Are Students “Real-World” Ready?

The Challenge in Preparing Students for Industry 4.0

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Key Takeaways

- Unprecedented convergences of technology and demographics are driving markets and highlighting the need for PLM strategies to help turn emerging markets into emerging economies, and mature markets into innovator markets—but this demands that the workforce understands PLM and how to use it to support the rapidly evolving realities.
- Support for Industry 4.0 (including a true digital enterprise, support for IoT, enabling simulation-driven product development, creating a model-based enterprise, and many other current initiatives) requires emerging workers to understand the information and process management capabilities inherent in PLM.
- Today’s industrial companies are experiencing a gap in understanding: what they need isn’t always what is being provided by many of today’s educational institutions. This is not just an issue at the university level, education for tomorrow’s work environment must start much earlier, and in some cases does.
- The approach to PLM education that is needed to prepare students to support today’s businesses requires more cross disciplinary thinking—PLM is not only about today’s students’ grandparents’ drafting. PLM is a much broader strategy.
- Educational organizations must prepare tomorrow’s leaders for tomorrow’s realities, this includes the need for engineering and manufacturing leaders to understand the impacts and value of PLM in driving new economies, markets, and technologies.
- The strategies and tools used in industrial companies today have far outpaced what is being taught in academic institutions. This has resulted in a significant gap in PLM education versus industry expectation—this is often cited as a problem by CIMdata’s industrial clients—emerging students do not understand how to employ PLM concepts beyond product design.

Introduction

Product Lifecycle Management (PLM), as defined by CIMdata, is a business strategy that supports the development of products including the information needed to support them throughout their lifecycle. In this definition, a product is anything that a company would create for its customers—physical, saleable items like machines or airplanes; services such as in-field operation and support; buildings, facilities, and infrastructure; chemicals or pharmaceuticals; and others. A PLM strategy cannot be supported by any single software tool. PLM includes all aspects of a product as a system of systems across multiple disciplines—management of requirements; mechanical, electrical, electronics, and software design; design of other elements such as lubricants and optics; simulation and analysis to verify designs; documentation that supports the
design, manufacturing, installation, or operation of the product; configuration management; product lifecycle process management; and access management.

Thus, a PLM solution may be composed of tools that support many disciplines. These include product data management (PDM), mechanical CAD (MCAD), electrical CAD (ECAD), computer-aided software engineering, simulation and analysis (S&A and CAE), digital manufacturing, computer-aided manufacturing (CAM and NC), architecture, engineering, and construction (AEC), reporting and analytics, portfolio planning, requirements management, and many others.

Unprecedented convergences of technology and demographics are driving markets and highlighting the need for PLM strategies to help turn emerging markets into emerging economies, and mature markets into innovator markets—but this demands that the workforce understands PLM and how to use it to support the rapidly evolving realities.

PLM continues to evolve and expand. Today it encompasses product development initiatives such as digital twin, collaboration, and systems engineering, and is an essential element in the realization of Industry 4.0 (the fourth industrial revolution as illustrated in Figure 1) and other emerging digitally-based business transformational strategies. Industry 4.0 is based on a number of current automation trends such as IoT, the cloud, and cyber-physical systems (integrations of physical processes—such as product manufacturing and usage—that are controlled and monitored in by highly interconnected networks of embedded computers that provide continuous feedback loops between the physical processes and their mathematical abstractions or models).

Companies have always managed their product lifecycles; however, they have done this through siloed manual methods. Manual PLM is insufficient to support today’s very complex products based on systems of systems and a multitude of cross-disciplinary requirements. Education into new ways of approaching and supporting product development and the complete lifecycle is essential to help companies exploit innovation that leads to continued business success.

When employed and supported properly, PLM is invaluable for guiding market transformations—from subsistence to sustainability, from borrowing to investing, and from extraction to innovation.
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PLM Education’s Crucial Role in Supporting Industrial Use of PLM and Industry 4.0

Today’s industrial companies are experiencing a very serious gap in new employees’ understanding of and practical experience with using a multitude of concepts that exist in the PLM realm. What companies need isn’t always what is being provided by educational institutions. This is not just an issue at the university level, education for tomorrow’s work environment must start much earlier in the education pipeline.

Education needs to expand beyond its current focus on a narrow view of PLM as CAD tools for product design—providing just a more advanced form of drafting, to a focus on PLM’s “big picture” with more attention on how PLM applies across and supports entire product lifecycle processes where information is not primarily geometry. While CAD data management or data management for product design (the product data management or PDM part of PLM) remains a critical capability for many companies, their focus needs to shift towards how PLM impacts businesses well beyond product design: allowing them to expand into emerging markets, transform mature markets, and support broad-based innovation.

