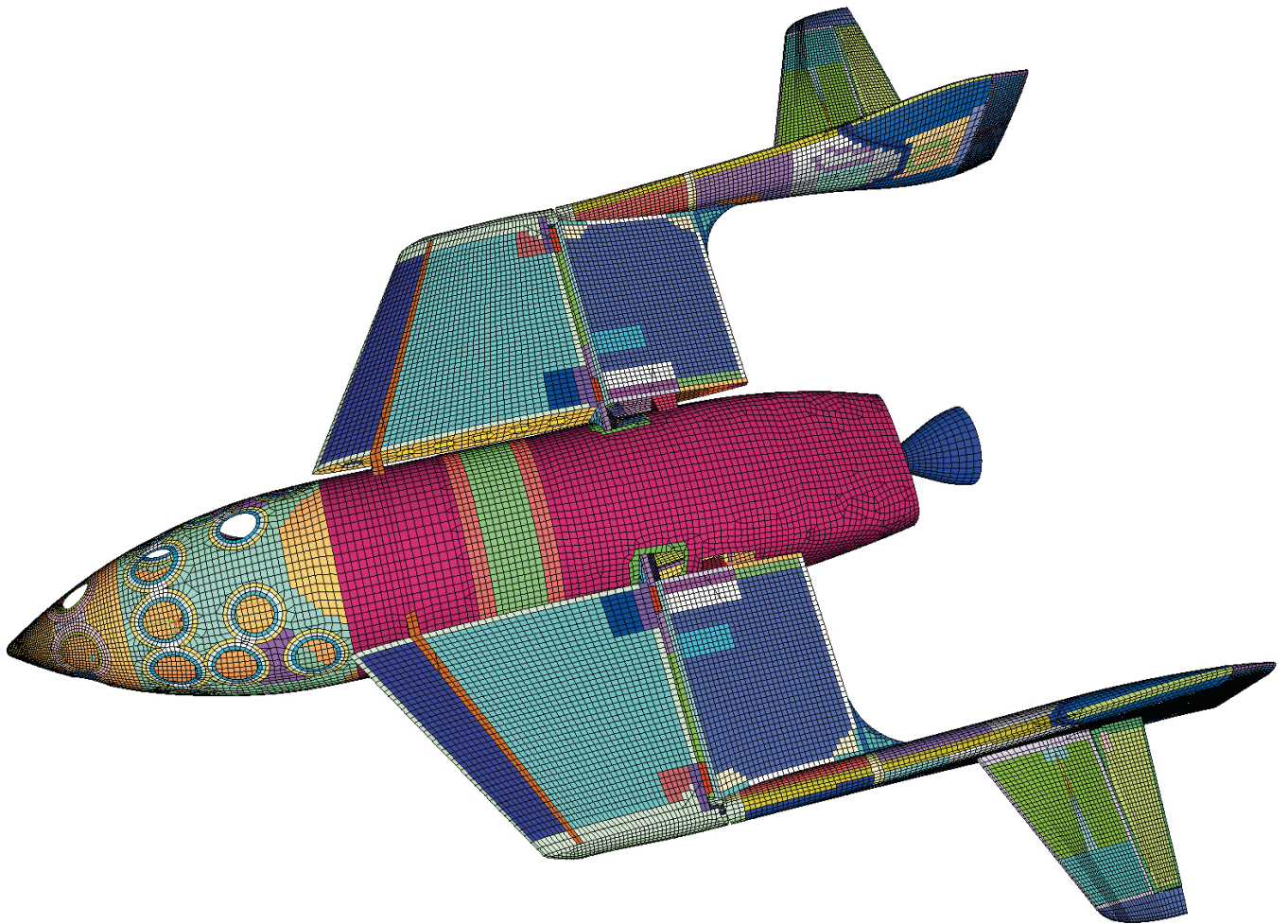


Best Practices for Implementing Digital Simulation and Analysis: *Five Lessons from Savvy Aerospace and Defense Program Managers*





