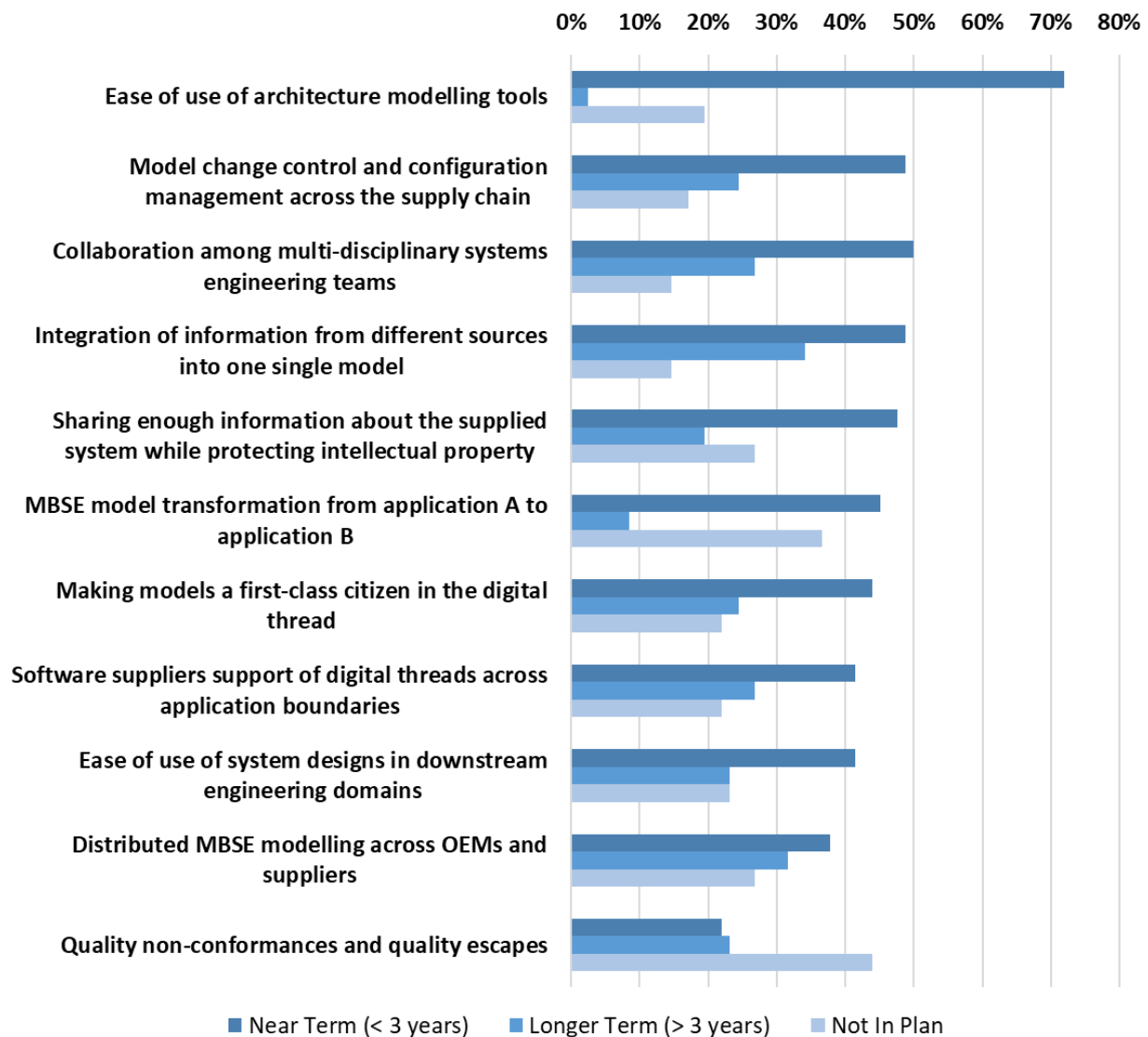


Figure 29 - “Pain Points” Respondents will be Targeting in Future MBSE Implementations (% of respondents)

While several different “pain points” were cited in this question, the responses tended to point to one common theme: the need to share MBSE models and data in a straightforward way within an engineering organization and between multiple enterprises that need to collaborate, based on MBSE models and digital data instead of documents. If the A&D industry is going to achieve the projected business benefits of implementing MBSE, then the multiple “pain points” related to the current lack of MBSE model/data interoperability need to be addressed by the standards bodies working in conjunction with the commercial software tool suppliers.

Respondents were asked how they plan to expand their MBSE implementations currently in place within and across lifecycle phases over time. Results are shown in Figure 30.

