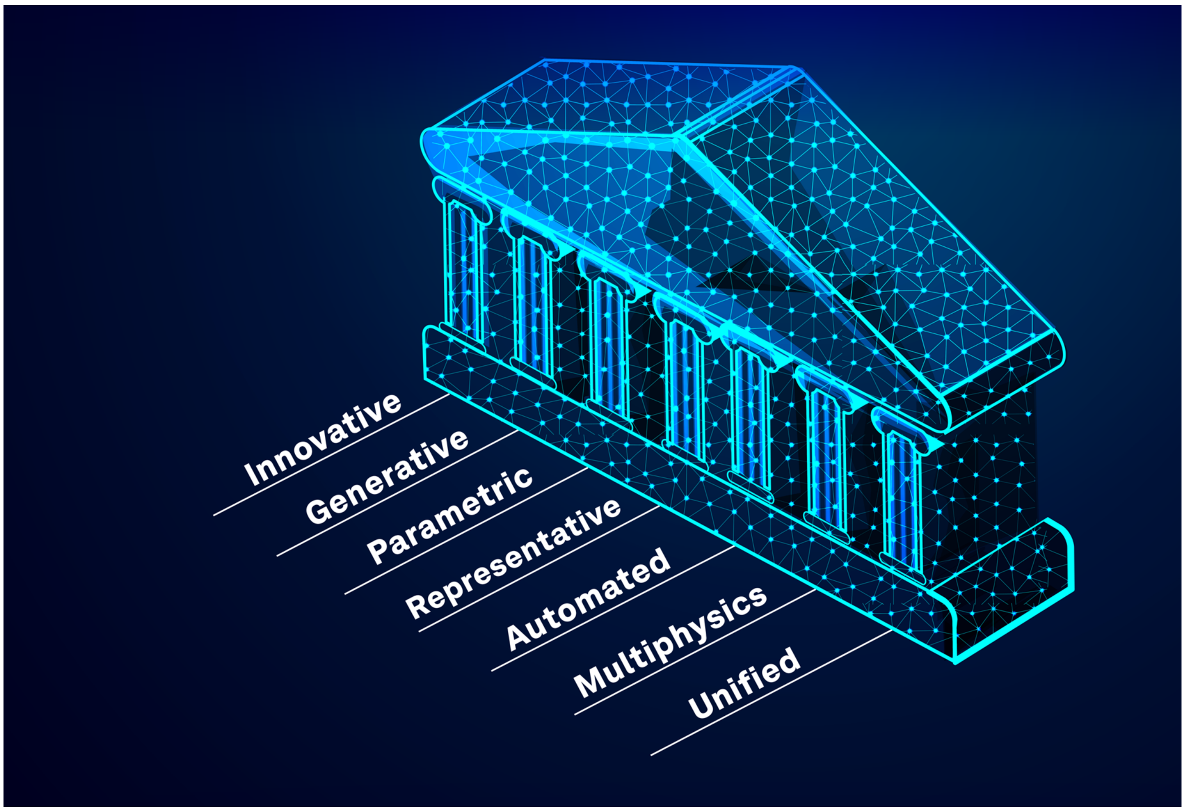
The Seven Pillars of Highly Productive CAE Simulation



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Executive Summary

The Computer-Aided Engineering (CAE) simulation industry is already over 50 years old and one of the 'Holy Grails' that still hasn't been achieved is to tightly couple the design and CAE representations of the product under development so that changes to the design are immediately included in the CAE analysis, and changes driven by the analysis are immediately incorporated into the design. Some have tried to solve the problem through embedding CAE capabilities inside CAD (Computer-Aided Design) software[1, 2] but that has typically involved compromises in accuracy and functionality or resulted in a compromise in the CAE user's experience within the design environment that has evolved to cater for the need of the CAD user.

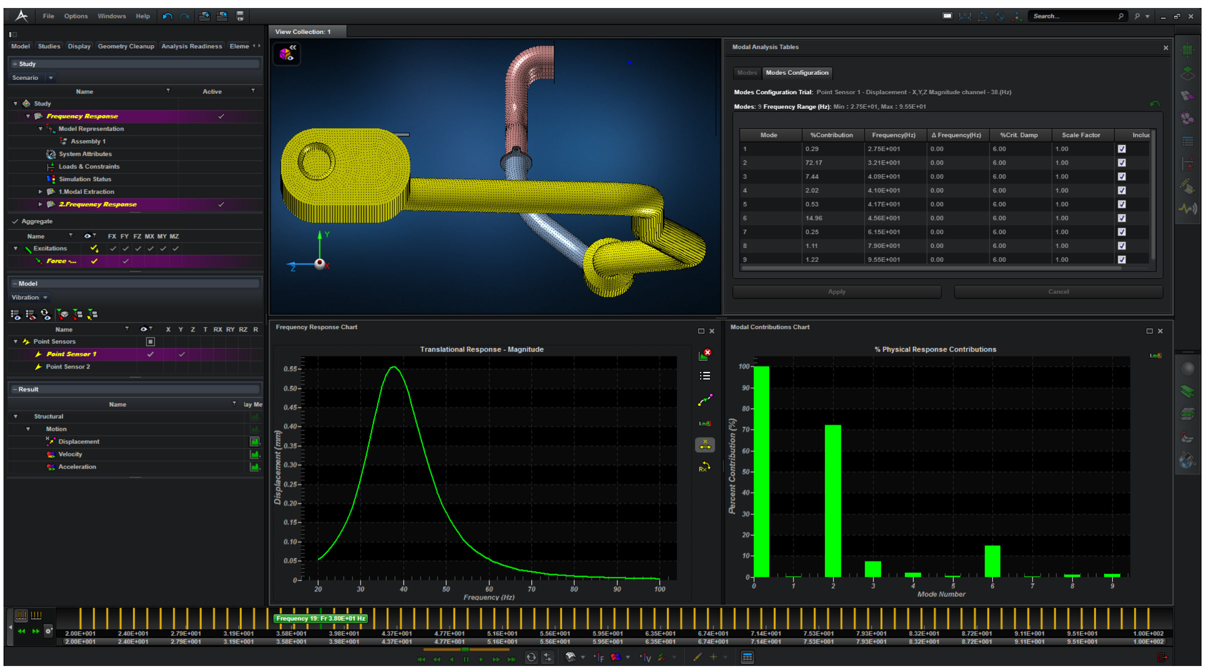


Figure 1. A glance of frequency response simulation within MSC Apex – the next-generation simulation platform from MSC Software

Introduction – Transforming the Traditional CAE Simulation Process

There has always been a gulf between the Mechanical CAD world and the CAE world over the provision and usability of CAE simulation tools that can work directly with CAD geometries, especially when considering the needs of industrial manufacturing requirements- accurate, repeatable, reliable simulations - within industrially relevant timescales for product research, development, production, manufacturing and deployment.