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Digital simulation and analysis is critical for aerospace and defense manufacturers to meet program objectives on time and budget – the complexity, performance and efficiency demanded of today's aircraft, space systems and defense products simply can't be achieved any other way. How do they do it? We interviewed experts at industry leaders around the world to find out. What we discovered is that these companies, together with aircraft engine manufacturers, are perhaps the world's most mature and sophisticated users of simulation and analysis – bringing the technology to bear far earlier and more pervasively in product development than most other industries. From hours of interviews we distilled five best practices that make this possible:

Manage people factors Garner executive sponsorship for new processes and technologies by tying simulation process improvement to corporate business objectives and to C-level initiatives and budgets targeting Six Sigma, quality, efficiency and requirements definition. Leverage marketing/sales dependence on simulation-based characterizations of forthcoming product. To create buy-in and ownership among analysts and discipline leads, engage these professionals' motivation to excel and be selected to participate in important new programs.

Manage simulation data and processes Investigate tools and techniques that automate simulation and yield richer, more informative results – multidisciplinary optimization (MDO), robust design, Design for Six Sigma (DFSS). Automate data transfer by tying analysis tools from disparate disciplines more closely together. Seek knowledge capture and simulation data management aids to increase efficiency and work throughput.

Rationalize the make/buy decision Use commercial software whenever it will suffice, but recognize the value or even indispensability of internally developed codes. Weigh the cost of maintaining in-house codes against moving to COTS solutions by identifying the true costs of change – not just software fees but re-integration, retraining, calibrating historical results against the new tool. Choose commercial software that is easy both to customize and to integrate with existing in-house and commercial codes.

Optimize simulation/test tradeoffs Leverage the relationship between digital simulation and physical test to get more value from both. Carry out as much design

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exploration and refinement as possible with simulation – drive test toward a role of final validation only. Use simulation/analysis early in a program, when designs have not been detailed to the point where test is feasible. Align analysis use with corporate initiatives to remove time and cost from product development. Use analysis results to optimize test design and execution.

Qualify and select solution providers To best support the long development cycles and product service lives in aerospace/defense, ground simulation/analysis purchase decisions in not only technical but also business criteria. Evaluate one set of solution providers on their ability to deliver the latest solver or mesher. Evaluate another set on their ability to help tie disparate tools together, streamline work processes, secure and shepherd corporate knowledge assets.

BUSINESS DRIVERS AND CONSTRAINTS

Aerospace and defense manufacturers are among the industrial world's most advanced and sophisticated users of digital simulation and analysis. Why? One reason is that products of today's complexity, performance and efficiency simply can't be developed any other way. But there's more to it than that:

"...we have to [use simulation] to meet our goals. We simply couldn't design our products without doing modeling and simulation..." – Aerospace/defense company A

Developing a new defense system or aerospace product is a massively complex undertaking that can cost hundreds of millions if not billions of dollars, and can span a decade or more. By making it possible to meet program objectives on time and within budget, simulation and analysis confers competitive advantage out of all proportion to its direct cost:

"...How can I assure myself the aircraft can meet range requirements without refueling? You have to use simulation to do that. In our industry we can't throw something together with limited simulation and then fly it to find out..." – Aerospace/defense company B

Simulation and analysis technology holds the key to competitive advantage in other ways as well. Commercial aviation has been hit hard by the economic downturn, the terror attacks of September 11, SARS outbreaks, and the Iraq war. While passenger volumes have recovered to pre-9/11 levels, many major airlines are struggling with high costs and competition from low-cost carriers in the U.S. and Europe. With all this, airlines are seeking more flexible, cost-efficient aircraft that are cheaper to operate and maintain. Major aircraft manufacturers also face growing competition from regional jet makers now developing larger and more capable planes. As a result, aircraft manufacturers face unprecedented challenges to deliver products that are more efficient, better performing, higher quality, better differentiated and more appealing to the flying public – all while keeping development and production costs under control.

"...simulation...is very helpful, especially at the systems level where interactions may not be obvious..." – Aerospace/defense company C

In the space systems industry, leaders are reporting price pressure in both commercial satellites and launch vehicles, due partly to low demand for new satellites because of overcapacity in the telecommunications industry. And while the U.S. government is voicing



renewed commitment to space exploration, faster-better-cheaper remains the watchword at NASA and elsewhere.