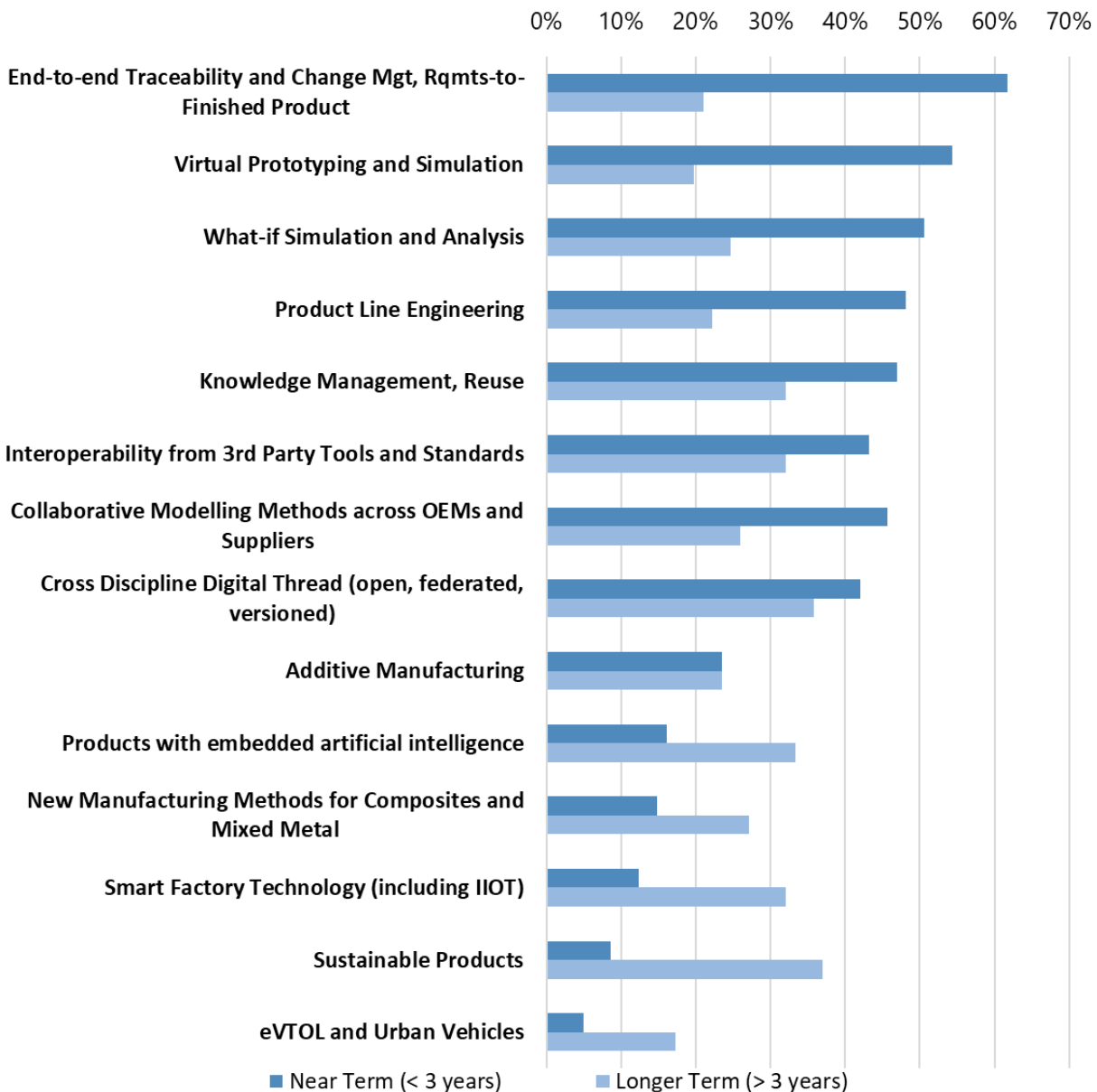


Figure 30 - Value Opportunities Respondents will be Targeting in Future MBSE Implementations (% of respondents)

The top three targets for investment – End-to-End Traceability and Change Management from Requirements-to-Finished Product, Virtual Prototyping and Simulation, and What-If Simulation and Analysis – are the core functions of systems engineering and MBSE. Several thought leader interviews reinforced the importance of S&A to an MBSE strategy and initiative. One industry thought leader commented very emphatically: “MBSE without simulation and analysis is meaningless. It is a key part of MBSE.”

Respondents were asked what business drivers in the A&D industry are they responding to in their companies’ MBSE solution strategy. Results are shown in Figure 31.

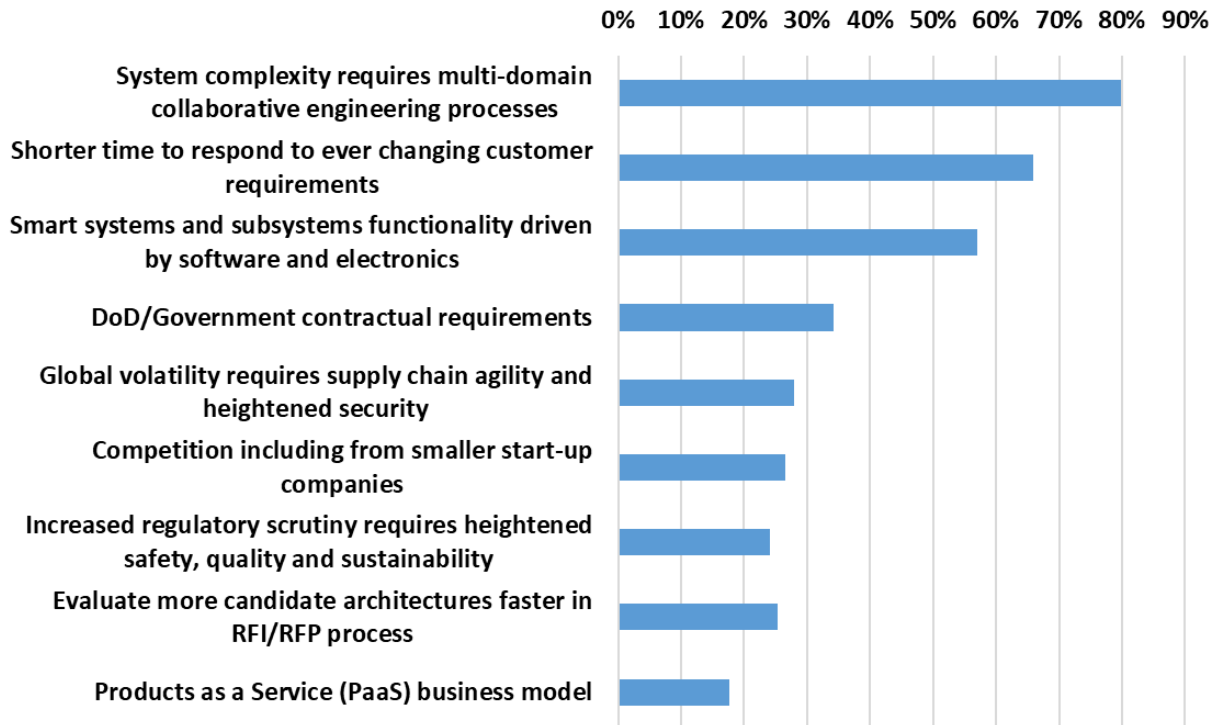


Figure 31 - Business Drivers Companies are Responding to in Future MBSE Implementations (% of respondents)