Either CAE has been used by highly educated (usually scarce, and highly paid) Analysts, or it has been only been used for limited applications within CAD software by Design Engineers working to tight product design, development and release schedules[3]. Although solution times within many CAE disciplines have become ever shorter over the years thanks to advances in high performance computing (HPC)[1], it remains true that the majority of time within a simulation workflow, typically more than 66%, is spent cleaning geometry, creating meshes, debugging and validating the simulation models. It leaves precious little time for engineers to review the response of the structures and mechanisms, understand their behavior and identify potential design improvements that could improve the product performance. Too many product development processes fail to produce optimum designs because the traditional CAE simulation process takes too long to complete. This causes companies to use simulation primarily for stress checking and not to identify optimum, or even just better designs

Today, it has been estimated that over 80% of all CAE simulations done in the world (by commercial codes) are still performed by CAE Analysts rather than Design Engineers because they haven't been able to access reliable and easy to use CAE simulations in numbers[1]. Hence, the biggest 'chasm' yet to be resolved in the CAE industry is to get the highest productivity out of existing CAE Analysts[1, 2, 3] while allowing these highly qualified engineers to do what they do best: make wise decisions in product development lifecycles. Ideally, engineering analysts who use CAE tools want to ask 'what if..?' questions early within their company's standard workflows. They want their CAE 'tool-of-choice' to come back with accurate answers- preferably in a real time and interactive manner, with minimal intervention to avoid onerous repeated pre-/post-processing tasks.

It should be noted that most CAE simulations performed around the world today are simulations of design iterations that have been simulated at least once before, and not new designs. A significant proportion of an analyst's time is therefore spent performing the same basic model setup and validation operations on successive sets for new CAD geometry, each representing the next design iteration.

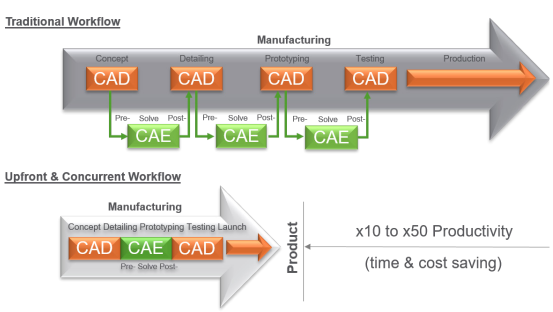


Figure 2. Comparison of CAE simulation design and engineering processes for a Traditional Workflow versus a Concurrent Workflow inside MSC Apex

CAE has matured to become an integral part of the product development lifecycle, whether creating, maintaining or reusing design and engineering. As such, design engineers or analysts require a sophisticated CAE environment that supports them to operate across the complete lifecycle and integrate with their CAD environments and provide open integration with their preferred CAE toolsets to aid productivity[3].

Moreover, CAE teams are adapting to new development cycles where new generations of engineers who are now expected to leverage multidisciplinary CAE knowledge to finish projects and collaborate across departments. They are also less tolerant of solver-keyword style simulation tools and too impatient to spend time to master them. They expect to be able to build complex simulation models without having an expert understanding of the specific CAE solver keyword interface. Thus, the ability to build valid CAE models using terminology that all engineers can understand is a crucial requirement to enable a concurrent workflow shown in Figure 2.

We believe that the key features for a 'next-generation' CAE simulation tool are to provide a user experience that is enjoyable, embed a goal-driven CAE simulation mentality, cover the complete Finite Element Analysis (FEA) of part to system simulation 'under one roof', adopt a generative and shared model representation that enables a series of truly coupled co-simulation across multidisciplinary CAE solvers, and automate as many mundane CAE tasks as possible.

In short, there is a need for CAE-centric engineering simulation software architected by the CAE engineer, for the CAE engineer.

Figure 3. The main business drivers for Product Manufacturing today

Manufacturers in every industry today are driven by business pressures (as indicated in Figure 3) to deliver better quality products, factory productivity, tighter security & warranty commitments to avoid recalls, legislative compliance that is both environmental-driven and safety-driven. But their design tools don't make it easy to access relevant insights and analyze decisions that could affect the cost effectiveness. Figure 4 shows that 70% of development costs for the creation of a new product, or the evolution of an existing product line process, are predetermined by decisions made early in research & development, namely the pre-CAD design stage. Pre-CAD design decisions also have the highest return on investment (ROI) of all CAE simulations in the complete design cycle. Get it right early, and you save costs fixing mistakes later in your manufacturing process. Once the product's geometric design is frozen, your company has already locked in most of your product's design value. Changes after that are very hard to make as the design, prototyping and manufacturing train has already left the platform.

If you can make most of your 'what if…?' decisions in the pre-CAD or initial CAD design stages such that your CAE simulations optimize the product performance early on, you get the most value out of the use of your CAE tools and deliver the elusive 'right-first-time' simulation ethos everyone strives for.

Repeatable, high-quality (i.e. accurate, yet fast) predictive CAE simulation is the 'Holy Grail' of engineering simulation and should drive the verification & validation process for any manufactured product. And such a simulation is always tied into a need for actionable CAE simulation data that is precise, targeted and timely. CAE can generate lakes of virtual simulation data, but the critical step is to make sense of that data early in the design cycle with the least amount of work for the CAE analyst. Generating smart and accurate CAE data early in the design process, which can be carried through and refined as the product is prototyped and tested, usually means getting the most significant ROI (return on investment) in your CAE implementation.

