

Curriculum Development in the Engineering Education

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ABSTRACT: *Engineering education is undergoing tremendous changes due to the digital technology growth where it embraces the curriculum changes in the business and social environment. In this work we have analysed deeply the kind of challenges and solutions, the new emerging topics and addressed the issue of how to develop creative skills so that the students can run projects. The project developments and required challenges in the engineering education are studied and the issues related to project management and risk management are addressed.*

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1. Introduction

Engineering education is faced with challenges that need new approach in organizing a companies, running a business and creating the everyday working habits in a new project environment. A certain surveys [1] worldwide highlighted this phenomena indicated that top two skills desired from new hires are project management and business process management. In addition in Europe a survey for appointment data [2], found that while there was a modest increase in overall IT recruitment, the need for IT management positions with project management skills grew faster. This trend was attributed to increased levels of confidence, leading to the implementation of the new projects requiring management professionals, while lowerlever technical tasks were frequently outsourced.

Projects complement regular business processes and are often the main vehicle for strategy implementation in an organization. The processes are how work gets done on a daily operational basis, projects are important efforts to meet the organization's strategic objectives and to implement changes. However, as projects take a more crucial role in organizations, project management discipline has become a leadership competence. In today's workplace there could be hardly found managers who just "do their job". Especially in engineering environment managing projects alongside one's regular function is a daily reality, and project success has become an important factor in any manager's performance evaluation.

2. Engineering Working Environment and Project Management Maturity Tracking

In a few recent years Prof. Ambler and Martinich members of IEEE – Engineering Management Society [3], have been conducted several focus groups to understand the needs of engineering companies with respect to their engineering managers. Their survey's conclusion was: "Recently appointed engineering managers lack the business skills and interpersonal skills necessary to successfully deliver their engineering projects. They are well trained as engineers, but they are not receiving the training they need to succeed as project managers." Upon their professional experience they are convinced that it is a true on a global scale. They have seen the problems in projects that result in China, India, Australia, Canada, Europe and the United States. Projects fail, they stated, not because of engineering challenges, but because in the projects engineering managers lack communication, collaboration, negotiation and business alignment skills. There are few maturity tracking elements that are worth mentioning and that could help to understanding a "new wave". Following such tracking elements and the identified trends, our curricula for project management is created in a way to consist practical examples that are selected from the project management practice. And, consequently, besides the new and worthy knowledge the students are obtaining, the lectures are more interesting and interactive. The students can explore themselves in a creative manner.

2.1. More Effective Project Teams

Remote or distant teams face the challenge of geography and diversity. To create a modern project team conditions is equal to the "art of management" in each company's mission control [4]. As an example, the following Project management practice made the effective teamwork possible: *Project Plan and Project Baseline*, Project Management Control (Continuous Critical path), Human Relations Emphasis and Risk Management Techniques.

2.2. The Risks Management

The sub-discipline of risk management has advanced in areas of risk identification, analysis, planning and management [5]. New techniques are on the horizon and we should explore them in our maturity tracking, especially in academia.

2.3. Project Competencies

Regularly in the beginning project practitioners focused on their subject matter expertise, such as financial analysis, telecommunications, power engineering, and IT design, or marketing plan. Those who became involved in projects were forced to include scheduling, status reports, and risk analysis in their competencies. In today's engineering challenging practice the project practitioners should move towards general business awareness. In that sense they should explore: *facilitation* (not only meeting management), financial knowledge, leadership, *creativity*, *problem solving and/or decision making*.

2.4. Basic Training for a Project Manager

The Basic training should include the: *Roles of Project Manager*, Types of Management Skills, Managing Former Peers, Building a Team, Effective Decision Making (*Problem Solving*), *Authority Delegating*. Here, we will emphasize the importance of Types of Management Skills and to be aware why are important for the Project Manager. The effective Project Managers, besides being well educated in the Project management basic concepts and tools, must develop three types of skills: technical, conceptual and human relations. The companies in high-tech sector reveals different organizational models to describe the roles of their Project Manager. Many parameters influence a company's approaches such as: Company budget, Team size, Capability maturity model level, Soft skills, Organization's depth, Technical expertise, Firm's project management expertise, Client relationship, etc. The balance needed to mitigate the risk introduced when splitting task responsibilities should be found by the company's management. The clear definition of roles and commitment to those roles reduce the chances that jobs will be overlooked. However, the dual role of technical expert and project manager enables the project manager to be acutely aware of risks and provides an understanding of company's commercial model, customers and competitors. In accordance with such recommendations we include basic training for potential project managers enabling them a short stay in industry to be in the center of the events and to understand project manager's duties and responsibilities.