In an earlier survey, the question, “What has changed over the past three to five years to elevate interest and investment in MBSE?” was asked. It is logical that some, but not all, of those changed conditions will be drivers for future investment. Likewise, some drivers for MBSE investment are not new and have not contributed to a change in the perceived value of MBSE. The bottom line is that responses to the two questions will overlap but will not be the same.

Notwithstanding the above explanation, system complexity, software and electronics enablement of smart products, and pressure for agility and collaboration have all increased markedly over the past three to five years. As a result, they have elevated the perceived value of MBSE, and they are drivers for future investment.

Respondents were asked to characterize the balance between immediate return and strategic value in driving MBSE investment and how that pattern is changing over time. Results are shown in Figure 32.

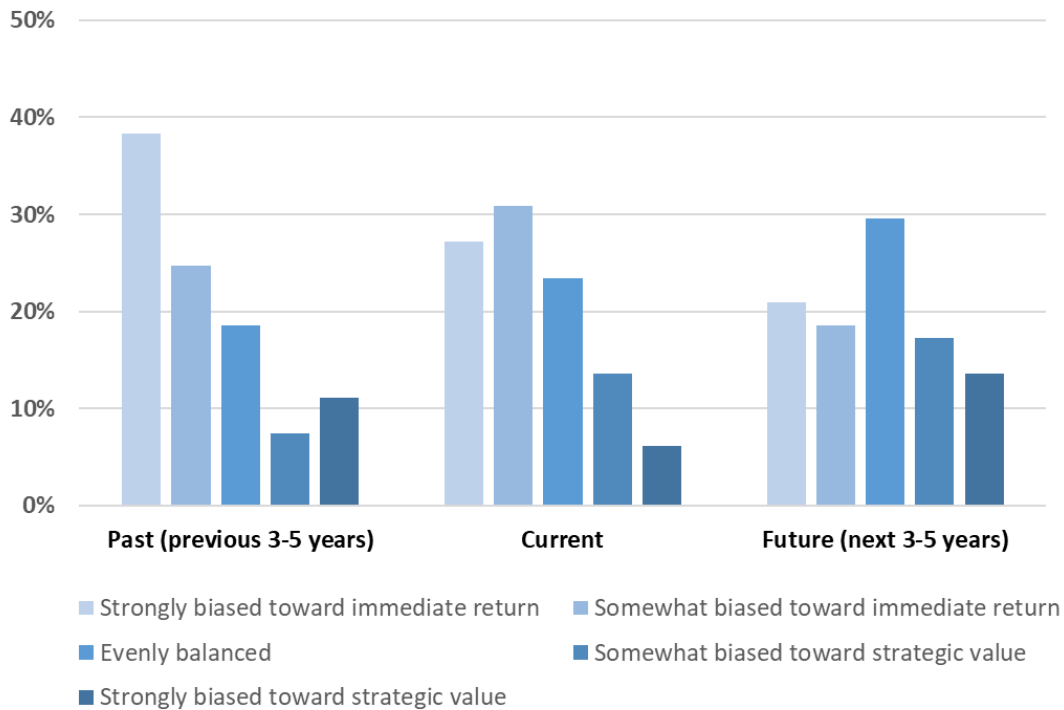


Figure 32 - Balance Between Immediate Return and Strategic Value in Justifying MBSE Investment Decisions and How that Pattern is Changing Over Time (% of respondents)

These responses highlight an interesting dynamic in how companies are justifying their investments in adopting MBSE. In the past, the ROI value justification was heavily biased toward immediate returns (one to two years) versus longer-term strategic value (three to five years). That bias has gradually shifted to a more evenly balanced approach that is growing in acceptance today. Over the next three to five years, the respondents see this trend continuing with a further shift toward the strategic value justification approach.

One industry thought leader offered the following comment:

- “You can rarely demonstrate immediate return on MBSE initiatives, especially since most A&D developments are long in duration (8 to 10 years). You must get company leadership to understand and accept the strategic value.”

Technology Considerations

This section explores how companies manage the technical complexities of implementing MBSE solutions within large-scale A&D programs. The line of inquiry catalogs the tools in use, the effectiveness of commercially available PLM solutions in supporting MBSE, and the alignment between a company's digital thread strategy and the capabilities of its solution providers.

Additionally, the inquiry sought to identify gaps in current solutions and pinpoint areas of alignment or misalignment between the company's MBSE objectives and those of its technology partners, which is critical for improving tool capability, useability, and digital engineering practices.

Interviews

Only the industry thought leaders were questioned regarding the topics in this section.

The initial discussion was to ascertain a general assessment of current capabilities of commercially available PLM solutions to meet industry's requirements for MBSE. The perspectives were not uniform, but the prevalent view may be summarized as follows:

- “The major platform solutions are evolving into full system lifecycle suites. PLM came into life for mechanical. Then ALM for software. Now, SysLM is a term coined to cover all perspectives of systems engineering (RFLP) through the full lifecycle for systems of interest. All the SysLM suites are conceived as monolithic platforms. As such, they are oriented to carry out all the system lifecycle activities within the platform. Consequently, these platforms provide a lot of possibilities for importing information but do not provide any capabilities for exporting the information to other platforms.”

