PARADIGM SHIFT: COLLABORATIVE SIMULATION

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ABSTRACT

Collaboration is the new buzz word across the globe in leading organizations. Collaboration is a Latin word meaning “to labor together” in other words “a process through which people / organizations work together for a common goal”. Organizations are collaborating employees / business partners / share holders / Suppliers / Customer under one plateform and gaining advantages. Modern IT and communications tools have made the approach possible. Organizations have gained advantage with IT tools such as PDM, ERP, PLM etc. Simulation is no exception to that. With gaining importance in any design cycle, it is mandatory to involve all stakeholders in the process from day one and also use the expertise and experiences of earlier simulations conducted on same or similar conditions. For the purpose of collaboration, data & processes of simulations are stored in a suitable environment / application and retrieved as and when required. Computer-aided Engineering developers have recognized the potential of the IT for collaborative engineering and have implemented applications for the managing, sharing and communicating of simulation related data. Commonly these applications are termed as Simulation Lifecycle Management, Simulation Data & Process Management, Simulation Data Management, Engineering Knowledge Management, Enterprise Simulation Management, virtual build & test management. For the purpose of this paper this will be termed as Simulation Lifecycle Management. This paper reviews the features of products of 4 major application developers in the field i.e. Dassault Systems, MSC Nastran Corporation, ANSYS Inc & Siemens AG & their products Simulia SLM product suite, SimManager, EKM & Teamcenter Simulation Process Management respectively. Available & desirous collaborative features of Simulation Life Cycle Management application in reference to impact on usage / industry are discussed & all four applications are analyzed. The goal of the efforts described in this paper is to provide the features useful for collaboration based simulation lifecycle management system, their impact on performance of its users.
1. INTRODUCTION

Simulation has gained an important place in today’s design offices / centers / design cycles. No design cycle is complete without major or minor simulation work involvement. In early CAx days simulation was performed for space research or defense applications only where physical testing of components / designs was not feasible. Slowly with reducing cost of hardware and increasing PC speeds, simulation made entry to bigger automobile organizations and now it is being used in almost all level of industries / organizations from large to medium & small size industries. Simulation is being used as a design tool now in place of design validation tool. In place of using after design cycle, it is being used during the design process to make sure that design does not change after spending so many man hours on same.

As per Wikipedia, **Simulation** is the replication of some real system, state of affairs, or process. A computer simulation is a computer program that attempts to simulate a theoretical model of a particular system. There are three methods for computing / solving / verifying engineering problems i.e. experimental, computational, and theoretical. In many cases, it is very difficult to find the theoretical solution for a complex engineering system. Thus experiment is the best choice, because experimental techniques can look into a wide range of verification issues very efficiently. However, experimentation needs high cost, time and is restricted in many cases. For this consideration, computer simulations are often used to get an understanding of a particular physical process or situation [1]. When mathematical resolution of optimization models is impossible or impractical, engineers resort to simulation [2]. System simulation is an effective approach that serves the purpose of providing extensive support for engineering system design [3]. A paradigm of simulation based design (SBD) has been proposed to study the role of simulation technology in the lifecycle of product design [4]. Simulation Based Design is a process in which simulation is the primary means of design evaluation and verification. When coupled with appropriate validation processes executed during the development of a simulation based design system, the resulting capabilities can provide companies the ability to design superior products in less time and at lower costs. The use of simulation capabilities in the ‘right-first-time’ approach has become an important tool in product and process design and development [4]. Computer simulations vary from that run for few minutes on single computer to ongoing simulations that run for days even on server using modern cloud computing capability.

Simulations is used in many contexts i.e. technology, safety engineering, testing, training, education. Simulation is also being used for training in defense, space & air flight fields to provide trainee a likewise environment and situations. Computer simulations are widely used in computational physics, astrophysics, human systems, whether and engineering as a mathematic modeler. For the purpose of this paper simulation will only refer to computer aided simulation in engineering design & analysis applications.

Computer simulations play an important role in today engineering design & have become the backbone of any design center or industrial setup. Design & verification cycles have been reduced to weeks in comparison to months / years. Dependency on the simulation technology has increased manifold in last one decade. In recent times
Companies have shifted to the concept of "Concept Verification" in place of Design Verification & Failure Verification. Companies have started using simulation / analysis tools at early design phases or initial decision-making processes that lead to a “first time right” design. This allows them to validate any decision at the conceptual stage thus reducing the cost / time of re-designing & expensive prototyping. Aberdeen’s Simulation Driven Design Benchmark Report 2006 finds that the best in class manufacturing companies who use simulation in their design phase average 3.0 prototypes compared to 4.6 for all other manufacturers and save from $21,000 on simple products to $19,000,000 on complex products.