3. Remarks on the Today's Engineering Workforce and Needs

However, today's work climate has changed. The number of engineering jobs has increased and engineering positions are more varied, while greater job mobility has reduced the opportunity for engineers to take advantage of longer on-the-job training periods [6]. As a consequence, engineering educators are being challenged to look at their curricula and retool coursework to incorporate non-traditional information and subject matter. Students' need for theory understanding to enable

engineering problem solving remains a top priority, but today's graduates could not enter the workforce only with technical skills. Engineering specialties have become varied and diverse, and therefore industry is demanding new "rounded" engineers whose initial skills stretches beyond technical competency having supporting work skills. The Needs of the parties are linked and identified and could be listed as follow:

Student Needs: Strong theory foundation; engaging; realworld application work; creativity/problem solving skills; critical work skills; risk analysis.

Industry Needs: Technical competency; communication skills (written, verbal, presentation); leadership and teamwork skills; enthusiasm and personal drive (a sense of a mission); intuitiveness; integrity; other supporting work skills.

Curriculum Needs: Theory; hands-on through lab work and practical examples; more intense hands-on applications work using industry-based scenarios and problems; opportunities to develop basic yet critical supporting work skills.

4. Curriculum Needs and Project Management Trends

In Graduates may initially be hired primarily for their technical skills while long-term career success is more dependent on non-technical skills. And these skills should be integrated throughout the curriculum, rather than be taught in isolation. That is a way the students will receive a full-picture view of real world of engineering. The professors in engineering and especially in emerging and fast changing technology, should seeking ways to introduce more workplace related experience earlier in the curriculum and to incorporate "supporting work skills" such as: communication skills, project planning and execution, project manager leadership, risk assessment, time management, decision making and ethics. However, to teach the undergraduate students project management theory and practice is not easy task, since there is a lot necessary and preparatory business things to be learnt. In that sense, curriculum has to follow the underway trends in project management and deliver the knowledge and skills that will prepare the engineers for project management profession. There are discussions [7] and studies [8] that reflect this issue and that could be easy checked-out among companies and young professionals.

The selected modern trends in project management are listed as follow:

1. Agile will gain more popularity in IT projects and continue to be accepted in wide range of industry projects. The Agile approach [8] is cost-effective, relies on self-organizing teams, and appeals to human needs like autonomy, mastery, and purpose. However, to be successful, it relies on timely frequent feedback, that could be needed in complex projects. Up to now there are discrete examples and sampling of the very few industries that are even familiar with project management to begin with. And that's about to change. Recently, agile project management has visibly crept into all industries. IT no longer has a monopoly on the project management technique. Several industries, including marketing, finance, and construction, were beginning to adopt the Agile development framework. Various research has shown that the Agile methodology improves communication, makes teams more adaptive to change, and has an overall higher return on investment, especially for small to midsize teams. There is the rise of business Agile. Moreover, DevOps (development and Operations) will be considered a part of Agile. Atlassian [9] explains this point well: "DevOps seeks to bring that Agile attitude toward change to a new audience: IT operations." If a project management community, can accept marketing Agile, construction Agile, and business Agile, then IT operations Agile should be no stretch.

2. Risk management will be an incredibly popular topic for project managers to be learnt and applied. In addition, with the growth of Agile, risk management will become a necessity for project professionals seeking new opportunities. While there is software available to help identify risks, the project managers have to be creative enough to identify potential budget or scope overreach and maintain organization over your projects.

3. PMP certification will become more popular, but changes are needed. Since there are graduate engineers struggle to find jobs, many will turn to a PMP certification to try to get a leg up in the project management field. Getting a PMP carries quite a bit of weight—it allows young workers to learn the knowledge of the field, attain networking opportunities, and distinguish themselves from the competition. The Program Management Improvement and Accountability Act (PMIAA) signed in 2016, increase the importance of certification and formal project management job titles in the government. There is an increasing need for professionals to understand the foundation of project management through formal training and develop their skill sets in communication, leadership, and stakeholder engagement. However, recently, since the companies just want someone

who can manage projects and do it well, there is also a trend losing the interest in PMPs. The PMP exam and PRINCE2 have been around since 1984 and 1989, respectively. There are a lot of certified project managers and many of them have begun calling into question the value of their certification, concluding that PMP certifications just aren't worth it. The reason for that, they are arguing, is in fact that exam content isn't updated often enough to keep pace with today's small business needs.