One industry thought leader offered the following comment:

- “It is important not to mix PLM and MBSE solutions; they are not the same. The capabilities are still quite limited for all the tool vendors regarding interoperability, exchanges, etc. The current modeling tools are also too complex, and the user experience and interfaces can and must be improved significantly, even with customizations if necessary.”

The next line of discussion was to solicit perspectives regarding notable gaps in capabilities offered by the solution providers. Results of this conversation are shown in Figure 33.

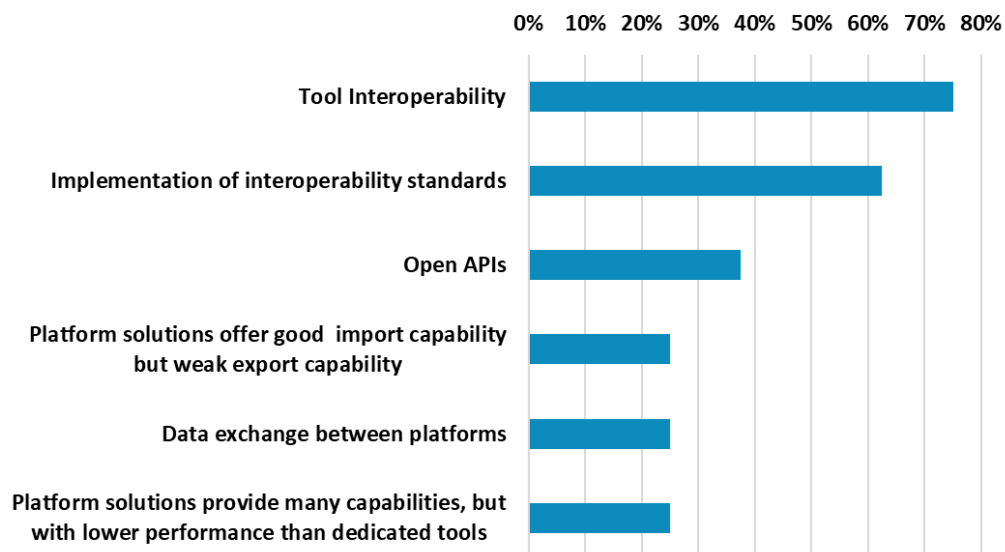


Figure 33 - Notable Gaps in Capabilities Offered by Solution Providers (% of interviewees)

It is significant that five of the top six gaps listed by the industry thought leaders are related to openness and interoperability.

Interviewees were asked how aligned their perspectives and strategies for MBSE investment are with those of their chosen PLM solution providers. Some said they are well aligned, but the majority said there are major gaps. For this pool of experts there was no middle ground.

Web-Based Survey

Respondents were asked what primary software tools they are using to implement systems engineering and MBSE solutions within their companies. It should be noted that this list includes tools with varying scope and purpose that cover a wide range of activities involved in MBSE from requirements definition/allocation to system architecture definition to software development to

verification and validation and model/data integration and interoperability. And in almost all cases, respondents indicated the use of multiple tools from this list. Results are shown in Figure 34.