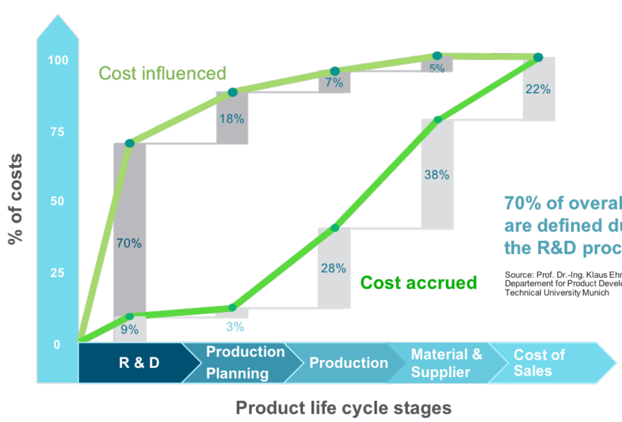


Figure 4. The relationship between costs incurred in product manufacturing versus stages of design from conception to production and deployment

Get the Right Solution at the Right Point in Time

CAE simulation tools confirm to the old computing adage that 'garbage in is garbage out', no matter how powerful the code is. A solver is only as good as the geometry, boundary conditions and material properties it is given to solve. In the simulation industry, we usually come up against the limits of physics or the numerical techniques we are employing. For example, to accurately predict the flutter boundaries of a wing (see Figure 5), high-order models or algorithms are adopted, which inevitably consume huge computing resources and engineering hours. Undoubtedly, such investment is worthy, because the accuracy of this multiphysics simulation does save lives.

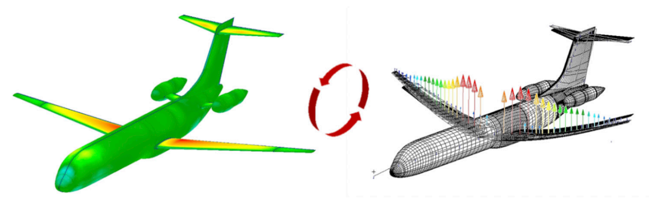


Figure 5. Fluid-Structure Multiphysics interaction of an aircraft in scFLOW and MSC Nastran

However, in an early conceptual design situation, exploratory models don't generally have enough detail to support truly accurate simulations – because that would involve way too much upfront design investment and lock you into complex 3D shapes, drastically reducing your ability to optimize or evaluate alternatives. It can feel that one-sided pursuit of accuracy in each simulation will backfire since it takes too much time, which could have been spent in exploring more possibilities to reach an optimal solution with better and more thorough performance. Therefore, the critical thing in real life is to understand what accuracy one can expect for a specific simulation complexity and choose the accuracy/throughput approach that's appropriate. We have architected MSC Apex software to achieve these goals. As an integrated simulation platform, it can offer you maximum engineering productivity yet enough simulation accuracy for different design purposes. The CAE productivity and corresponding accuracy behind MSC Apex is enabled by a set of complementary interacting technology we have devised and perfected.

Seven Enabling Technologies for Highly-Productive CAE Simulation

Since its release in 2014, MSC Apex from MSC Software has matured over the years to be a successful CAE-centric engineering design platform for both analysts and design engineers. It was conceptualized and architected to be a fully integrated simulation environment[3]. We rethought the CAE process from scratch, and have found many opportunities to deliver dramatic productivity enhancements to design engineers and analysts alike so that critical decisions can be made wisely while considerable time and money can be saved. We identified seven underlying technologies (shown in Figure 6) necessary for a paradigm shift in CAE usage and productivity enhancements of x10 to x50 for CAE Analysts across a wide range of industries that we have proven for FEA-led simulations and associated CAE toolchains to traditional FEA workflows.

1. Innovative Simulation Productivity

CAE users drive new features that improve their productivity and save time so they can identify more potential design improvements, and optimize them faster. MSC Apex has been architected with functionalities that directly address industrial pain points, and boost the productivity of CAE engineers through multiple innovations. MSC Apex incorporates direct modeling technology that enables CAD modification in a modern engineering environment. It is powered by a unique CAE-specific direct modeling and meshing engine that accelerates the CAD-to-Mesh process by a factor of 10. This unprecedented productivity gain for FEA Analyst versus traditional workflows.

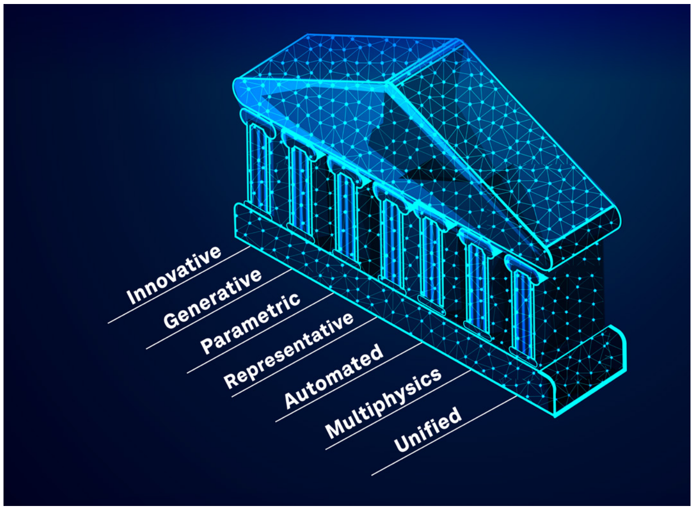
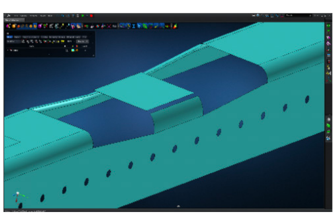
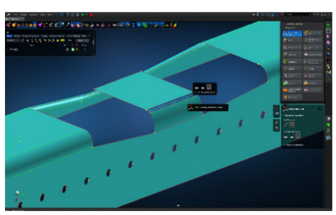


Figure 6. The seven enabling technologies that empower MSC Apex to deliver high CAE productivity