“...if you look at the complexity of our product, just go back to earlier versions of [a fighter aircraft] that’s been in production for nearly 25 years. In its infancy in the 1970s, it was a much less complicated product. The amount of simulation required was minimal compared with today, where many complex subsystems are interoperating and multiple sensors are collecting loads of information. You have to rely on simulation tools to validate performance. We’re constantly pushing the edge of the envelope in simulating physics...” – Aerospace/defense company B

In defense markets, current U.S. administration plans call for modest sustained growth in both the procurement and R&D budgets of the Department of Defense. The DoD, which accounts for almost half the world’s aggregate defense budget, is making a big push toward what it calls net-centric warfare. “Net-centricity,” according to DoD, “is an information superiority-enabled concept of operations that generates increased combat power by networking sensors, decision-makers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization.” In practice, the DoD’s focus on net-centricity, long-range strike capability, unmanned air combat and reconnaissance vehicles, precision guided weapons, joint operations, interoperability among weapons systems, and integrated capabilities for the armed forces all mean defense contractors must cope with unprecedented complexity, capability and reliability requirements.

Against this background, we interviewed experts at industry leaders around the world to find out how they do it. What best practices have they developed for using simulation and analysis to achieve the business objectives that they and all manufacturers face – to boost product quality, performance, efficiency and innovation, shorten program schedules, improve engineering productivity, and reduce development costs? Participants asked not to be identified, but were pleased to share their insights and lessons of experience.

“...every one of our engineers does simulation and analysis in some form or fashion – that’s just an ongoing part of being an aerospace engineer. We’re not actively seeking out areas where we need to hire more people to do simulation. We don’t go out and hire CFD engineers; we hire aerospace engineers who use CFD...” – Aerospace/defense company B

What we found is that use of simulation and analysis is pervasive throughout the product development process. In contrast to many industries, best-practice aerospace and defense manufacturers bring digital technologies to bear in the early stages of customer engagement to capture product requirements – more, to aid the customer with the process of requirements definition. Even before contract award, these companies begin using simulation and analysis for system- and product-level performance characterization, then continue using it post-award for product development and refinement into detail design.

“...to create sustainable growth, we’re addressing five drivers around product development: customer integration, architecture, developing the capabilities of our people, knowledge sharing, and reuse. Customer integration involves issues such as: how do we get systems engineering into closer relation with business development and the business as a whole?...As you move up the value chain and start to ask where the leverage is, simulation and modeling become increasingly significant. There’s a much



increased focus today on modeling and simulation throughout our company...For example, we've created a Mission Innovation Group focusing on the pre-contract award period, even before a proposal is put out. We're trying to focus on modeling and simulation as a lever to leapfrog us forward [by] getting into that up-front, pre-award space with the customer..." – Aerospace/defense company D

As this statement makes clear, maximizing the technology's business impact involves far more than simply buying today's best point functionality and handing it off to the analyst or discipline lead. Instead, contemporary best practices focus on making more efficient use of existing resources – both software and engineering staff. No one we interviewed named software budgets as a constraint on product development's ability to contribute to corporate business objectives – all identified time and human resources as limiting factors. New demands on product performance, mission complexity, product efficiency, total cost of ownership (TCO), new product cycle time and product development costs are driving companies to wring more value and output from their engineering resources.

"...we always need better tools that can work faster and better together. That's what I do for a living – make tools work together at a system level, able to cycle through faster and more accurately, and bring higher fidelity further and further up to the front end of the design process. [The objective is] to cut design cycle time by reducing the number of design iterations...Also, if you can have higher fidelity right away, you can speed things up...The other thing we're heading for is factoring in a lot of the other aspects of the design – to optimize to a fixed price, for example..." – Aerospace/defense company C

To this end, initiatives to improve the efficiency and impact of simulation and analysis abound – Six Sigma, systems engineering, robust design, multidisciplinary optimization (MDO), Design for Six Sigma (DFSS) – and often enjoy C-level endorsement and funding.