4. The Need and project requirements – not organizational chart will create project team. Celoxis [10] smartly predicts that project requirements will chip away at the organizational chart. Project complexities will decide how the teams will be structured, what tools they will use and how the execution will happen. It's time for enterprises to take a cue from the manufacturing sector and bring that level of rigor to their project management methodology. Another study [11] suggests, that managers should be as aware as possible of how interdependent relationships are distributed across a cohort before they do any reorganization.

5. Remote teams will become normal. According to Intuit [26], 40% of the American workforce will be freelancers, contractors, and/or temporary employees by 2020. These contractors are already working remotely using sites like Upwork, Freelancer.com, and Demand Media. Also, fulltime employees are increasingly telecommuting. A recent Gallup study [12] found that 37% of Americans have telecommuted and it's even more likely that those working in white-collar professions have telecommuted (44% vs. 16% in blue collar jobs). That means that the technology can help with the growing presence of remote teams. It is well known that distributed teams allow for companies to break down geographical borders in their quest to find top talent in non-traditional businesses.

6. The rise of BYOD will cause project management software to have more ticketing options. BYOD ("Bring Your Own Device") has been making waves in all industries throughout last years. The concept is simple: companies are allowing employees to use their own smart phones, computers, tablets, and other electronics for work purposes. This trend is contributing to growth in mobile project management software. In the business environment it is pointed out that BYOD will also pose a number of challenges to the project management field such as, dramatically increase of the complexity of technical support provided by the IT Help Desk and the development of software for multi-platform use. In other words [13], BYOD means that not all technologies are streamlined in the office. While there is specific help desk software for IT (like Samanage IT Help Desk & Asset Management or C2 Atom), project managers will likely prefer help desk ticketing included in their multi-platform project management software. Examples include Workfront and Clarizen.

7. Emotional intelligence will be most desired skill for new project managers. It is (by Psychology Today) the ability to identify and manage your own emotions and the emotions of others. In projects it is project management personality assessments of the right candidate that "feel," has charisma, or has developed "soft skills." Whatever it means, emotional intelligence (EQ) will get a lot more important to project managers. In general EQ include three skills:

- Emotional awareness, including the ability to identify your own emotions and those of others;
- The ability to harness emotions and apply them to tasks like thinking and problems solving; and
- The ability to manage emotions, including the ability to regulate your own emotions, and the ability to cheer up or calm down another person.

With all value statements aside, this is a trend that is trickling in from the business community and the political climate as a whole. It is for sure that the Internet of Things (IoT) and Artificial Intelligence (AI) are going to affect most small businesses in 2018. The growth of IoT and AI in union are going to change how project management is effectuated. In some industries, that change will be dramatic. The most notable effect from these concurrent trends in 2018 will be in project management role and project management software itself.

Artificial intelligence is slowly making its way into project management tools, for example an options such as *Aurora*, *Clarizen*, *ClickUp*, *Forecast*, and *Rescoper*. These tools are using AI to automate many existing project management tasks, including matching talent to tasks, reducing calculations for level for effort, providing a hub for knowledge management, and creating reports with untiring objectivity [13].

However, it is not easy all above mentioned trends to include in the courses and to teach the students, but as professors we

are creating the environment and apply methodology such trends to be more familiar with their project tasks and seminar works. Their success depends on our efforts to be open to new knowledge and practice and creative approach making them ambitious to be well prepared for the professional work [14, 15, 16].

5. Conclusion

Since the education is a life-long process, introducing project management to meet the needs of the students and industry (and not to forget the entrepreneurs) is a challenging mission. It is no doubt that our industry, companies and organizations will embrace, value and utilize project management and attribute their success to it. However, the efforts that are making both University and industry working together, a common engineering education in project management will find the way to ensure that our graduates and master degree students have all of the tools they need to succeed and continue to contribute in economic and technological growth. The Engineering universities in their curriculum have to be up-front in the following, understanding and applying new trends in project management. It is a very complex task the professors are faced with and their mission is challenging that ever before.

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