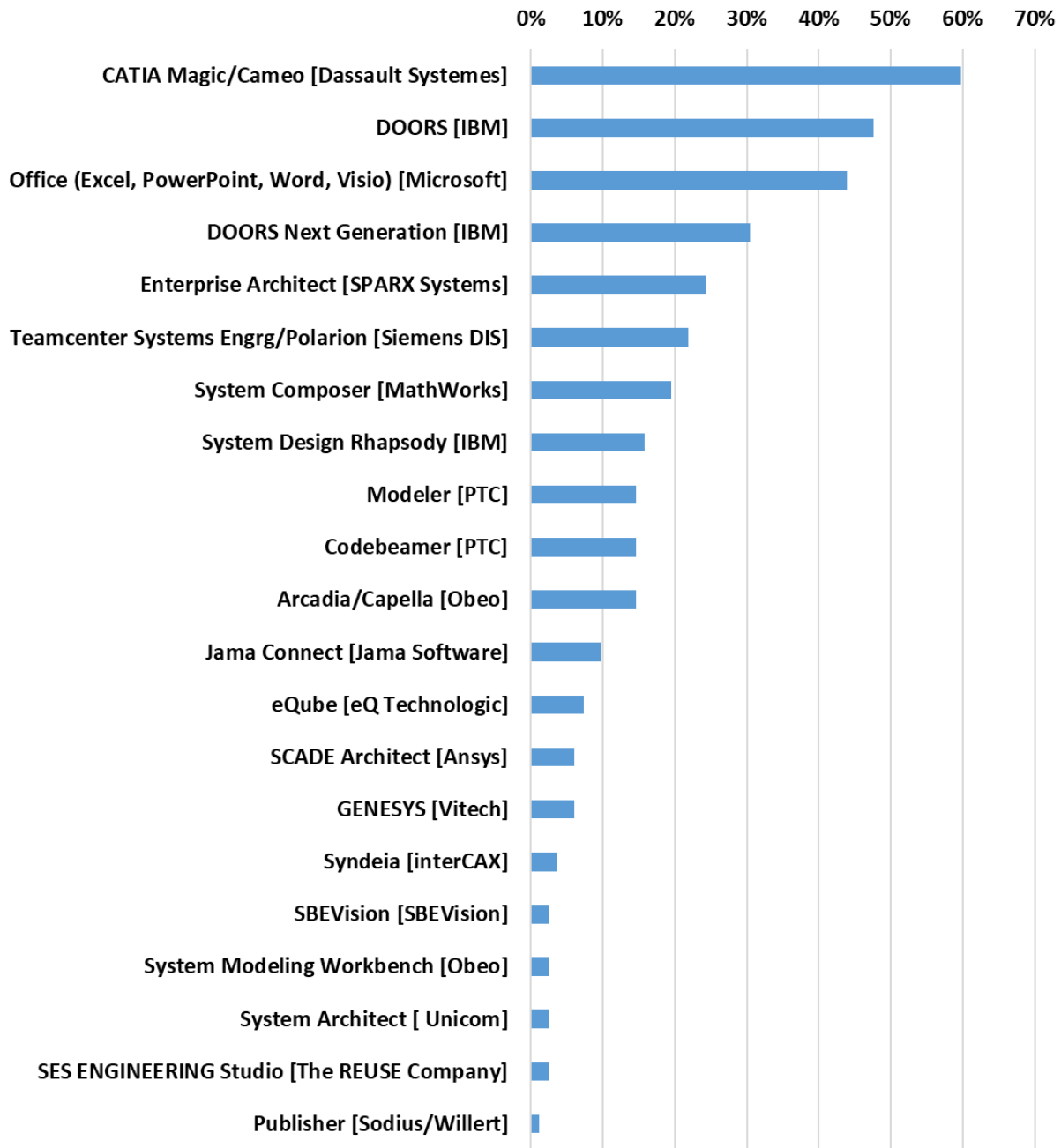


Figure 34 - Primary Tools Used to Implement MBSE Solutions (% of respondents)

Other tools listed by respondents include OpenMETA, MetaEdit+ with our DSL, Aras Innovator (Aras), hypervisors, Medini (Ansys), MetaEdit+, Preevision, PTC Windchill RV&S, 3DX, and Innoslate.

The responses to this question highlight several significant points.

1. A large number of commercial software tools are used within the discipline of systems engineering, MBSE, and Application Lifecycle Management (ALM), and the list shown is by no means comprehensive.
2. Over 40% of respondents use Microsoft Office Suite in doing systems engineering, and it is third on the list of tools used. Excel, Word, and PowerPoint are used extensively throughout industry, and this is not likely to change much in the near term.
3. Many, if not all, of the larger A&D companies have developed customized in-house software tools they use in their systems engineering activities. We did not explicitly ask that question in the web-based survey. However, it was a finding from the in-person interviews with the A&D PLM Action Group member companies and other industry SMEs.

These points underlie the call from industry for PLM and MBSE solution suppliers to provide solutions based on industry standards, as well as robust Application Programming Interfaces (APIs) that will enable integration of models, data, and metadata between data authoring platforms that span multiple systems engineering domains (i.e., mechanical, electrical/electronics, embedded software/controls, chemical, biological, etc.) and the extended community of collaborating participants.

Respondents were provided with a list of choices and asked to indicate any notable examples of gaps in capabilities offered by their chosen solution providers. Results are shown in Figure 35.