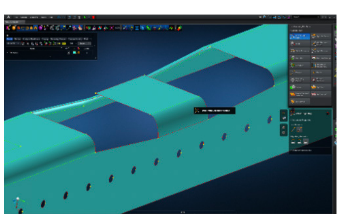
CAD geometry is not usually suitable for analysis immediately, and frequently so-called ‘dirty geometries’ are given to CAE engineers by CAD designers. Subsequent geometry repair, clean-up, and meshing operations are usually tedious, error-prone, and time-consuming. MSC Apex features a complete set of direct modeling tools to make geometry clean-up and idealization steps in an extremely fast and efficient manner. These features provide dramatic productivity improvements for engineers. One of the typical toolsets in MSC Apex is ‘Vertex/Edge Drag’ which means that instead of tedious operations of creating lines, splitting geometry and deleting, users can simply drag a vertex or edge to repair the geometry fast, as shown in Figure 7. This capability allows users to clean up geometry without any prerequisite experience and can reduce the number of user operations by a factor of 10.



a. Defects exist in the geometry file



b. Activate ‘Vertex/Edge Drag’ tool and close the gap



c. Defects are fixed and geometry is refined automatically

Figure 7. Demonstration of Vertex/Edge Drag tool to fill a geometry gap

The traditional CAE simulation environment depends on CAD software to modify geometries but MSC Apex removes this dependency. Figure 8 shows an intuitive yet powerful ‘Push & Pull’ tool inside MSC Apex to morph the geometry model directly to get the desired result quickly.

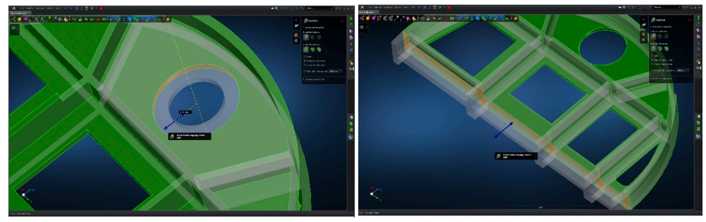
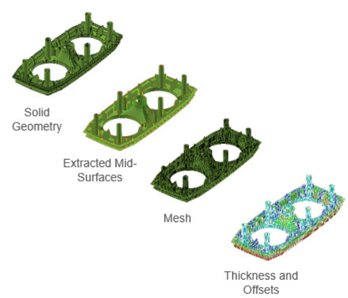


Figure 8. Modify geometry dimensions directly within MSC Apex by intuitively ‘Push and Pull’ a surface.

MSC Apex has also been architected with smart FEA/CAE workflows in mind. A radical workflow improvement inside MSC Apex is its smart mid-surfacing capabilities that enable fast converging of 3D FEA models to 2D models. Figure 9 shows detailed timing comparison on a benchmark geometry. Using MSC Apex, a watertight mid-surface model can be derived by simply walking through the process of surface pair identification, merging, offset-setting, and extraction. Users can easily achieve 10x productivity gains in a typical CAD to analysis-ready FEA workflow by employing this approach inside MSC Apex.



Time Spent	Current Workflow	Using Apex
Expertise Required	High	Low-Medium
Analysis Geometry	7 hrs.	0.75 hr.
Mesh Creation	2 hrs.	0.17 hr.
Property Assignment	1 hr.	0.08 hr.
Complete Entire Scenario	**10 hrs.**	**1 hr.**

Figure 9. Benchmark of a CAD to analysis-ready workflow with using MSC Apex’s mid-surface extraction method

The coupling of smart workflows with the generative characteristics of MSC Apex make it a very powerful tool. A dependency manager and generative framework are embedded within the software. It enables users to carry out end-to-end simulation workflows with full associativity between the geometry and analysis data. When new parts or objects are imported into the model, MSC Apex identifies dependencies between this new object and other existing objects. Once the ‘upstream’ object has modifications, the change will be synchronized to ‘downstream’ objects automatically, including mesh, attributes, and even simulation results. This fully generative behavior ensures that all aspects of the model are consistent and up-to-date following design changes. This is unique in the CAE industry and is a tremendous user experience benefit that enables engineers to drive the CAE solution with the geometry and receive significant productivity gains.

The smart model preparation functionality inside MSC Apex fully provides an integrated model validation toolset. It usually takes 3 to 5 experimental launches in conventional FEA for engineers to ensure their simulation is set up, without any guarantee of accuracy and correctness. Even this common validation process requires some level of experience and expertise. Imagine how much time such an approach can consume when you face multiple simulation tasks of different types?

To facilitate 'debugging' of model preparation, MSC Apex offers simulation readiness checks and a model diagnostics module, as shown in Figure 10. This module enables rapid exploratory studies to be set up by pointing out model defects in clear yet concise details, especially for structural FEA simulations. By leveraging such a capability, users can generally achieve baseline simulations within the first launch of solvers, such as MSC Nastran.

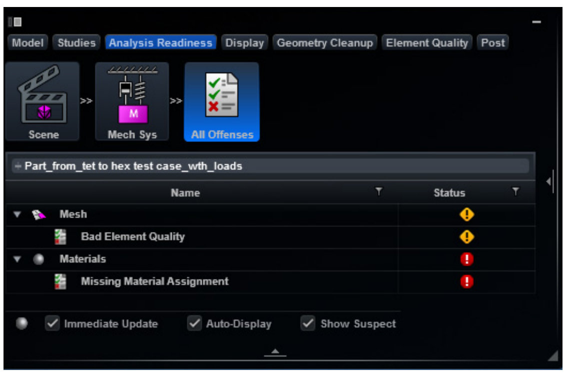


Figure 10. The integrated simulation readiness checks within MSC Apex

Today MSC Apex offers analyst-level CAE predictions with designer-level user experiences without compromising simulation accuracy. It offers a unique, enjoyable and easy-to-use engineering simulation experience, making it possible for non-CAE experts to learn the software in a single day, which is almost unheard of in the CAE industry for high-end solvers.

MSC Apex trims the training time from days to hours by employing a self-educating philosophy. As illustrated in Figure 11, each function has tool tips and tutorial videos to guide the user. Further, these tutorials and videos are available in 5 languages (English, French, German, Japanese and Chinese). This makes it easy for engineers to pick up and become productive in quality CAE simulation quickly. MSC Apex provides users with a CAE user experience that enables the democratization of CAE without loss of simulation fidelity.