![Figure 1, Simulation / FEA after completion of Design for design verification.](image1)

![Figure 2, Simulation / FEA at early / concept design stage](image2)

Time to market the product is a priority of manufacturing industries to beat the competition and capture share in the market before the others launch their products. This leads to pressure on design teams to design / develop products faster maintaining / improving the product performance. As per Aberdeen survey 2008, the factors affecting the process of improving product performance are predicting product behavior in real world environment & finding problems / errors late in design cycle. Aberdeen’s “Engineering Executive Strategic Agenda” 2008 report found that use of simulation to assess product performance is both a highly popular effective strategy. Simulation facilitates to predict product behavior early in design cycle when there are options and time to address the problem in place of redoing / modifying the design at launch / prototype stage. As per the survey objectives behind the running of simulations are to optimize the product performance, to look for failures & to make the physical testing more effective.

### 1.1 Simulation Lifecycle Management

The need for a managed simulation environment has been there since the inception to reap the benefits like “reduced cycle time” and “improved quality”. The need have
been driving force behind the initiative taken by the organizations to implement Total Quality Management and Six Sigma. In early 1990s Product Lifecycle Management (PLM) was incepted and thought to be taking care of the job. But PLM is an information-driven approach to manage all aspects of a product’s life. A product’s “lifecycle” includes its design, manufacture, deployment, maintenance, and eventual removal from service and disposal or in other words the whole set of phases, which could be recognized as independent stages to be passed / followed / performed by a product, from “its cradle to its grave. PLM seeks to streamline these steps by coordinating and integrating all the various processes, methods, tools and data used during a product’s lifetime. Currently the PLM is playing a “holistic” role, bringing together products, services, activities, processes, people, skills, IT systems, data, knowledge, techniques, practices, procedures and standards [6]. The approach has gained a wide audience; however, there are still many shortcomings when applied to simulation lifecycle management.

The requirements of Simulation Lifecycle Management are more demanding than those associated with traditional PLM. Simulation data is much richer than CAD or other business data and includes initial and boundary conditions, material properties and solution procedures which can span multiple physical disciplines (mechanical, fluid, thermal, electromagnetic, etc.). This requires techniques not typically present in PLM based systems [12]. However to reap in the benefits of PLM, these two management systems should be integrated such that SLM becomes a window to simulation from PLM system. A PLM system captures the form and fit of product designs through digital mockup (DMU), while simulation lifecycle management compliments PLM by associating behavioral simulation data and processes with the DMU; in essence offering behavioral-digital mockup (B-DMU) [13].

PDM is a subset of a larger concept of product lifecycle management (PLM) that is responsible for the creation, management and publication of product data. Product Data Management (PDM) systems developed initially to manage computer-aided design (CAD) data. As a result PDM systems still tend to be very document centric and are not well-suited for managing the processes and data associated with simulation. In fact, simulation usage is most commonly restricted to a small but extremely important segment of a product’s lifecycle data.

Multifold simulation demands simulation flow management, engineering data management to manage large amount of data which are produced by various specialty engineering software, & collaboratively working by many people due to field complexity of news mechanical system. Namely there are Information Island, application Island and flow island in simulation. At present the mature PDM system can’t solve these problems at all [7]. Unlike Product Data Management (PDM) or Product Lifecycle Management (PLM) software, the Simulation Lifecycle Management solution is dedicated to focus on the simulation portion of engineering efforts [17].

Although the current product data management (PDM) system could provide perfect management to the CAD/CAM model and documents, the management of simulation data not only requires to manage the results of the simulation data, more importantly, manages the simulation process, so the PDM system can not manage the complicated simulation process and its mapping relation between simulation data [8] [9]. Since
managing simulation processes and data is in reality a specialized field and hence a dedicated management system is required to cater the need.