Academic institutions appear to have difficulty positioning PLM outside of the engineering domain and beyond product design documentation (i.e., 2D drafting). The approach to PLM that is needed to prepare students to support today’s businesses requires much broader cross disciplinary thinking including consideration for simulation-driven product development (SDPD, systems thinking, an understanding that PLM is a business strategy, that it impacts many business decisions such as product profitability, supplier relationships, manufacturing strategies, product delivery concepts, and product maintenance. PLM needs to become much more immersed into curricula broader than engineering so that its breadth and depth lead students towards a more wide-ranging consideration that product design is only one step in the whole product realization continuum. As Professor Nate Hartman, Purdue University, said “Academia must embrace PLM as a methodology, like Lean, Six Sigma, and other initiatives. They need to understand that while different functional areas in the enterprise need to know about or participate in PLM to various degrees, it is important that everyone in their respective positions has a level of literacy.”

PLM Education Survey—Determining What is Being Done Today

To learn more about the issues that educators face, CIMdata executed a focused survey on PLM education and use in educational institutions today. We received responses from professors, teachers, and practitioners in universities, community colleges, and high schools from around the world.
We also performed telephone interviews with some of the respondents and their insights augment the selected survey results reported herein.

The range of topics covered in PLM-related course offerings is quite broad, but is heavily biased towards what has always been taught in drafting classes, that is mechanical CAD, documenting the product design, but not preparing for the challenges of realizing and optimizing a product for use by its customers or maintaining it once it is released. In fact, the top four topics reportedly covered as shown in Figure 2 are all related to product design and manufacturing. The disappointment and danger in these results is that well over three decades into its history, PDM concepts are taught in fewer than half of the programs surveyed, and when PDM is used, it is fairly limited to managing CAD data. The strategies and tools used in industrial companies today have far surpassed what is being taught in the academy. This leaves a significant gap in PLM education versus industry expectations that is often cited as a problem by CIMdata’s industrial clients—emerging students do not understand how to employ PLM concepts beyond product design, and are often still doing little more than computerized drafting.

Figure 2—PLM Topics Covered in Courses

Figure 3 examines issues that educators have with teaching PLM and using PLM tools. The chart is ordered top to bottom by overall weighted ranking. Training in using the various software tools is most critical. Some of the tools are difficult to use (notably CAD and CAM) and students do not usually have much time to learn, often only a portion of a single class per semester. In interviews, educators cited tools as being difficult to use and expressed a desire for more training materials and use case guides—turning the tables on the solution providers to do a better job educating the educators and their students. One way to do this is for
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people from industry to do a “reverse sabbatical.” That is, for industry subject matter experts to spend time in the academic community educating faculties and students on current use cases and best practices. Notably, training for faculty is also a problem—related to lack of training material and time with tool-knowledgeable trainers. As Professor Vahid Salehi of Munich University of Applied Sciences mentioned “It is so hard to bring the PLM idea to the students. A lot of PLM vendors do not really support the activities at the university. But they want to always have educated students. This is a mismatch.” A potential solution here would be for educators to come together with their providers to form very strong industrial advisory boards to help the PLM solution providers create better solutions to support education’s needs. Financial support was expected to be a major issue, but educators report getting plenty of support from PLM solution providers and industrial companies as shown in Figure 4. This was especially expressed as being true for student competitions, but for cross-disciplinary class work as well.

![Figure 3—Issues that Impact Teaching PLM-Related Topics in Weighted Order With Most Important from Top to Bottom Ranked: 1 Most Important, 5 Least Important](image-url)

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The list of topics educators want to pursue is promising. As can be seen in Figure 5, the top items are both related to the digital manufacturing realm. From discussions with some of the educators, additive manufacturing appears high on the list because the method allows students to make things without having to learn to use complex machine tools. There is promise for overall PLM with PDM and PLM processes next highest—this demonstrates an understanding that these are critical in the overall education of PLM strategies and are needed to broaden the reach beyond engineering design.

We would like to see model-based enterprise (MBE) including systems engineering and other related strategies such as SDPD higher on this list. While these may not be as adopted by industry today as they will be in the future, academia needs to lead the way in both education and research of these techniques that are critical to improving the concept to design to manufacturing processes productivity. Doing so would accelerate industry learning their value from new, more recently educated, employees.
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The metrics people monitor often indicate important areas in their activities. Figure 6 shows a balanced picture of how educators monitor success, although we think that the ultimate measures would be how well and how quickly students can perform and contribute once they enter the industrial world. Other metrics mentioned included:

- Number of companies that consider hiring our students to PLM related positions
- Placement of students in industry and demand generation in industry
- Student feedback and course reviews

We think that the ultimate measure of PLM education success would be how well and how quickly students can perform and contribute once they enter the industrial world.