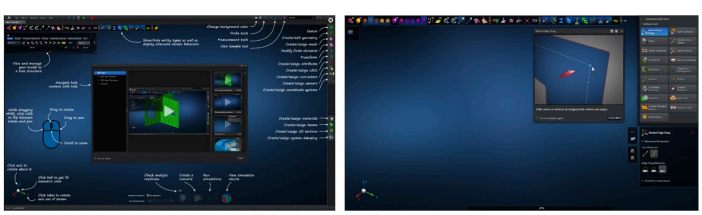


Figure 11. Embedded Help tutorials and at-mouse instructions in MSC Apex

2. Smart Generative Design Driven by Simulation

It's a deep rooted belief amongst analysts that CAE starts with CAD geometry, which is understandable because engineering has always started with a design. However, the increasing cost and tight schedule of product development does not allow engineers to build something from scratch every time. Therefore, to walk through design iterations at a fast pace, taking advantage of existing legacy resources becomes a natural step. However, such steps are not easy to make in some simulation tools.

One typical example would be projects related to product repairs, modifications, and services in the aerospace industry. Engineers working on such projects usually only have FE mesh files to start with. The original model geometry files may be either lost or inaccessible due to security reasons, which results in a huge effort for a group of design engineers and analysts to retrieve the geometry first. Direct edit on FE mesh files is an option, but this usually requires tedious manual work and leads to prominent comprise in model fidelity.

MSC Apex fulfills this missing link from simulation to geometry. Thanks to its geometry kernel and interoperability with MSC Nastran, MSC Apex enables the unique functionality of simulation generated design. Users can simply import an FE mesh file (a BDF for example) into MSC Apex and extract a high-fidelity geometry model directly from it (as presented in Figure 12). The newly constructed geometry can be edited as any other CAD geometry. Such a unique capability of MSC Apex allows engineers to reuse, redesign, and re-engineer from existing legacy models.

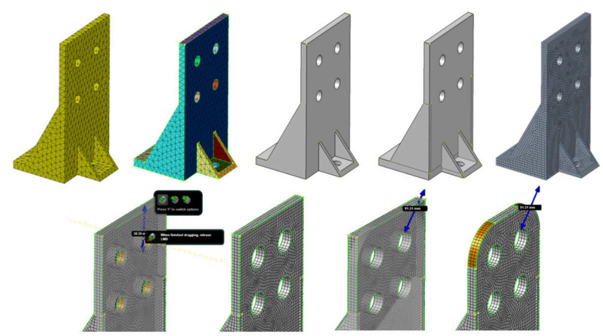


Figure 12. Regenerate geometry and recreate a Hexhedral mesh from a Tetrahedral meshed model (Top). Direct modeling on newly generated mesh (Bottom).

With the emergence of additive manufacturing (3D printing) as a viable new manufacturing technique, it has now become possible to manufacture novel designs using classic topology optimization methods[4, 5]. The standard approach is to look for the stiffest design at a given weight target, but this approach has many disadvantages. For example, the weight is not the result of an optimized design but needs to be prescribed as an input. This means that the lightest result is not found automatically, and the found design is not stress-proved so it must be validated in a subsequent step. If the stress is too high, manual geometry adaptations and further check loops are necessary. What's more, classical CAD topology optimization does not deliver a final part design, but an indeterminate idea in terms of a blurred density field. Interpretation and (semi-)manual derivation of a distinct design are necessary, which increases the workflow effort significantly. Even smoothing algorithms have difficulties in transferring this density field into a tangible geometry, as there is no unique solution.

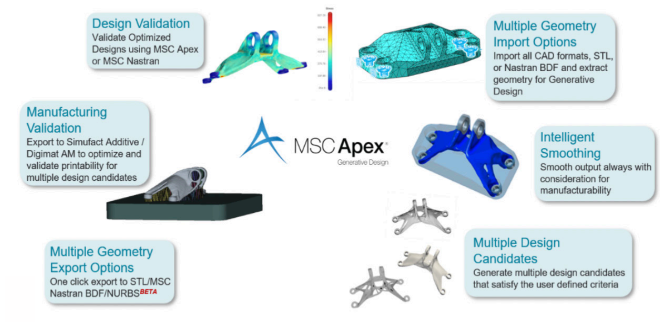


Figure 13. MSC Apex offers a unique Smart Generative Design capability results in stress-optimized parts validated for additive manufacturing

To overcome the constraints of classical topology optimization, MSC Apex smart Generative Design offers engineers a paradigm shift away from general-purpose CAD-centric optimization technologies to an innovative, purpose-built software solution for additive manufacturing that meets the needs of CAE engineers (see Figure 13). It enables the efficient development of highly complex components with numerous benefits as standard, from material saving and weight reduction to efficient, cost-effective production baked into the CAE decision making. Smart Generative Design technology eliminates inefficient manual effort that significantly slows today's additive manufacturing workflows, thus accelerating traditional 3D printing design workflows by an order of magnitude from several weeks to several days[6]!

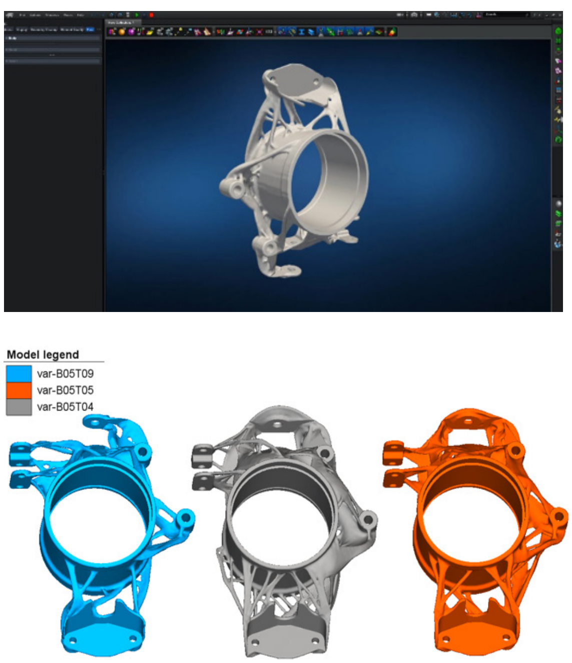


Figure 14. MSC Apex Generative Design engine enables optimization with smoothing (Top) and fast creation of multiple design variants (Bottom).