Effectively storing and reusing simulation data is more than file management or commonly termed as version control in PDM systems. In order to store the data in a way that makes sense to an unfamiliar future user, an archiving system needs to allow for searches based on relevant and descriptive tags that help identify files and their contents. These tags, also called metadata includes not only file or version information but also information about tools used, simulation processes and other properties associated objects. Thus, what is involved is capturing both, data content and context rather than just file or data management. Thus the management of the intellectual property / information associated with simulation tools, data, and processes is collectively referred to as Simulation Life cycle Management [13]. It is a computer based systems that address the need to manage simulation related information that is mainly formal and computer interpretable. It forms an environment through which simulations are run; information is retrieved, edited and reused. To do this, SLM provide technology in four foundational areas:

- Simulation Data Management
- Simulation Process Management
- Decision Support
- Enterprise Collaboration

Aberdeen’s Simulation Driven Design Benchmark Report 2006, conclude that the best in class manufacturing / design companies track simulation configurations at least in some way, most frequently by using the simulation model or by using data management tools (and using them twice as frequently as other manufacturers). These data management tools are small tailor made solutions to specific problems and simulation software / tools and not the universal kind of environments with standard set of tools which suits all or maximum simulation tools (with add on plug-ins). With the rising demand from analysts, leading CAE developers developed the solutions in the shape of Simulation Lifecycle Management systems containing the above mentioned components.
2. NEED FOR COLLABORATIVE APPROACH

In last one decade, there is a paradigm shift from standalone user / professional to professionals working in close collaboration irrespective of role, discipline & physical location. This collaboration has been made possible with the advancement of IT enabled tools and spread of high speed internet. Michael Sampson in the report “The 7 Pillars of IT-Enabled Team Productivity” has identified Shared Access to Team Data, Location-Independent Access to Team Data, People and Applications & Real-Time Joint Editing and Review as the first three pillars / tools in IT enabled application to increase the team productivity [14]. These three pillars / tools are collaborative functions of IT applications and increase the productivity of teams manifold.

No product or process is designed / developed in isolation, thus simulation should be equipped to fulfill its role as part of the team. Design & development today is spread over multiple domains i.e. across industry segments, across companies (design consultants, suppliers, customers etc.), across simulation disciplines (fluid, structural, multi physics, acoustics etc.) & across different methodologies / applications / software (Table 1 depicts a scenario of multi domain design). Furthermore these stakeholders can be present at same location or can be far away in different continents. Simulations impact a wide spectrum of product and process design functions and thus should be accessible to each. Furthermore, the design changes suggested by the simulation results of one individual or team can often be at odds with the direction suggested by other individuals or teams, whether they are simulation related or not. For effectiveness of simulation a continuous collaboration is required between all stakeholders.

Study conducted by Aberdeen Group in 2008 explains that out of product developed over the last one year, 91% had a mechanical component, 82% had an electrical component, and 66% contained embedded control systems. Thus analysts are required to consider multiple disciplines [11]. The best design requires simultaneous treatment and awareness of the impact of proposed changes by multiple areas of functional responsibility, as illustrated by the mobile phone design example given in Table 1.

| Table 1: Cross Functional Simulations for Cell Phone Design adopted from [16] |
|---------------------------------|---------------------------------------------------------------------------------|
| Mechanical Simulation          | Consumer taste has driven cell phone designs toward smaller and lighter models. Yet consumer expectations on wear, strength, and durability continue to rise. Cell phone manufacturers regularly incorporate virtual drop and vibration testing, using technology that is proximal to that used in automotive crashworthiness and NVH, into their design process. |
| Thermal Simulation             | The cell phone is no longer just a phone. The devices now regularly perform as cameras, music and video players, and personal digital assistants. In addition, the devices are expected to work reliably in extreme environmental conditions for long periods between battery charging. As a result, the ability of these devices to manage and channel thermal energy plays a significant role in their design. Thermal simulations play a critical role in influencing the design of the phone casing and electronics. |
Electromagnetic Radiation Simulations

The cell phone must emit radiofrequency energy at levels high enough to reach antenna towers kilometers away. This objective must be balanced with regulations regarding the potential health risks associated with absorption of this energy by the human head. The design of a cell phone casing, electronics, and antenna construction influences widely different near and far-field radio frequency energy signatures around the phone. Electromagnetic radiation simulation is regularly employed in cell phone design to balance functionality with safety.

At present, many commercial software packages are available, and are matured enough in the analysis of a specific domain in engineering design. All those software in use today are focused on improving the productivity of the individual analysis. However, those cannot be used to achieve the multidisciplinary collaborative simulation for a complex engineering system directly. As the design tools are usually self-governed, heterogeneous, and distributed in a networked computing environment, it is necessary to adopt an efficient collaborative design environment to coordinate the activities of multidisciplinary design teams and to guarantee the interoperability among the different engineering tools [10]. An effective approach is to adopt multidisciplinary collaborative simulation, which combines different disciplinary models and integrates heterogeneous simulation tools, and also facilitates good communication and cooperation among different development teams [4].

