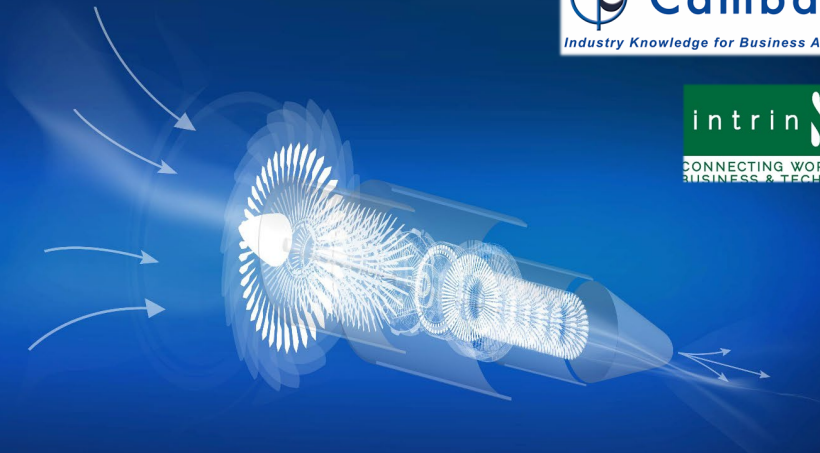


# The Changing Role of Simulation and the Simulation Revolution



Joe Walsh, CEO. intrinsicSIM  
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*Engineering Simulation has grown into significant importance in the engineering design process over the last four decades with technology drivers enabling its broader and improved application. This growth in importance has been accompanied by a growth in awareness of the benefits and key business drivers, which then also brings a new set of opportunities and challenges related to increased demand. The Engineering Simulation market is struggling to meet this surge in demand, and a Simulation Revolution is needed to overcome the shortage of expertise, which prevents broader application. Cambashi has been providing insights into the 2D & 3D CAE market with its CAE Observatory since 2015. The 2020 release of the CAE Observatory illustrates that the Simulation Revolution has begun with increasing annual market growth rates forecast compared to previous years – excluding 2020 of course. The emergence of Generative Design and Digital Twins are combining with the other business drivers to increase the demand for Engineering Simulation.*

*This paper reviews the Changing Role of Simulation and the start of the Simulation Revolution.*

### Evolution Through Technology Drivers

From the mid-1970s until recently, the role of simulation has been determined by the state of the technology enabling different uses. The advancement of technology enabled more applications and more efficient application of Engineering Simulation while delivering higher value. The application and role of Engineering Simulation within organizations have typically followed a series of Technology Drivers – Failure Analysis / Design Validation / Design Decision Support / Design Drivers / Systems Engineering / Generative Design.

These technology Drivers have enabled a sustained double-digit annual growth of the Engineering Simulation market from the mid-1970s through to 2009. The improved efficiency, coupled with user training, enabled the high growth rate to be sustained. The worldwide downturn in 2009 affected the Engineering Software market as well (more about that later), and after a significant dip in 2009 and a recovery from 2010 to 2011, the growth rate continued at a new "evolutionary" rate of high single-digit percentage growth per year. This growth rate was noticeably slower than the pre-2009 rates but was still significantly higher than the other engineering software markets (e.g., PLM, CAD, CAM, ...)

Cambashi released the first version of the CAE Observatory in 2017, which included data on over 450 software vendors offering 2D and 3D Engineering Simulation. The CAE Observatory illustrated that the projected annual growth rates until 2019 were consistently in the "evolutionary" rate of double-digit percentage growth per year.

The nature of the advancements of technology and the Technology Drivers associated with Engineering Simulation made it clear that long term evolutionary growth was sustainable.

## Revolution Through Business Drivers

The worldwide downturn in 2009 had a much broader impact on business in general and a complete rethink of what it took to build and maintain competitiveness. The changing role of Engineering Simulation since 2009 is really about Business Drivers for improved competitiveness:

- Increase Innovation
- Increase Performance
- Improve Quality/Risk Management
- Reduce Time
- Reduce Cost

Organizations around the world began to understand that a better understanding of product and process behavior and the associated risk was crucial for making a positive impact on these Business Drivers. The realization is also quickly following that Engineering Simulation is the only viable method to achieve this improved understanding and is, therefore, a major key to all 5 Business Drivers. However, Engineering Simulation software is still typically used only by expert analysts leveraging more and more sophisticated tools, and there is a need to significantly expand the usage to a broader audience to impact the Business Drivers. The Business Drivers are going to force a "Simulation Revolution" to overcome the expertise-based limitation, and Engineering Simulation will be forced to find a way to support its newly found role as a key enabler to increased competitiveness.