"...we're building more capability around modeling and simulation tools and techniques...The first step is to build awareness of the power of these junction points. From a DFSS [Design for Six Sigma] perspective, the industry and we do a lot around performance modeling, cost modeling, defect modeling and other things – but are they all integrated together so you're trading off across these spaces?" – Aerospace/defense company D

These initiatives are focused on process change, and on implementing technical enablers to overcome what one manager called the "entropy chain":

- Toolset integration
 - CAE-to-CAE
 - CAD-to-CAE
 - Commercial off-the-shelf (COTS) as well as internally developed tools
- Process automation
- Knowledge capture
- Simulation data management

In all this, we found that success depends on tight focus on five best-practice areas:



- Manage people factors
- Manage simulation data and processes
- Rationalize the make/buy decision
- Optimize simulation/test tradeoffs
- Qualify and select solution providers

MANAGE PEOPLE FACTORS

Much of the challenge in optimizing use of simulation and analysis and maximizing its impact has to do with organizational considerations and people factors. Our research found that best practice focuses on two objectives:

- Garner executive sponsorship
- Create incentives for discipline leads, analysts, engineers to take ownership of the new tools and processes

“...we are attacking the problem at two ends, where people are most receptive...One is senior management of the company...senior managers and people with oversight over programs are very receptive to the idea of doing things differently and better. At the other end, individual engineers are also receptive and eager – they want to design a great product, and to use the latest innovative tools to design better, neater things than they can now...” – Aerospace/defense company A

Garner executive sponsorship

Why is executive sponsorship important? Because optimizing use of simulation and analysis is an investment. It requires budget. It requires process change. And progress is not always smooth, so when things hit a bump, it requires commitment to stay the course. If improvement initiatives cause short-term hits to productivity, C-level understanding and backing can be invaluable.

“...[the president of our operating division] will have seen information firsthand pertaining to predicted performance of [our upcoming new product]. He’s going to have firsthand knowledge of what that [product] can do on the basis of simulation and analysis...” – Aerospace/defense company A

Here’s how to get it: Tie simulation process improvement to corporate business objectives, and to C-level initiatives and budgets such as Six Sigma, quality and efficiency programs.

“...[being] a very big company that has been very successful for a very long time...creates inertia that can make it difficult to do things in new and better ways...[strong] competition is doing as much as anything to help us crack through some of this [resistance]...senior managers...are very receptive to the idea of doing things differently and better...” – Aerospace/defense company A

Another C-level focus is requirements definition – engaging deeply with customers early in the pre-award phase. The objective is for companies to leverage their systems-integration



competencies to help the customer develop an optimal definition of mission objectives and how the program can best achieve them – simulation and analysis are key to these feasibility and concept-design studies.

“...our corporate CEO – an engineer by training – is a big proponent of moving up the value chain by doing more modeling and simulation. He wants us to get even better at systems engineering...his thrust is growth through customer-focused marketing and systems integration...” – Aerospace/defense company D

Another best practice is to leverage the dependence of the marketing and sales organizations on simulation/analysis characterizations of new products.

“...our marketing department is very technically oriented. They go into meetings with customers highly technically prepared. Their answers, by and large, are based on modeling and simulation...Our marketing department is having discussions today about [an upcoming product] and we haven’t built one yet – not a single flight test hour recorded. All the information in their sales pitches is based on modeling and simulation...” – Aerospace/defense company A

“...they use that data to market our product capabilities. Our business development organization is made up of engineers and pilots. They are all very technical...” – Aerospace/defense company B

“...they use [simulation and analysis results] to sell our product...” – Aerospace/defense company C

“...[visibility of simulation with the marketing department] is growing...[our CEO] is getting us focused on customer-focused marketing, systems integration, and close interaction between these two...” – Aerospace/defense company D

Create incentives for discipline leads, analysts, engineers to take ownership

Of course, winning C-level buy-in is no guarantee of success. Alienating the head thermal analyst by forcing him or her to use a tool he/she doesn’t like or trust is not the best way to deliver product on schedule. How can managers create incentives for these individuals to take ownership of new processes and enabling technologies?