Simulation Lifecycle Management environment enables simulation collaboration both within an enterprise and across its users/stakeholders. Since all simulation activities are managed by the Simulation Lifecycle Management system, it provides a secure environment for simulation. User simulation roles and responsibilities can be defined and the system will ensure that each worker has access to his or her needed data and can only perform those actions for which they are authorized.

Working under constraints of first time right and reducing time frame, an essential element of Simulation Lifecycle Management is to foster collaboration as a means of enabling innovation and instilling quality into product and process design under tight time constraints. There are enormous benefits associated with sharing and co-locating design and simulation data from multiple disciplines in a central, collaborative work environment—where all parties can have insight into the latest intellectual property and can monitor the progress of colleagues associated with specific projects.

Leading CAE development companies such as Dassault Systems, MSC Software Corporation, ANSYS Inc & Siemens AG are spending significant amount of resources toward the development of collaborative Simulation lifecycle Management systems. When fully integrated, these applications facilitate the simulation process through the sharing of simulation data, processes and resources. This paper explores and details collaborative functions available within SLM applications and how these functions help to benefit enterprise simulation processes.
While all identified solutions have many tools, we identified following functions those are of utmost importance to enhance collaboration:

- Open Interface to Third-party Simulation Software
- Integration to PLM / PDM / ERP solutions
- User Integration & Web based data browser

### 2.1 Open Interface to Third-party Simulation Software

As per PC Magazine encyclopedia, Open System Interface implies that more than one program exists to interface with the application that has the open interface or that a program can be readily written to communicate with it. In other words a system that allows third parties to make products those plug into or interoperate with it is termed as Open Interface system.

A true global enterprise requires the sharing of information from many different vendors, associates, consultants, and enterprises. This information comes in different formats / software data files, since there are more than 300 registered simulation solutions along with small tailor made solutions including excel sheets. Even with smaller, more geographically constrained companies, it is difficult to maintain one standard CAE application. Moreover, there are multidisciplinary simulations which involve different application solutions, as clear from mobile phone example taken in Table 1 i.e. thermal, electromagnetic, structural simulations etc. Due to the utilization of various CAE applications within one organization, Simulation Lifecycle Management systems are required to manage multiple CAE formats.

The CAE industry along with overall computation industry is changing at a rapid pace. There are new technologies being developed every now and then, products are being merged and there are takeovers / consolidation of industries i.e. Dassault System taking over ABAQUS, Siemens / UG taking over SDRC and so on. This makes a CAE application obsolete / redundant / merged in other due to new technology / merger of organizations. Thus an Simulation Lifecycle Management system should be able to accommodate all such changes as well.

To be successful, any simulation lifecycle management system has to be open and agnostic to simulation application being used. It should accommodate content and processes that come from any source. This can be done by having plugins for different simulation applications or developing the Simulation Lifecycle Management application for all popular applications.

#### 2.1.1. Study Results

Dassault SIMULIA simulation lifecycle management tools also offer Add-on Components, which provide interfaces to Abaqus FEA software, major third-party simulation applications, and a range of design exploration and optimization algorithms. Additionally, the open framework supports the integration of Add-on Components developed by customers and partners using publicly documented APIs [16].
As per MSC SimManager, there are roughly twenty production implementations of SimManager globally (Data source MSC Software website, year 2008). But approximate 10% of the applications running on those implementations are from MSC. Most of those are external and third party i.e. Hypermesh, Hypergraph, Abaqus, Fluent, LS-DYNA etc. alongwith MSC Nastran & ADAMs. SimManager has been specifically developed to be tool-agnostic, supporting all types of design and analysis tools in an open platform environment t [17].

ANSYS EKM is tightly integrated with other ANSYS simulation offerings, and it can be very easily integrated with other simulation codes, including legacy and other commercial off-the-shelf (COTS) software directly or through separately licensed features [18].

Siemens Teamcenter addresses this issue with an open & scalable framework that can easily configure and launch different CAE applications and automatically store results with the correct relationships to existing data. 60 percent of Siemens PLM Software’s installed PLM seats manage multi-CAD/ CAE data [19].