## The Simulation Revolution is Real And Coming to a Town Near You

The concept of an inevitable Simulation Revolution was first introduced by the [ASSESS Initiative](#) which was formed in 2016 to facilitate a revolution of enablement that will vastly increase the availability and utility of Engineering Simulation, leading to significantly increased usage and business benefits across the full spectrum of industries, applications, and users. The vision of the ASSESS Initiative is to bring together key players for guiding and influencing the software tool strategies for performing model-based analysis, simulation, and systems engineering. Several organizations have collaborated with the ASSESS Initiative to enable this Simulation Revolution, including [Revolution In Simulation](#), [NAFEMS](#), and [INCOSE](#).

Cambashi has just released the 2020 update of its CAE Market Observatory and the data shows that the CAE market has been growing in double digit figures and will continue on that path - except for 2020 – illustrating that the efforts of the ASSESS Initiative and other organizations are beginning to make an impact on overcoming the expertise based limitations for Engineering Simulation.

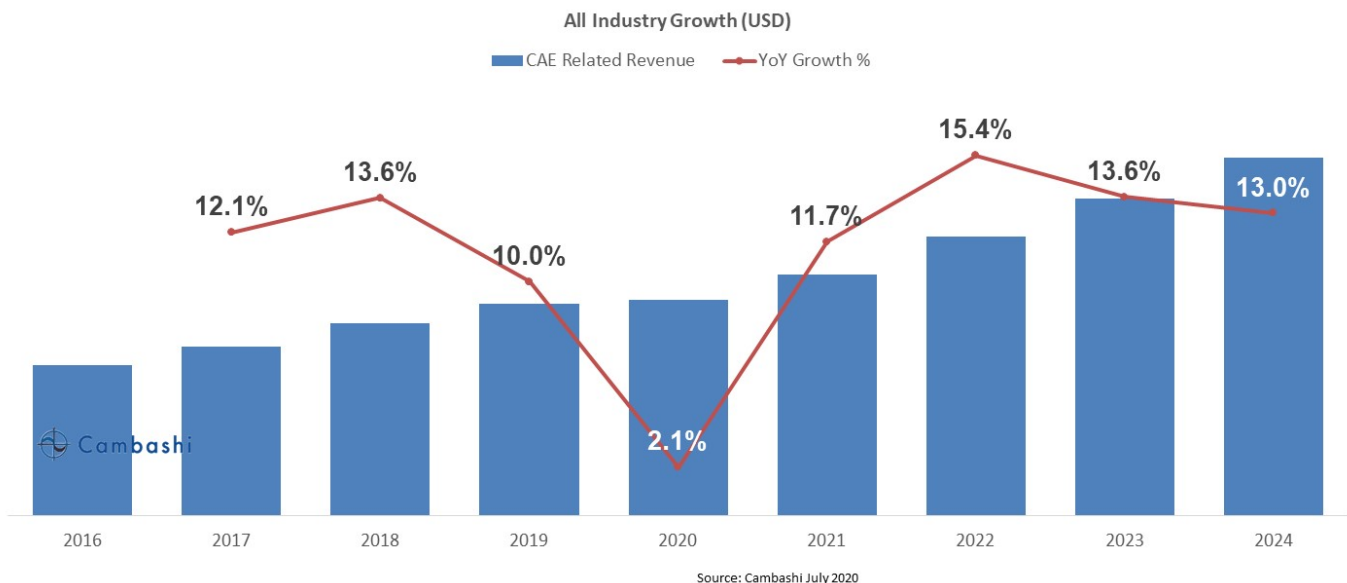


Figure 1: 2D & 3D CAE Market Growth - Cambashi

These growth rates illustrate that this is just the beginning of the Simulation Revolution, which will continue to grow as more and more organizations realize that Engineering Simulation is a Key Driver to the Business Drivers that enable increased competitiveness. While 2020 will present lower growth rates, and Cambashi expects negative growth from e.g. the automotive industrie, growth overall is still expected to be positive. Going forward, the trends that were driving adoption of simulation have not gone away because of COVID-19. The need to develop new, greener versions of any kind of product will accelerate, especially in industries generating vapour trails. And COVID-19 is also opening up new opportunities especially around modelling air flow, people movement and space organization in any kind of building – be that a factory, a museum, an office, transport, etc. – where people spend significant amounts of time in close proximity. The need to provide a safe working environment to get industries back to some kind of normal situation could also result in new linkages between CAE and BIM vendors and CAE and IIoT/Connected Application technology providers.