3. Parametric Simulation Boosts Productivity

The vast majority of CAE simulations that are run on any given day around the world are variations or evolutions of simulations that have already been run previously. Very few are simulations of completely new designs because today, more than ever product design is an iterative process. As designs evolve from initial concept to final design, a new simulation model may be constructed to represent the initial design concept and this single model usually requires multiple modeling iterations before it can be validated and used to predict product performance. Successive design iterations drive updates to the validated simulation model and subsequent reanalysis to predict the performance characteristics of the new design iteration. This traditional product development workflow leads to the creation of very few new models and simulations, but a large quantity of modified models and simulations.

MSC Apex provides two key capabilities that significantly increase simulation throughput and efficiency for iterative product development processes:

Automatic Generative Update

The MSC Apex platform includes an integrated dependency manager and generative framework. When new objects are added to the model, MSC Apex identifies any dependencies that the new object may have to existing objects. Later, if an 'upstream' object is modified, the dependency manager drives any 'downstream' objects that are dependent upon the upstream object to be automatically updated. For example, if a geometry body is modified to reflect a product design change, all mesh bodies, materials, properties, loads, constraints, connections etc., that reference the modified geometry body are notified of the change by the MSC Apex dependency manager and automatically update themselves to reflect the change to the upstream geometry body. If the part containing the geometry body has previously been used in a simulation, MSC Apex will automatically solve the updated model to produce new CAE results data to reflect the design change. If post-processing plots have previously been generated from the original results data, these will also be automatically updated to reflect the updated design.

Automatic generative updates can significantly increase simulation throughput and efficiency, plus significantly reduce the time required to generate new product performance data following design changes.

Parametric Expressions

Product designs can often be expressed parametrically. For example, a product may be available in a range of sizes where the differences between each size can be defined using different sets of key dimensional values. During product development, it is often valuable to investigate the effect that different shapes, sizes, features or just about any other model property has on the performance of the product. Traditionally, simulation systems have required users to manually construct different models for each unique combination of shape, size, feature or other model property and then run the simulation and review the responses. MSC Apex enables users to define any model property parametrically. Instead of entering a value for the property, users may define an expression that will yield a particular value when being evaluated. The expressions are defined using the Python scripting syntax and can reference other objects in the model.

The use of parametric expressions offer engineers huge productivity gains by reducing the amount of time and effort required to build, simulate and post-process different variants of a model. Parametric expressions are fully supported by the MSC Apex generative framework, and therefore changes to one object driven by an expression can generatively update other objects in the system simultaneously.

4. One Representative Definition for ALL Missions

Reliable prediction of product performance typically involves multiple simulation technologies. System-level loads may be calculated using a multi-body dynamics approach, subsystem loads using finite element models constructed from shell and beam elements, and detailed stress levels using non-linear finite element models constructed for solid elements. Traditionally, each of these simulations is carried out using completely different models – despite the fact that each analysis is actually simulating the SAME product design. The use of separate models for each discipline is time-consuming, error-prone and makes sharing of information between disciplines and departments awkward. The inefficiencies of this approach are further amplified when a design change is introduced, then ALL of the models need to be independently updated.

MSC Apex provides a multi-representational simulation environment to address such inefficiencies. Assemblies, parts, connectors, loads and constraints can each support multiple representations and solutions can be performed using any of MSC's trusted Adams, MSC Nastran and Marc solvers, as presented in Figure 15. A single part, for example, can contain a rigid representation suitable for multibody dynamics simulation using Adams, a beam/shell element representation suitable for linear finite element simulation using MSC Nastran and a solid element representation suitable for nonlinear finite element simulation using Marc. Each of the representations are synchronized through a backbone of the same geometry definition – so when a design change is introduced, ALL of the part representations are immediately aware of the change and can be automatically updated by the generative framework embedded in MSC Apex. This novel mechanism significantly reduces the time and expense to update each simulation to include the design change and ensuring that the design change is correctly included in ALL simulations.

In addition to improved simulation efficiency, multi-representational simulation allows for a simple comparison of key result metrics from different simulations. Because each simulation uses different representations of the SAME part, connector, etc., equivalent simulation responses are easy to identify and can be compared for a complete analysis of the same part.

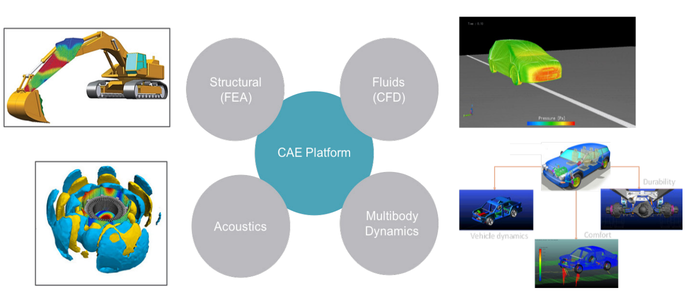


Figure 15. Multiphysics simulation enabled by the multi representational simulation environment in MSC Apex

5. Automated User-Defined Workflows for Maximum Productivity

Most CAE applications have an old style embedded Application Programming Interface (API) to achieve automation. MSC Apex delivers a modern, comprehensive Python-based API. Because Python is a popular and accessible high-level language, it drastically reduces the threshold of coding experience and democratizes the capability of process automation and workflow customization to engineers without previous coding experience. For example, creating rivets among parts in a thin-wall assembly is quite tedious and time-consuming. Figure 16 shows that users can develop a Python script in an intuitive manner to automate the repeated workflow by taking advantage of the simulation API.