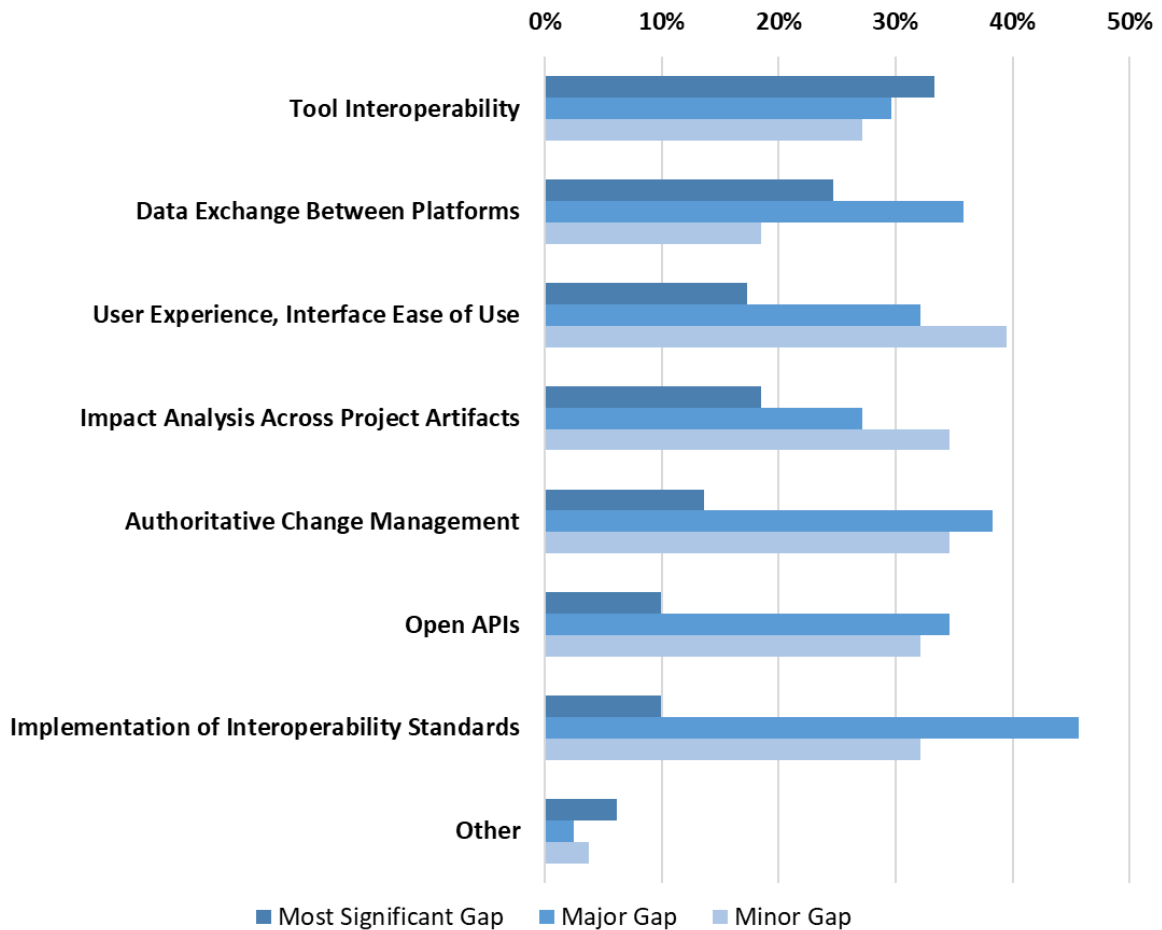


Figure 35 - Notable Examples of Capability Gaps in MBSE Solutions Offered by Respondents’ Chosen Providers (% of respondents)

This question highlights the importance of key productivity issues for MBSE practitioners related to the commercial software tools available to them today. Model and data interoperability and data exchange between users via open APIs, as well as implementation of data interoperability standards are identified as key areas for improvement. Other important areas for improvement are enhancement of user interfaces for tool ease of use and enablement of change management and change impact analysis.

Respondents were asked how well their perspectives and strategies for MBSE investment are aligned with those of their chosen PLM solution providers. Results are shown in Figure 36.

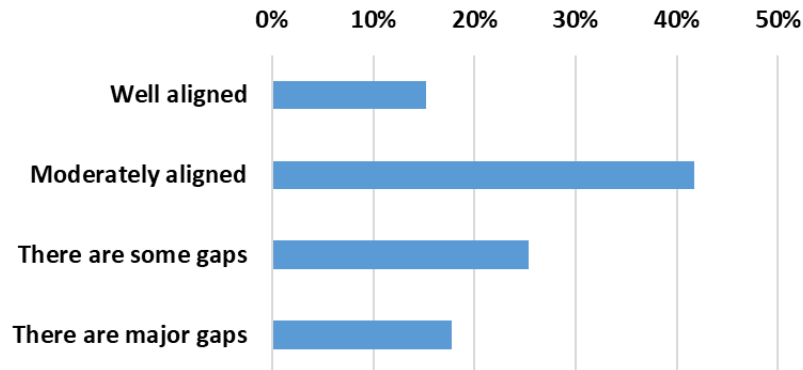


Figure 36 - Alignment of Perspectives and Strategies for MBSE Investment Between Respondents and Their MBSE Solution Providers (% of respondents)

The responses here form a bell-shaped curve skewed more toward Aligned than Having Gaps. Some level of misalignment between the expectations of software users and the companies that build and support the tools is inevitable.

A response to a related question during the interview with one of the leading software solution providers is indicative of the challenge faced by the users, as well as by the solution providers.

Question: How would you rate the ability to integrate and interoperate today? Is it getting better or worse? What can and should solution providers do to make it a non-issue?

Response: “Interoperability may never be a non-issue. Everybody needs to be willing to be part of this open community. Problems arise when a player does not subscribe to the openness philosophy. We have high hopes for SysML v2.0 as it is a major step forward for openness compared to SysMLv1.”

Respondents were provided with a list of choices and asked to indicate any notable examples of alignment or misalignment between their companies and their chosen MBSE solution providers. Results in Figure 37 are rank ordered by degree of respondents' agreement with the statement.