We found the answer often comes down to best practices for change management. What will motivate these individuals to change the way they work? One key, we found, lies in individual engineers’ professional motivation to excel, and their consequent receptiveness to new processes and technologies:

“... individual engineers...are also receptive and eager. They want to design a great product, and to use the latest innovative tools that let them design better and neater things...senior and mid-level managers are focused on having the company design really great products...the individual engineers have that same focus...” – Aerospace/defense company A

Best practices also focus on introducing new processes and techniques in ways that mitigate resistance and risk:



“...lower levels of management [resist change]...lower-level managers have the focus of ‘stick to the schedule, stick to the old way of doing things.’ They’re the ones being asked to assume the schedule risk, the program risk, all the risk that comes with doing things a different way...They are the configuration manager [and others] responsible for drawing out the best candidate designs...Throwing MDO [multidisciplinary optimization] at them disrupts everything they’ve done for 40 years, asks them to think about the configuration process a whole new way...[to win them over] we got the configuration manager and the chief engineer on [a new program] to agree to run the old and new processes in parallel – so if the new way doesn’t work, the old way is there to mitigate the risk...” – Aerospace/defense company A

A related best practice is to implement simulation and analysis process change in ways that minimize disruption in engineers’ day-to-day work habits:

“...in our MDO [multidisciplinary optimization] initiative, we don’t make any predetermination for the preferred tool...bringing MDO to fruition in a big company is a social battle...one thing we’re doing to break down resistance is to make no a priori decisions about analysis tools. We say, ‘What tools do you currently use to perform this analysis?’ And we will integrate them into an MDO process...” – Aerospace/defense company A

Indeed, we found that engineers and analysts involved in exploring “design spaces” – using methods such as MDO, robust design, Design for Six Sigma (DFSS) – are often passionate about these new techniques for expanding the reach and impact of analysis tools.

Another best practice we identified is to tap discipline leads’ motivation to build reputes among program managers as the best people to bring into important and challenging projects:

“...the program manager has to get his job done. He can’t do research projects; he doesn’t want to be the pioneer or pathfinder of new ways of doing business...[his] tendency is to identify people he trusts in the engineering area...he lets them worry about how to use the tools to get the job done. The [discipline lead] in charge of the people and technology has a different agenda. He wants to be called on by the project people to supply people and processes, so there could be a win/win here if the discipline lead is ready for the program manager to come and ask him for people and process...It is an issue of culture change among the engineers. If I were a program manager in charge of staffing, and I went to a discipline lead – the person responsible for the processes, tools and people – and I knew he had an integrated design process...then I would feel good about it...” – Aerospace/defense company C

“...the problem [is] the silo-ing of talent in the groups. Are they in play? Sometimes the people with technical skills have less capability as social entrepreneurs than others – you may have a great stats guy, but nobody knows he’s even there. Use social-network approaches to get them out of their silos and into play...” – Aerospace/defense company D

A related best practice is to create the role of change agent:

“...in my new role...I’m going to focus on several thrusts – cost as an independent variable, Design for Six Sigma, others. I’ll focus on helping projects and programs...figure out how to integrate all these thrusts that aid cost, program, schedule. I’ll help them find



[new processes and technologies] for modeling and optimization, and integrate them into the programs... – Aerospace/defense company D

MANAGE SIMULATION DATA AND PROCESSES

In aerospace and defense, best practice here is about being able to handle simulation/analysis data in the context of global organizational process requirements:

“...our PDM system is much more than CAD data management. It's a portal into our entire product development virtual environment. It enables collaboration across our design facilities around the world...it includes a lot of the data that is an input to simulation as well as the simulation results...” – Aerospace/defense company B

Best practice also centers on new tools and techniques for automating and speeding up the execution of simulation and analysis codes in order to more efficiently explore “design spaces” – methods such as MDO, robust design, Design for Six Sigma (DFSS). These methods offer new approaches to better managing problem setup, problem execution, and data interchange between different simulation and analysis tools, and between simulation/analysis tools and CAD tools. Related to this is the ability to capture, archive and retrieve simulation models, input conditions and results, together with related assumptions and conclusions.

“...The only constraints [on usage] are getting simulations set up and knowing how to do them. It's a matter of corporate knowledge...” – Aerospace/defense company C

The principal constraints on getting more value from simulation and analysis are availability of trained, knowledgeable professionals and time, not a shortage of software licenses or budget. We found that a key best practice being pursued to overcome these constraints is to tie these tools closely together, using knowledge capture and simulation data management aids to increase work throughput.