2.1.2. Benefits of Open Interface

- Elimination of inefficient and error- prone manual data transfer.
- Efficient use of customized / third party simulation components.
- Standardization of corporate simulation best practices.
- Reduction of software maintenance and training costs.
- More readily available niche expertise from researchers and specialist companies.
- Low cost access to the market.

2.2 Integration to PLM / PDM / ERP

In a global market, simulation input comes from a variety of sources. Contributors in the simulation process includes CAD / Product designers, manufacturing team, customers / suppliers feedbacks, marketing team, vendors and material suppliers. All or any may have some important criteria / information to input in simulation process. “Companies who embrace the diversity of their suppliers, partners, and customers must link processes and systems together more dynamically, to create a complete source of product knowledge that crosses organizational boundaries” (PTC, 1999). Modern enterprise management methodologies focus on enterprise resource planning (ERP), Product Lifecycle Management (PLM), and Product Data Management (PDM) or supplier / tailor made system to link sources or stakeholders such as designers, vendors, customers and manufacturing, marketing teams.

Simulation Lifecycle Management integrates with enterprise management applications & simulation is no longer decoupled from the product lifecycle. Simulation data and processes can be linked with design changes, parts, the BOM and other elements in the PLM process. Users can navigate to the exact simulation results that drove the design decision. This exposure of simulation to the enterprise PLM provides a critical bridge between design and engineering.
2.2.1. Study Results

All the applications surveyed as mentioned above complement existing enterprise environments such as TDM, PDM, ERP, or supplier systems, including both batch and interactive systems. All applications support an end-to-end solution with leading product lifecycle management (PLM) systems via a common middleware application.

Simulia’s simulation Lifecycle Management solutions are part of an overall PLM environment & designed and tailored to support the CAE specialist and S&A process and data [16].

MSC SimManager is integrated with PDM using PROSTEP OpenPDM technology. SimManager supports an end-to-end solution with leading product lifecycle management (PLM) systems via a common middleware application. SimManager is also integrated with distributed resource management systems i.e. LSF & PBS Pro and fully compatible with job queuing and submission systems including MSC Analysis Manager [17].

With ANSYS Engineering Knowledge Manager™ (EKM) one can accommodate critical needs within organization’s global product development process, from integration with PLM systems (CAD/PDM) and execution (HPC) to collaboration and communication [18].

Siemens Teamcenter powers end-to-end PLM with the solutions related to simulation lifecycle management in Teamcenter’s unified architecture and drive company’s simulation productivity [19].

![Figure 4, PDM & SLM Integration](image-url)
2.2.2. Benefits of integration with Enterprise applications, PLM/PDM/ERP

- Increase confidence and eliminate errors with tight PLM integration.
- Simulation visualization throughout the enterprise.
- Improve decision-making with greater access to simulation data.
- Identify inaccuracies and eliminate errors throughout the lifecycle.
- Lower customization and integration costs with a common environment for design and engineering.
- Improving use of cost-center resources like core R&D, engineering, prototypes, and samples.

2.3 User access management & Web Based Data Browser / User Interface

Information is among the most valuable assets of today’s organizations. Ensuring that authorized access is available when required and that unauthorized access is prevented is a key outcome of well-applied user-access management. Important task in an integrated multi-functional simulation / development environment is to give the right people access to the right information and technical data at the right time, and also to handle the status and integrity of the technical data that are developed in the process.

As defined by the Gartner Group, “Access Management systems are solutions that provide a unified mechanism to manage the authentication of users (including single sign-on) and implement business rules determining user access to applications and data.” Below is a schedule of access policy which can be implemented to keep desired access to every authorized person based on its rights:

<table>
<thead>
<tr>
<th>Access Type</th>
<th>Example(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identity-Based</td>
<td>GM, System Analyst, IT personal</td>
</tr>
<tr>
<td>Role-Based</td>
<td>Manager, Analyst, Supervisor, Design Engineer,</td>
</tr>
<tr>
<td>Group-Based</td>
<td>Simulation based groups i.e. electromagnetic, structural etc., Group formed on the basis of responsibilities</td>
</tr>
<tr>
<td>Context-Based</td>
<td>Results for vendors / designers, No. of simulations, simulation data analyses</td>
</tr>
<tr>
<td>Entitlement- Based</td>
<td>Marketing, customers, suppliers</td>
</tr>
<tr>
<td>Relationship- Base</td>
<td>Manager of analyst,</td>
</tr>
<tr>
<td>Rule-Based</td>
<td>Combination(s) of above</td>
</tr>
</tbody>
</table>
Web-based user interfaces or web user interfaces (WUI) are a subclass of user interface that accept input and provide output by generating web pages which are transmitted via the Internet and viewed by the user using a common web browser program [wikipedia]. Newer technologies provide real-time control in a separate program, eliminating the need to refresh a traditional HTML based web browser. Web based interface allows users to sit at different geographical areas and operate the software application at its will. Holmes, etc. introduce the integration of Metadata tools with a Data Services Archiving capability, resulting in a service-oriented and web-based architecture. It provides end users the ability from their desktops to manage and understand simulation results for very large, complex problems [15].