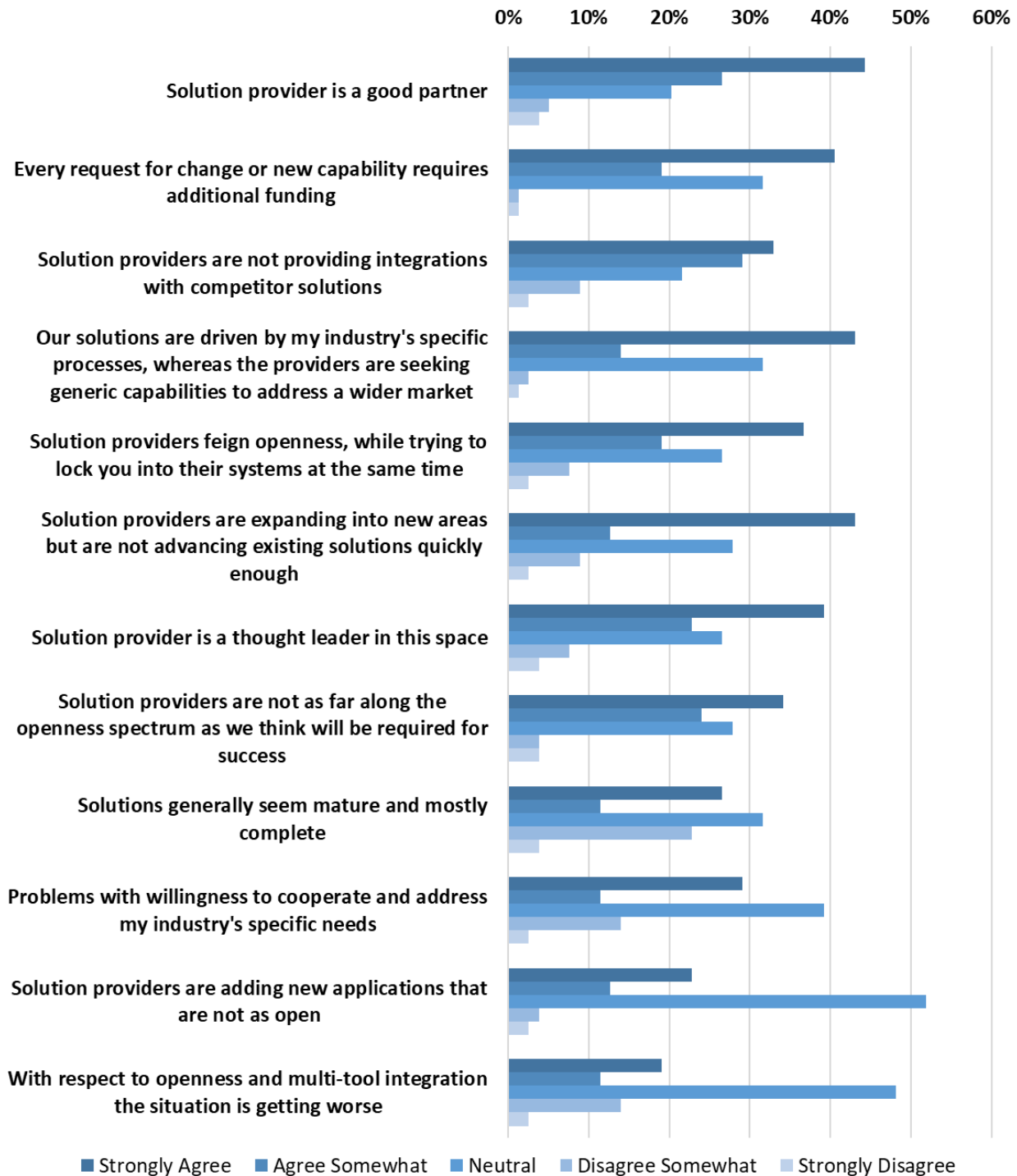


Figure 37 - Notable Examples of Alignment or Misalignment Between Respondents and Their Chosen PLM Solution Providers (% of respondents)

The answers to this question provide the next level of detail related to the answers in the previous question with respect to user alignment or misalignment with their MBSE solution suppliers. Though many of the response selections were worded to imply a negative condition, the user responses were generally answered with a positive view of their MBSE software suppliers. Approximately 70% indicated that their MBSE solution supplier is a good partner, and ~20% held a neutral view.

Summary Observations

CIMdata derived the following key takeaways from analysis of the interview and survey results.

Value Positioning

- There is broad agreement across industry and within the solution provider community that MBSE has risen dramatically in perceived value and importance over the last three to five years. Both communities agree that increasing complexity—of products and services, of value chain collaboration, and of control over the lifecycle system engineering process—are primary factors responsible for this change.
- Most solution providers accept INCOSE’s definition of MBSE. But many within industry have modified or augmented the INCOSE definition for their own use. Some thought leaders criticize INCOSE’s definition as being too vague and overemphasizing models without proper linkage to systems engineering fundamentals.
- Most in industry (55%) see a strong connection between MBSE and digital engineering. Many in industry (40%) see the DoD’s Digital Engineering strategy as a significant factor elevating the level of interest and investment in digital engineering and MBSE. While most in industry (70%) perceive MBSE as an engineering-only initiative, a significant majority (58%) are pursuing MBSE as a corporate digital transformation.
- Despite a good deal of buzz, SysML 2.0 is not currently considered a factor elevating the level of interest or investment in MBSE. With respect to the pending release of SysML 2.0, most of industry (60%) is assessing or waiting to see what the solution providers do; only a few end users in industry (12%) are investing in training and experimentation.

Value Footprint Over Time

- Industry investment in MBSE is concentrated in the Concept and Development stages. All companies have implementations in these stages currently or planned for the near term (63% and 37% respectively).
- There are significant examples within industry of current MBSE implementations in the Production (18%) and Support (12%) stages. Interviewees offered the view that it is often more straightforward to define clear business use cases and quantitative return on investment (ROI) metrics in these downstream lifecycle areas.
- Industry and solution providers agree that requirements definition and allocation, system architecture definition, and logical/functional analysis are the most relevant MBSE use cases today. A significant disconnect is that most in industry (75%) assign high importance to system design verification and validation, while only a weak minority of solution providers (25%) share their view. The scope of enabled systems engineering processes and product lifecycle data align closely with industry’s declared most promising use cases.

- MBSE solution providers believe their technology and services can be applied much more broadly within the product lifecycle than industry has deployed them to date.

Readiness Assessment

- There is broad agreement across industry and within the solution provider community that MBSE is in its early days, and that A&D is more advanced than other industries in applying systems engineering practices in general and in implementing some level of model-based best practices for MBSE in particular. Notable comments offered by those interviewed include the following:
 - “MBSE is in its infancy. We all individually feel we are behind but find that everyone is roughly in the same early phase of MBSE adoption and rollout.”
 - “The industry, from our perspective, seems to be in transition. Practices are not yet completely adopted, nor standardized.”
 - “Comparing MBSE [maturity] to [the progression of] CAD, from emergence in the 80s to the fully parametric CAD now, we are in the mid-90s.”
- Industry considers their use cases to be highly proprietary and were very reluctant to share details. The benefit most frequently cited by industry was product quality improvement (68%). Metrics for MBSE success are rare in industry, but the metric most frequently cited was the ROI (42%).
- Complexity of organizational impact and cultural resistance were cited as a major or the most significant inhibitor to MBSE success by almost all within industry (85%), and a strong majority of solution providers (75%) share this view. As is common with emerging methodologies and technologies, executive commitment is viewed as the most critical success factor by a strong majority within industry (72%). Comments regarding the critical influence of middle management were particularly insightful.
 - “Support from top management is a necessary-but-not-sufficient condition for the successful deployment of MBSE in an organization. However, support from middle-management is crucial. They are responsible for the spreading and establishment of the corporate culture in an organization.”
 - “The greatest resistance comes from program managers. Their evaluation by middle management is short term, but the payback from MBSE implementation is long term.”
- Lack of data and system model interoperability was cited as a major or the most significant inhibitor by a strong majority within industry (75%), but a minority of solution providers (38%) share their view.