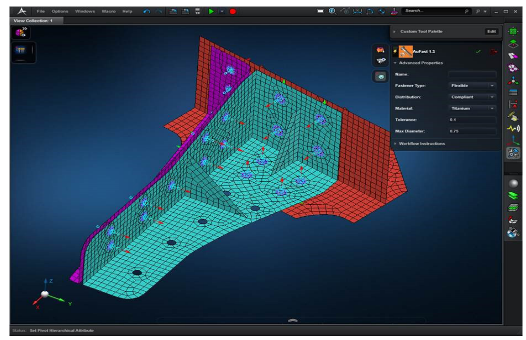


Figure 16. Leverage the simulation API to automate rivets creation on aerostructures

Even if you have no previous knowledge about coding in Python, MSC Apex offers a convenient Macro Record/Play tool to enjoy productivity enhancements from automation. Rather than wrestling with a new scripting language to call the API, they can simply record operations they want to automate as a macro program and replay it on other models. MSC Apex intelligently captures the user's operations and converts them into Python scripts for your future use automatically. More importantly, the comprehensive simulation API of MSC Apex allows users to customize an 'in-house' workflow that integrates specific 'engineering knowledge'. A good example would be the unique conceptual modeling environment for an OEM's aircraft design.

MSC Apex can automatically generate as many variants of an aircraft's design as needed to search for the optimal design configuration. The scripting capabilities delivered in MSC Apex allow the user to create full vehicle models automatically based on user-defined parameters, pre-defined fuselage sections, and idealized representations of stringers, spars, and frames. Engineers can therefore fully automate model import, partitioning, meshing, assembly connection, part attribution, scenario definition, execution, and post-processing. With this approach, it is not only easy to customize Python scripts for various design purposes, but also to capture engineering knowledge and connect to PLM databases to build an analysis-ready model for MSC Nastran.

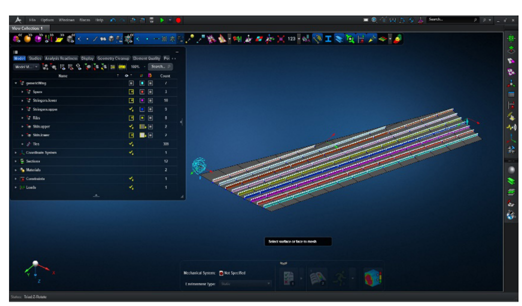


Figure 17. Automate conceptual modeling of wing structures by using MSC Apex API

The user benefit of such automation capabilities can be extended far beyond daily productivity gains. Engineers can now explore as many options as possible in the early design stage to avoid meaningless iterations on a suboptimal design, while simultaneously reducing the huge costs that result from long design processes, and potential human errors(3).

6. Trusted Multiphysics Simulation

MSC Apex was architected from conception to become the world's first co-simulation multiphysics platform to employ the world's most trusted CAE solvers across multiple physics types to the same geometric part. Gold standard FEA and motion solvers (MSC Nastran, Marc, Adams) that form the basis of regulated and large enterprise workflows are now loaded in the platform so that users prepare and perform multiple types of physics simulation within exactly the same environment and experience.

One of the trusted solvers MSC Apex is able to interact with is MSC Nastran. MSC Nastran has been widely regarded as the gold standard FEA structural analysis code for a wide range of industries and applications today and for 50 years. It provides multidisciplinary structural analysis software used by engineers and analysts to perform static, dynamic, and thermal analysis across both linear and nonlinear domains, complemented by automated structural optimization and award-winning embedded fatigue analysis technologies, all enabled by HPC. MSC Nastran is the most widely used solver, and also the most extensive, the most trusted and the most accurate version of Nastran.

However, preparing a simulation-ready deck for Nastran simulation is not that easy. The conventional preprocessing tools either require significant expertise to use or are not user-friendly. This not only impedes less experienced engineers accessing advanced FEA analysis, it also reduces the daily productivity of expert users. To address such pain points torturing FEA analysis users in Aerospace, Defense and Automotive companies, MSC Apex has been connected interoperably with MSC Nastran, combining world-class user experience with the industry's most trusted multi-disciplinary FEA solver effortlessly. With robust support for industry-standard '.BDF' file import and export in FEA, MSC Apex makes data migration easy and smooths the integration of the software into existing toolchains that involve MSC Nastran (as shown in Figure 18).

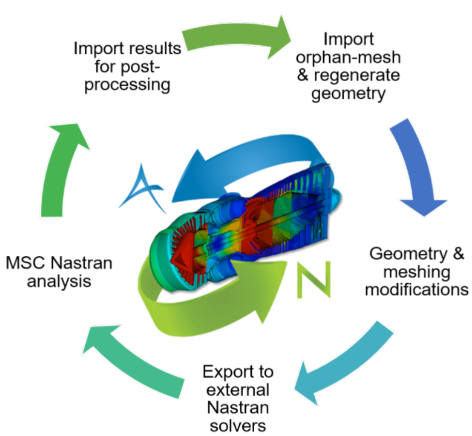


Figure 18. Interoperability between MSC Apex and MSC Nastran

In addition to MSC Nastran, MSC Apex is incorporating Adams, Marc, gold standard solvers for Multibody Dynamics (MBD), Nonlinear Mechanics respectively, into the platform. MSC Apex can now access an Adams mission within MSC Apex. This enables users to define their own workflow to connect their MBD (Adams) model to an FEA solver (MSC Nastran) for a multiphysics simulation.

At most companies today, CAE is performed as an isolated activity within a single functional team or engineering discipline. The performance, safety, and reliability of products, however, is greatly influenced by the interactions between these physics types. To maintain high quality standards throughout a product development pipeline, it is inevitable to push exploratory analysis into the hands of those without deep expertise in the analysis (Design Engineers) while allowing Analysts to focus on advanced analysis and derive improvement insights. This trend raises challenges to dramatically reshape engineering workflows in OEMs (Original Equipment Manufacturers), and the groundbreaking technologies inside MSC Apex make it a cutting edge platform with which to address future challenges, described in Figure 19.