In addition, educators mentioned benefits that students receive from PLM courses and competition projects. They begin to understand the ideas and theories of a PLM strategy. This is enhanced by allowing the students to gain
practical knowledge by using one or more PLM solutions, often to help them solve real-world problems such as designing and building a race car. This results in well-rounded engineers that understand how products are conceived, designed, manufactured, maintained, enhanced, and taken out of service, making them more employable. Additionally, in support of the global economy, students learn how to collaborate globally using PLM tools through project challenges.

What Academia Must do to Support Industry

Certain key characteristics and capabilities must be part of the education syllabus to support a better understanding of how PLM and other enterprise solutions throughout an extended enterprise enable processes and data for the entire user community. These key characteristics include an understanding of how PLM impacts areas outside of product engineering, such as marketing, purchasing, product support, project management, costing, manufacturing, etc., and how PLM changes the ability to support product engineering’s use of new initiatives such as MBE, systems engineering, SDPD, etc. The breadth of people involved in product development decision making demands that many disciplines need access to PLM—their work depends on the information and processes that are parts of that are enabled by it. This requires that PLM education extend well beyond engineering techniques and capabilities (e.g., beyond CAD) so that it has a truly cross-disciplinary impact. The students of business and operations strategies need PLM-based information, they need to be PLM literate (again, CIMdata finds a large gap in their knowledge and understanding of PLM) to help them better understand product development processes and how to support them with project management and marketing programs. Unfortunately, this is not often supported in the institutions with whom we interacted. Professor Hartman made the point that “For PLM education to succeed, faculties need both enlightenment and recognition that PLM is not just an engineering discipline.”

In a more practical, supportive sense, the educational institutions pointed out what they most need just to keep moving forward with PLM, even in a limited sense. In Figure 7 four responses received equal weight. The “Other” response category was not well documented, but included expanding the concept of PLM beyond just engineering, funding the purchase of additive manufacturing materials, and encouraging more support for PLM inside educational institutions. A struggle that was voiced is that finding new information to support current and expanded curricula was difficult. A solution provider sponsored consortium of educators willing to share their course materials is one way to help alleviate this problem. Access to more training was cited repeatedly throughout our discussions with educators. While the solution providers received praise for what they are doing to support education of PLM, the reality is that they could do more. Professor Harvey Bell of the University of Michigan provided insight that “Students usually have low exposure to industrial PLM tools and design practices—they benefit from participating in contests such as the solar car where they gain exposure to both of these critical aspects of their
future work in industry.” However, these must be funded and supported from outside the academy—with training, strategies for teaching about PLM, and monetary assistance.

![Pie chart showing the needs of educators to improve engineering and manufacturing education.]

**Figure 7—What Educators Most Need so they Can Improve Engineering and Manufacturing Education**

The “Other” response category included the need for faculty recognition that PLM is not only an engineering discipline—that it has business impacts well beyond product design and other engineering disciplines, a need for funding the purchase of materials to be used in 3D printing the parts students design using the PLM solutions, and more internal support from others in the institution.

Some characteristics of PLM that CIMdata looks for include support for PLM platforms: these provide the ability to connect and interact with other enterprise business process enabling solutions and databases, role-based user experiences, scalability, support for cloud and other alternative PLM implementation strategies, openness, ease of use, low total cost of entry and support, etc. The PLM platform concept extends beyond the structure of the PLM-enabling tools to include the other factors listed above. Providing this helps get beyond the immediate problems associated with PLM strategies and technologies. As Dr. Frank Mill of Edinburgh University (Scotland) says “The problems associated with supporting any sort of PLM application within a university context mean that we probably in future are most likely to use a cloud based application which is supported by a vendor. Easy setup, minimum cost, and minimal paperwork involved to secure licensing and support are important too.”

But just having the right software is not the complete solution for educators. They must also have the support that allows them to create challenging and fulfilling curricula that will deliver both the PLM experience and its business value to their students. The old saying that “you can lead a horse to water, but you can’t make it drink” applies here. Without easy-to-use software that covers
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the breadth of PLM, and supporting use cases and industry experiences that help educators deliver PLM knowledge to their students (and other faculty members), the challenge of expanding PLM education is all the more difficult.

Siemens PLM Software’s Approach

Siemens PLM Software delivers a multitude of PLM capabilities in support of education. The educators we talked to were pleased with how helpful it was to have an integrated solution that covered the gamut from planning to engineering design to manufacturing within one platform, making data more accessible for roles beyond engineering, and providing these capabilities to educators in a cost-effective manner.