CAE Market Growth for Selected Industries

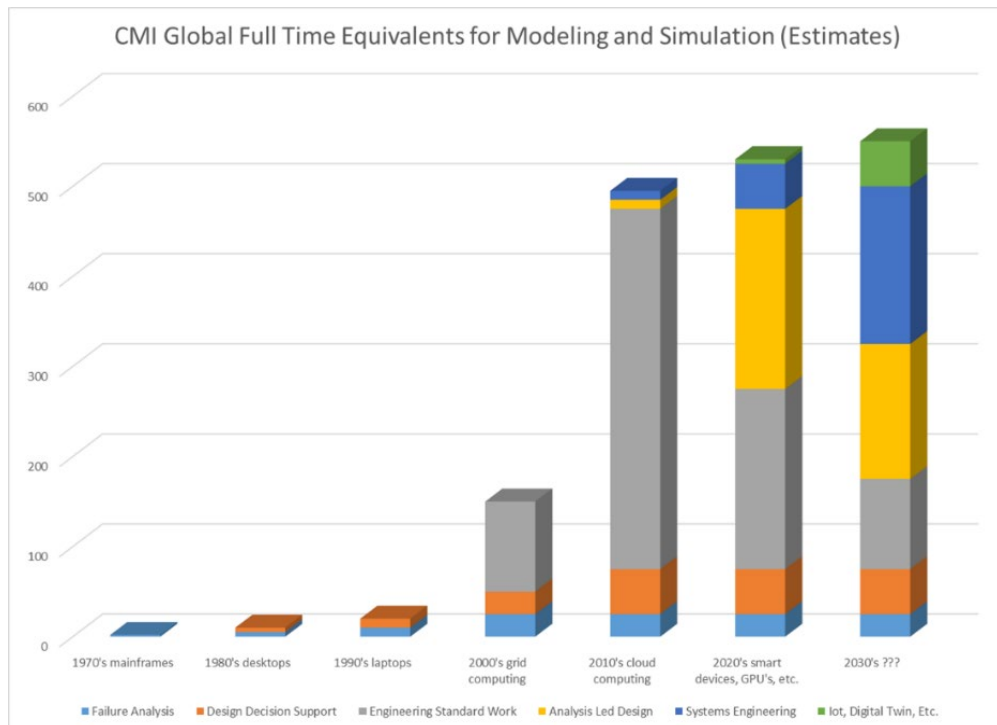
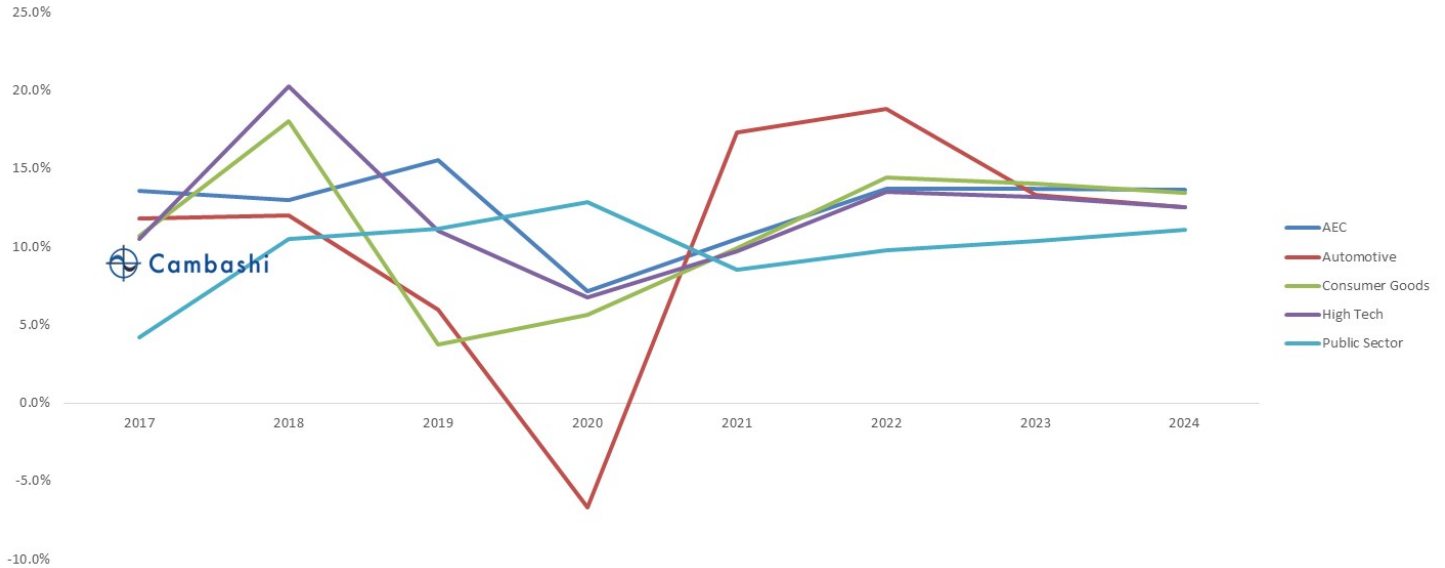