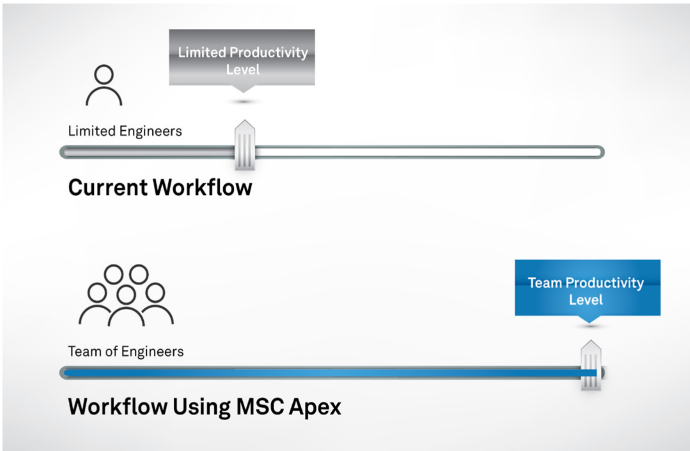


Figure 19. Figure Comparison between engineers capable of accessing simulations between a traditional workflow and a concurrent workflow

7. Unified Simulation Experience

Achieving consistent product quality is one of the most complex and demanding challenges OEMs face today. Requirements are driven by a mix of customer expectations, government regulations and quality issues and determines the bottom line in every industry.

To guarantee product quality, engineering teams want to prove their products are defect-proof under more complex operation scenarios, where multiple types of simulations are required. However, the burden of performing multidisciplinary simulations is placed back on the engineer. Practically, most engineers would probably be only proficient in a specific type of simulation software. Traditional advanced simulation tools require a steep learning curve to master the technology. To compound this, the company's existing simulation software stack may consist of products from different vendors and in-house tools, each with a different user interface and environment. In addition to the inconvenience of switching environments and loss of time, there is a potential risk of data loss due to translation.

MSC Apex provides a unified simulation experience so that users with different experience levels can access new types of simulation with a minimum learning threshold. Its features and workflows are designed and arranged in a manner matching engineering intuition. This refers to as "Common Engineering Abstraction" within MSC Apex. Users can leverage their prior knowledge and experience to help them approach a different kind of simulation. Using MSC Apex "mission" concept, users can switch back and forth between different types of simulation seamlessly within a concise and intuitive environment so that they can focus on a specific task all the time. Though the front-end interface is easy to access, it does not mean the simulation solvers at the backend compromise accuracy and performance, such as traditional CAD-embedded CAE tools. MSC Apex's design paradigm guarantees that users can enjoy both a consistent stylish GUI and its unique direct modeling and generative capability in any simulation missions. In other words, if you could receive a 10x productivity gain in your FEA mission, you can naturally expect the same enhancement in the MBD or Generative Design mission as well.

To better facilitate the unified user experience across different types of simulations in the MSC Apex platform, MSC Software has introduced an expanded product token system, called MSC One, that lets users access a broad array of MSC products and take advantage of the breadth and depth of MSC Software's simulation portfolio without concerns about licensing and subscriptions. No matter what size of a company, MSC One can allow users to create a flexible environment and accelerate innovation.

Conclusions

Bridging the chasm between CAE and CAD is a significant challenge and a bold vision. We have shown that to provide a coherent holistic solution to revolutionize CAE simulation-driven design requires technology innovations in interactivity, automation, generative design, democratized user experience, tool chaining of co-simulation applications, and goal-oriented workflows for industrial applications.

MSC Apex is the next generation design-centric CAE engineering platform that real world engineers need today. With its unique built-in direct-modeling technologies and smart workflows, MSC Apex aims to provide users a world-class user experience and at least a 10x productivity enhancement versus traditional CAE simulation. It is ideal for large OEMs that require a unified CAE environment to collaborate across departments and disciplines and share design data across applications. With greater efficiency it provides a modern GUI that accelerates model definition and improves usability compared to traditional CAE workflows.

The business benefits are clear for such an innovative CAE environment delivering unprecedented efficiency and proven accuracy:

- Enhance productivity through user-defined CAE simulation workflows
- Accelerates design maturity with 'right-first-time' simulation

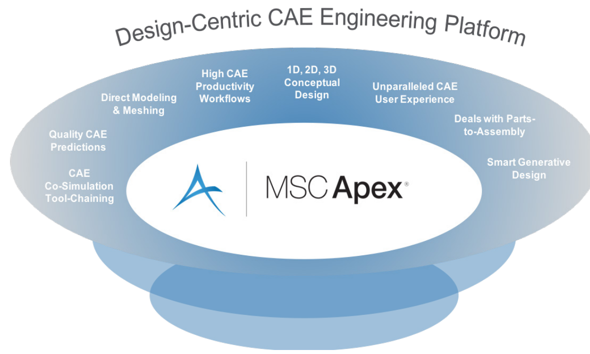


Figure 20. MSC Apex is a design-centric CAE engineering simulation platform

- Optimize designs to improve product performance and quality
- Improve OEM's confidence for governmental certification and compliance
- Increase time-to-market to gain an essential competitive advantage
- Fast-track onboarding time and future-proof engineering skills

References

1. "The Democratization of CFD", Hanna R.K., Weinhold, I., Mentor Graphics White Paper, 2017, https://www.mentor.com/products/mechanical/request?selected=100369&null&fmpath=/products/mechanical/techpubs/requestpubs&id=100369
2. "Back to the Future: Trends in Commercial CFD", Hanna, R. K., Parry, J., NAFEMS World Congress, Boston, USA, 2011
3. "The State of Simulation-Driven Design", Lifecycle Insights Report, 2013, https://www.lifecycleinsights.com/resource-library/the-state-of-simulation-driven-design-report/
4. '"Generative Design" – What's That?', K. Mientjes, CIMData blog, June 26, 2017, https://www.cimdata.com/en/news/item/8402-generative-design-what-s-that
5. "Generative Design: The Road to Production", P. Keane, June 7, 2018, Engineering.com: https://www.engineering.com/DesignSoftware/DesignSoftwareArticles/ArticleID/16973/Generative-Design-The-Road-to-Production.aspx
6. "Hexagon Acquires AMendate to Shape the Future of Generative Design", Hexagon/MSC Press Release, 24th June 2019. https://www.hexagonmi.com/about-us/news/media-releases/2019/june-2019/hexagon-acquires-amendate-to-shape-the-generative-design-market

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