- Manage intellectual property (IP) exchange with subcontractors and offshore partners.

“...CAE data transfer is an infrastructure issue between us and the subcontractor. If the sub doesn't know how to take your data – maybe that's one of the ways you should select your subcontractor...” – Aerospace/defense company C

- Automate data exchange between analysis disciplines, and between geometry modelers and mesh generators.
- Readily re-run or update analyses months or years later.
- Ensure that design changes trigger re-analysis; ensure analysts receive correct inputs from modified design; ensure re-analysis results feed back to design.

RATIONALIZE THE MAKE/BUY DECISION

Rationalizing the make/buy decision is all about managing the tradeoffs between commercial off-the-shelf (COTS) software and internally developed tools. Over the years, aerospace and defense manufacturers have made substantial investments in developing proprietary



simulation and analysis codes, understanding them, certifying them and getting comfortable with them. The key questions are: When and how should an organization move to an off-the-shelf solution? How can in-house codes best be integrated with COTS solutions? What should organizations do to keep their internally developed tools refreshed so they can take advantage of leaps in hardware performance?

“...our usage may average 70% commercial/30% in-house. But the ratio changes depending on where the program is. In the earlier design stages there will be much greater use of in-house-developed tools. As the program moves closer to production, the mix goes more commercial...” – Aerospace/defense company A

“...The majority of our tools today are based on commercial codes. The minority are in-house-developed from scratch...” – Aerospace/defense company B

We found there is no blanket answer at present. There is a general trend to use COTS whenever it will suffice, but also recognition of the value and in many cases the indispensability of internally developed codes.

“...We have a lot of internally developed proprietary codes for trajectory analysis and other applications...[but] half to three-quarters of our work is done using standard COTS codes...We now use COTS codes whenever possible. That’s been the move over the last few years, to generally accepted government and commercial codes...” – Aerospace/defense company C

“...In some [of our businesses] COTS may be just 30% of total software usage; elsewhere it may be quite higher...[the overall mix] is more home-grown, but with increasing COTS usage. We’re always looking for ways to reduce costs, and sometimes you can benefit by reducing usage of your own codes, and figuring out how to move up the food chain and become more of a mission systems integrator. In doing that, you look for opportunities for supply chain integration, so you are always looking for opportunities to buy rather than make...” – Aerospace/defense company D

To weigh the cost of maintaining in-house codes against that of moving to COTS solutions, best practice is to identify the true costs of change. Beyond software license fees, these also include software re-integration, retraining, and the all-important calibration of historical analysis results against the answers produced by the new tool – that is, understanding and quantifying the algorithmic differences between the old tool and the new.

“...there was a discussion to replace one of the old structural analysis tools that was being used on a program with a more accurate one. The new one really was a lot more accurate, but the engineers said, ‘No, we know how to interpret the results of this old code, and we know how to predict reality with it. We know it always over-predicts the load by 10% to 12%. It’s a big error, but we know that’s what’s going on. We have too little experience basing the [new tool’s] improved simulation results on reality [compared with] basing the [old tool’s less accurate] results on reality.’...” – Aerospace/defense company A

One best practice we uncovered is to choose commercial tools that:

- Accommodate collateral use of internally developed codes wherever these best serve the objectives of either product programs or process change initiatives



“...bringing MDO to fruition in a big company...is an uphill battle...so we’re doing everything we can to break down this resistance. One thing we can do is to make no a priori decisions about analysis tools [so that analysts can continue using their choice of point solutions]....” – Aerospace/defense company A

- Can readily be modified internally

“...We modify commercial code for our specific use. We generally don’t use COTS software without modification for product development...” – Aerospace/defense company B

Thus, a value proposition to look for in COTS suppliers is not only quality codes, but also toolkits and service offerings that help customize COTS solutions and make it easy to integrate tools with one another, both COTS and in-house. Companies that do this well are getting high value from their systems, and finding relief from some of their resource constraints.