To reduce costs and make use of global acumen / manpower, organizations are decentralizing engineering, design, simulation, and manufacturing activities. Work functions are no longer limited by geographic, cultural or time barriers; instead work is being done where it can be done most efficiently. With groups located around the world, it’s a challenge for organizations to keep team members in sync with one another. People need up-to-date information to make decisions, and there should be right balance between the needs of the team and the needs of the enterprise. A natural result of a global enterprise is increased competition. To overcome this problem, progressive engineering and manufacturing companies utilize principles of concurrent engineering to facilitate the design process. According to Prasad (1996), within a concurrent engineering philosophy, “everyone contributing to the final product, from conceptual design to marketing teams, is required to participate in the project from its very inception”. User access management and web based user interface / data browser facilities of simulation lifecycle management application facilitates organizations to involve every stakeholder in the process of simulation decision making throughout the process suitable to its role and irrespective to its geographical location.

The SLM application should enable team members to provide input during the design cycle, so as to lessen the likelihood of later design changes. Figure 2 represents architecture of Simulation Lifecycle Management application system as proposed by [10] shows the top layer as web enabled browser and integration of multidisciplinary users.
2.3.1. Survey Results

All studied SDM applications provide avenues for stakeholders to view designs through commonly used / web browser during the simulation cycle. Supplying simulation data, results and executable templates, in an easily navigable 3D format to key stakeholders in various roles accelerates decision making and enhances insight and innovation.

Simulia “Live Simulation Review” is an extension with simulation focused functionality such as the ability to identify and navigate to all simulations performed on a given part or assembly. It empowers collaborators to access simulation data, configure instantiate and execute simulation templates, and review simulation results for collaborative decision making during the product development process [16].

Within MSC SimManager the “Enterprise Simulation Portal” is a Web based, data browser with customizable data presentation for viewing processes or data stored. It’s easy to use, and doesn’t require engineering expertise, making it the ideal way to share engineering data across the enterprise and with suppliers [17].

ANSYS EKM software is also based on a web-enabled platform that provides enterprise-wide access to any team member, regardless of where the team resides. A user simply opens a web browser, types in a URL and logs on to ANSYS EKM. The web application portal allows multiple users to access the same database, making information easy to retrieve and share [18].
With Siemens Teamcenter, an organization can establish a single source of product and process knowledge that connects all global team members everywhere, all the time. The teams can access this single source to find needed information quickly, reducing the time it takes to search for information by up to 65 percent [19].

2.3.2. Benefits of User access management & Web based user interface

- Need based access to right team member at any time, place.
- Prevention of unauthorized usage / access of intellectual property of organization.
- Use of commonly available web based data browser.
- Close integration of all decision makers / performers.
- All time monitoring / updation of simulation process by superiors / experts.

CONCLUSION & IMPACT ON INDUSTRY

These tools are impacting industry in four significant ways: (a) increased global collaboration, (b) faster time-to-market, (c) lowering development cost, and (d) Better use of resources and protection of intellectual property. Developers of engineering simulation tools have recognized the need to integrate modern communication technologies to facilitate the growth of global markets. Now, with the advent of simulation lifecycle management applications, analyst, designers and customers can collaborate in real time. Companies that once were restricted by geographic boundaries can now expand.

Collaborative features in simulation lifecycle management applications help to facilitate concurrent engineering philosophies and techniques through the integration of users, resources & other management applications. This collaborative approach benefits the organization in terms of faster time to market, reduce simulation cost and increase quality.

REFERENCES

16. Dassault SIMULIA Isight Website www.simulia.com
17. MSC SimManager website www.mscsoftware.com
18. ANSYS Engineering Knowledge Management (EKM) website www.ansys.com