The continuum of digital enterprise capabilities from Catchbook to Solid Edge through the high-end NX and Teamcenter solutions as well as Tecnomatix digital manufacturing, existing in the same platform framework, is very attractive in the education environment. These provide essential support for teaching advanced product development concepts such as systems engineering and SDPD. Synchronous Technology was cited several times for simplifying the user experience for students who do not have much time to learn tools and often must import data from other CAD solutions.

Siemens PLM Software provides a global academic program that is focused on empowering the next generation of digital talent. The educators we talked to were pleased with how helpful it was to have an integrated solution that covered the gamut from planning to engineering design to manufacturing within one platform.

Siemens PLM Software provides a global academic program that is focused on empowering the next generation of digital talent.1 It coordinates activities with educators at all levels from primary to high school to junior college to university. While small, this group is a great help in providing educational materials and training. Part of Siemens PLM Software’s education program is their Learning Advantage program: a self-paced on-line training facility, that is always available to educators and their students.2

High school teacher Christopher Faust of Huntsville (Alabama) City Schools, stated that “Siemens PLM Software has been very supportive, providing financial support to Greenpower,3 taking an active interest in the teaching program, and providing good product training courses for the teachers.”

Conclusions

Educational organizations must prepare tomorrow’s leaders for tomorrow’s realities as embodied in Industry 4.0, systems engineering, SDPD, and similar initiatives. This includes the need for educators as well as engineering and manufacturing leaders to understand the impacts and value of PLM in driving new economies, markets, and technologies. The education of the next generation of workers for industrial companies is a critical element, and having them

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1 See: http://www.plm.automation.siemens.com/en_us/academic/resources/training/index.shtml
2 The 24x7 online Learning Advantage portal go to: https://community.plm.automation.siemens.com/t5/Academic-News/Learning-Advantage-online-training-FREE-for-students-and/ba-p/344250
3 See: http://www.greenpowerusa.net/

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cognizant of the capabilities inherent in a PLM strategy is critical to ongoing success.

Educators need to do much more to promote PLM literacy. They MUST expand PLM education beyond 2D drafting and a purely engineering focus to encompass the other business areas in which a modern PLM strategy has a profound impact. To not do this will reduce PLM education to teaching a trade (drawing with CAD instead of on a drafting board) that does not support current and future industrial company needs.

PLM solution providers have to do their part as well. When they do not support the activities of educators they do not promote well-educated graduates—the future product developers and product lifecycle managers. This mismatch hampers industrial growth, the growth of PLM, and the potential benefits to be realized through PLM.

It is important to realize that without organized education, PLM expertise in industry is grown in much the same way that systems engineering expertise is grown: many years of experience at a company in a variety of positions, learning processes by absorption, gaining knowledge of the products and operational strategies. However, that takes much too long.

While the PLM solution providers continue to support education programs with free (or very inexpensive) software, they do not do as much in the areas of training and providing use cases and supporting materials. Providing additional support would help PLM in industry to move to a new level of adoption and value. But, this also assumes that educators would use additional materials and training to improve their curricula.

Siemens PLM Software is on a path with curriculum and software support that will help educators to continue building a valuable supply of more qualified PLM practitioners prepared to participate and thrive in the evolving digital future.

About CIMdata

CIMdata, a leading independent worldwide firm, provides strategic management consulting to maximize an enterprise’s ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM) solutions. Since its founding over thirty years ago, CIMdata has delivered world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wide-ranging set of PLM-enabling technologies.

CIMdata works with both industrial organizations and providers of technologies and services seeking competitive advantage in the global economy. CIMdata helps industrial organizations establish effective PLM strategies, assists in the identification of requirements and selection of PLM technologies, helps organizations optimize their operational structure and processes to implement solutions, and assists in the deployment of these solutions. For PLM solution providers,
providers, CIMdata helps define business and market strategies, delivers worldwide market information and analyses, provides education and support for internal sales and marketing teams, as well as overall support at all stages of business and product programs to make them optimally effective in their markets.

In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The company also provides industry education through PLM certification programs, seminars, and conferences worldwide. CIMdata serves clients around the world from offices in North America, Europe, and Asia-Pacific.

To learn more about CIMdata’s services, visit our website at www.CIMdata.com or contact CIMdata at: 3909 Research Park Drive, Ann Arbor, MI 48108, USA. Tel: +1 734.668.9922. Fax: +1 734.668.1957; or at Oogststraat 20, 6004 CV Weert, The Netherlands. Tel: +31 (0) 495.533.666.