A related best practice is to seek help from solution providers with tools and methods to correlate results of in-house legacy codes with those of COTS solutions chosen to replace them.

OPTIMIZE SIMULATION/TEST TRADEOFFS

The relationship between digital simulation and physical test can be used as a lever to drive change in how each is used in product development. We found that best-practice leaders are pursuing a goal of carrying out as much design exploration and refinement as possible with simulation/analysis, and driving physical test toward a role of final design validation only. While none feel this goal is fully practicable – for example, use of new materials not yet characterized in software will continue to require physical testing – all identified this as an ideal and an aim point.

“...in the future it’s crystal clear that modeling and simulation will become more and more important, [and] physical test less important. You can only get rid of so much of it – people are constantly coming up with new physical materials [which] have to be tested to be understood. But given how expensive [physical] tests are, modeling and simulation will be used in their place whenever possible...” – Aerospace/defense company A

“...we use simulation first, then physical test to validate...” – Aerospace/defense company B

Key elements of this are to:

- Use simulation/analysis early in a program, when designs have not been detailed to the point where physical test is possible.
- Use simulation/analysis to drive the role of physical test away from discovery and refinement to final validation.
- Align simulation/analysis with corporate initiatives to drive time and cost out of product development.
- Use simulation and analysis to optimize physical test.



“...A lot of people think about product optimization, but they don’t think about test optimization...One best practice is to use Markoff chain principles: build a node diagram modeling the customer’s states of use of the product, then let the probabilities tell you the transition points from one state of the system to another...you can run a Monte Carlo analysis that mimics actual customer use, or use critical-path and other models...to actually test in the ways the customer will use the product. Another test optimization approach getting a lot of interest is the use of combinatorial design methods analogous to design-of-experiment techniques...to tell where to spend your test dollars to get the most valuable results...getting more value from test, and being able to find out things earlier about how the product will actually be used...” – Aerospace/defense company D

QUALIFY AND SELECT SOLUTION PROVIDERS

For companies with long development cycles and product service lives, simulation/analysis purchase decisions need to be grounded in not only technical but also business criteria. Current best practice is to separate these two variables: evaluate one set of solution providers on their ability to deliver the latest solver or mesher, and evaluate another set on their ability to help tie disparate tools together, streamline work processes, secure and shepherd corporate knowledge assets.

“...[technical software procurement] is a complex, bureaucratic, ad hoc process...Sometimes decisions will be made purely on technical grounds; other times they will be made purely on a business basis...nothing is ever cast in stone...nothing is ever final. In that sense it’s very good. You’re constantly in the mode of evaluating tools and their fit to the job at hand...” – Aerospace/defense company A

“...[simulation tool] requirements emerge out of [a particular program]. Some are unique to that platform, so those tools get purchased out of that contract. Others are more generic across product lines; those tools are bought out of our central engineering organization, and standardized [across the company]...A fair amount is bought with program money and direct-billed to that customer, and then a fair amount is directly bought and capitalized...” – Aerospace/defense company B

Technical evaluation criteria

Simulation and analysis software tools comprise (1) engineering analysis programs called solvers, and (2) programs used to create the data for input to solvers, and to interpret the results that solvers generate. Technical evaluation criteria focus on the functionality of these two classes of tool.

- Solvers – can they predict the physics?
- Meshers, gridgers, other tools for problem setup and results interpretation – can they speed up the process?

Current best practice is to treat point solution providers somewhat opportunistically, evaluating technologies and adopting them as they become proven. The art is being able to incorporate these into the next project without betting the company’s future – not a difficult challenge for companies that have made the right business evaluation.



Business evaluation criteria

- Openness to integrating internally developed codes
 - Ability to help ready internally developed codes for commercialization
- Attractiveness as long-term partner
- Premium on stability and relationship
- Commitment to providing help with process change, human/cultural issues
- Commitment to providing:
 - Knowledge capture tools
 - Process automation tools
 - Simulation data management framework

In aerospace and defense industries, the overriding business criterion to look for in a solution provider is its ability to help a company increase its permeability and access to new technologies and code streams – without requiring prohibitive new investments in integration, support and personnel.