Figure 2: Automotive Supplier estimated use of Engineering Simulation - courtesy of the ASSESS Initiative

## The Emergence of Generative Design

Generative Design has the potential to initiate a significant paradigm shift in the design processes used today by enabling designs to be computer-generated based on a clear specification of rules, requirements, and constraints. This overturns the current practice of design, where designs must first be created so they can be evaluated against their performance requirements. Generative Design has the potential to be a key enabler of Democratization of Engineering Simulation by enabling the user to define a design scenario and allow a Generative Design tool to explore the design space for feasible design options.



Figure 3: Generated design options - courtesy of Autodesk

The vision for Generative Design is an environment, or platform, for design space exploration that enables a wide range of technologies, including optimization algorithms, robust design, artificial intelligence, and machine learning to consider and evaluate significantly more design options than a human could. Generative Designs are best employed in "early stage" design concepts to produce viable design concepts that are likely to pass subsequent evaluation/validation efforts. Driving Generative Design upfront to the "early stages" of the development process will change the nature of the work that is done, which will cascade to change the work done later in the process. Generative Design tools are continuing to expand their support of different manufacturing process and some Generative Design tools support "Design for Manufacturability" and manufacturing cost estimation.

## The Emergence of Engineering Simulation Digital Twin(s)

Digital Twin(s) and specifically Engineering Simulation Digital Twin(s) are an essential part of any enterprise Digital Thread strategy to enable digital transformation across the domains of product development, manufacturing, and in-service operations. To address the objectives of digital transformation, most major PLM and Engineering Simulation vendors are actively pursuing some form of Digital Twin strategy that includes a physics-based Engineering Simulation Digital Twin(s) to enable capturing knowledge and developing an understanding of the current and predicted state and performance of its Physical Twin.

Exploitation of Engineering Simulation Digital Twin(s) is a potentially positive disruptive approach for certain types of physical assets where: (a) servicing is hard or extremely expensive, (b) ongoing maintenance is critical, (c) physical assets have a long life, or (d) physical asset operations are considered mission-critical and/or safety-critical. The use of Engineering Simulation Digital Twin(s) is also expected to open up the potential for multiple new business models for products-as-a-service such as aircraft engine contracts that provide "power by the hour" to the airlines, including 24x7x365 maintenance.

## A Rash of Acquisitions

It should come as no surprise that the larger software vendors in the engineering software space were the first to recognize the sustained long-term growth of the Engineering Simulation market along with the potentially larger growth associated with the Simulation Revolution. This recognition quickly elevated the strategic importance of Engineering Simulation software to their portfolios and has resulted in a rash of acquisitions. The pace of these Engineering Simulation related acquisitions is not likely to decrease soon.

More on acquisitions in the Engineering Simulation market later.

## The Simulation Revolution has already begun!

The changing role of Engineering Simulation is really about business drivers for improved competitiveness. Engineering Simulation provides a better understanding of product and process behavior, variability, and risk to support the drivers for increased competitiveness.

- Increase Innovation
- Increase Performance
- Improve Quality/Risk Management
- Reduce Time
- Reduce Cost

The Simulation Revolution to support this changing role has already begun and is gaining traction quickly; However, this revolution is still in its early stages with substantial, sustained growth of the Engineering Simulation market likely for the foreseeable future.