Future Investment

- The top “pain points” cited by industry interviewees were related to interoperability. Others related to collaboration across disciplines and across the supply chain. These are two aspects of successful digital thread implementations, which is foundational to MBSE.
- The “pain point” most frequently cited by industry survey respondents as a target for near-term investment was ease of use (75%). This seems to conflict with the view of those who were interviewed. Perhaps these results reflect a difference in perspective, where interoperability is more significant to deep experts and ease of use is more significant to a broader user community. In any case, interoperability and ease of use are rated at or near the top for both communities.
- The value expansion opportunities most frequently cited by industry for near-term investment were what-if S&A, knowledge management and reuse, and product line engineering (all at 45%). The business driver for future investment most frequently cited by industry was that system

complexity requires multi-domain collaborative engineering processes (82%). Industry's perspective on MBSE investment is shifting from an emphasis on immediate return toward a balance between immediate return and strategic value.

Technology Considerations

- Interoperability and data exchange were most frequently cited by industry as major or most significant capability gaps (both at 60%). Ease of use was third most frequently cited (52%).
- Industry interviewees offered the following general assessment of the current capability of commercial PLM solutions to meet industry's requirements for MBSE.
 - “System lifecycle management (SysLM) is a term coined to cover all perspectives of systems engineering through the full lifecycle for systems of interest. SysLM suites are conceived as monolithic platforms. As such, they are oriented to carry out all the system lifecycle activities within the platform. Consequently, these platforms provide a lot of possibilities for importing information but do not provide any capabilities for exporting the information to other platforms.”
 - “The current modeling tools are too complex, and the user experience can and must be improved significantly, even with customizations if necessary.”
- A great many commercial software tools are used within the disciplines of systems engineering, MBSE, and ALM. The Microsoft Office Suite—Excel, Word, and PowerPoint—are used extensively throughout industry, and this is not likely to change much in the near term. Many, if not all, of the larger A&D companies have developed customized in-house software tools used in their systems engineering activities.
- The areas of greatest skepticism and concern within industry toward the PLM and MBSE solution providers relate to their commitment to providing integrations with competitors' solutions (63%) and their commitment to openness (56%).
- Industry's view of alignment with their solution providers is a bell-shaped curve skewed more toward Aligned than Having Gaps. A strong majority within industry (70%) indicated that their MBSE solution provider is a good partner, while only a small minority (8%) expressed a negative view. A substantial majority within industry (60%) consider their solution provider to be a thought leader in MBSE.

About A&D PLM Action Group

The Aerospace & Defense PLM Action Group (www.ad-pag.com) is an association of aerospace and defense companies within CIMdata's globally recognized PLM Community Program, which functions as a **PLM advocacy group** to:

- Set the direction for the aerospace & defense industry on PLM-related topics that matter to members (*including promoting, not duplicating, the work of standards bodies*)
- Promote common industry PLM processes and practices
- Define requirements for common interest PLM-related capabilities
- Communicate with a unified voice to PLM solution providers
- Sponsor collaborative PLM research on prioritized industry and technology topics

CIMdata administers Group operations, coordinates research, and manages the progression of policy formulation.

About CIMdata

CIMdata, a global strategic management consulting firm, provides services designed to maximize an enterprise's ability to design, deliver, and support innovative products and services. For more than forty years, CIMdata has provided industrial organizations, providers of digital technologies and services, and investment firms with world-class insight, expertise, and best-practice methods on a broad set of product lifecycle management (PLM) topics and the digital transformation they enable. CIMdata also offers research, subscription services, publications, and education through certificate programs and international conferences. To learn more, visit www.CIMdata.com or email info@CIMdata.com.

Appendix: Partial List of Respondents' Job Titles

For survey respondents who provided their name and corporate email address, CIMdata's customer relationship management (CRM) database and LinkedIn were searched to learn their job titles. Those job titles are listed below.

Airframe Method & Tools and Support
Associate Director, Enterprise Architecture & Strategy
CAD & PLM Team Leader
CEO
Chief Solution Advisor
CTO - VP of Technology
Development Engineer Embedded Real-Time Systems
Digital Transformation / MBSE Lead
Digital Transformation PLM Simulation-Analysis Lead and Product Owner
Director, Business Development and Strategic Planning
Director, Customer Engagement
Engineering Manager
Executive Director
Expert Business Consultancy
Global CAD Manager
Head of Advanced Materials
Head of Competence Center Product Lifecycle Management (IT)
Industrial Modelling and Simulation Expert
IT Business Partner (Global) for Digital Strategy in Engineering
IT Chief Engineering Strategist
IT Engineer
IT Technical Specialist
Managing Director
MBE Engineer
Mechanical Engineer and Project Manager
PLM Program Manager
PLM Specialist - System Engineering
Principal Architect
Principal Engineer
Process & Applications Manager - Concept to Product
Product Manager
Program Director
Project Engineer
Project Engineer and Project Manager
Senior Director of Engineering

Senior Engineering Manager
Senior Manager Systems Engineering
Senior PLM Strategist
Senior Principal Engineer
System Engineering Leader
Systems Architect
Systems Engineer
Systems Engineering Manager
Vice President of Innovation
Vice President of Solution Architecture