Another key business criterion is staying power. With service lifetimes of aerospace and defense products often measured in decades, the solution providers most likely to maintain business continuity on this time scale are the ones that best-practice leaders choose to partner with. Manufacturers in some respects bet the company on those relationships: these are the companies that help with the essentials of tool integration, process definition, data management, knowledge capture.

SIX NEXT STEPS

To put these best practices into action, what can program managers and others do to get started?

Seek new-technology insertion points The highly program-centric nature of the aerospace and defense industries can slow adoption of new technologies and work processes. New-product development programs often span many years. Tools and techniques are validated and adopted at the beginning of a program, and build up a legacy of both data and user experience as the program advances. To insert a new tool, demonstrating payback is necessary but not sufficient; also needed is a process to ensure consistency in the changeover – a way of calibrating results from the old and new tools. In cases where a new technology offers significant benefit but the risk of a wholesale switch can't be justified, it may be possible to use the new tool in parallel to validate or supplement the existing one.

Best-practice leaders also pointed out that the appetite and aptitude for change varies tremendously from one program manager to the next. They advise seeking out managers especially open to change and comfortable managing the risks inherent in innovation, and working with them to pilot the new technology in a well bounded portion of a project. When the pilot shows results, start promoting the tool as a new standard – using everything from word-of-mouth to program-office mandates.



A new best practice we uncovered is the “found pilot.” More than companies realize, their people already have many of the newest tools and methods in use today – but in “fringe” areas. Instead of laboring to create pilots, look for unrecognized instances where new tools have already created success, and use that evidence to pull them into broader use.

Manage people factors **Garner executive sponsorship** – Find an appropriate time and venue to brief your CEO on the business impact of your organization’s simulation and analysis competencies. Reinforce management awareness of how the technology contributes directly to board-level objectives. Identify cases where early use of simulation and analysis was key to contract award. **Create incentives for discipline leads, analysts, engineers to take ownership of the new tools and processes** – Identify champions of advanced simulation and analysis within your organization. Enlist professionals who enjoy strong peer respect to lead process improvement initiatives. Cultivate corporate and public recognition of these champions.

Manage simulation data and processes For most organizations this is a new area where best practices are still being developed and validated. One way to start is to assemble a multidisciplinary team – include representatives from program management, the analysis and simulation groups, and the IT department – to audit current practices, benchmark them against industry best practices, identify gaps and bottlenecks, and develop detailed recommendations for improvement.

Rationalize the make/buy decision Make this an agenda item in planning and budgeting. Audit your current expenditures on both commercial software and internally developed tools, and revisit this allocation in each future budget cycle. Benchmark your organization against competitors.

Optimize simulation/test tradeoffs Audit three past projects – one highly successful, one typical, and one that could have gone better – to gauge whether superior management of the tradeoffs between simulation and test contributed to success. Use the audit to map existing processes for design refinement and validation, and identify opportunities for improvement,

Qualify and select solution providers In your organization’s next procurement cycle, revisit your qualification and selection policies for simulation solutions to ensure they address your requirements not just for superior point functionality but also for simulation data management, tool integration and process optimization. Factor in solution-provider stability and longevity.



***Best Practices for Implementing
Digital Simulation and Analysis in...***

- ***Aerospace and Defense***
- ***Aircraft Engines***
- ***Automotive Powertrain***
- ***Consumer Electronics***
- ***Off-Highway***

Five reports that reveal how savvy program managers at the world's leading manufacturers are implementing digital simulation and analysis to create business value.

Digital simulation and analysis is key to making better products more quickly at lower cost. But maximizing the technology's business impact requires far more than just buying the right point functionality and handing it off to the analysis department. Spar Point interviewed program managers and discipline leads at top-ranked manufacturers around the world to find out how they do it – what best practices have they developed to use simulation and analysis to break through the critical business constraints their companies face today?

Each of these concise, industry-focused reports details five best-practice lessons from savvy program managers. Use this exclusive intelligence to benchmark your company against industry best practices – learn where you excel, where to improve and how. And discover key learnings in other industries that you can apply to your own efforts.

For complete product information and details on price and ordering, contact Tom Greaves, Spar Point Research, at email tom.greaves@sparllc.com or phone 978.774.1102.