Managing R&D Projects - The Engineering Perspective

An Online Continuing Education Course for Engineers

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1 Preliminary Considerations

An accepted definition for the Research & Development activities (R&D) is the set of "systematic activities combining both basic and applied research and aimed at discovering solutions to problems or creating new goods and knowledge"[i]. The R&D activities are divided into:

- Research – activities that employ basic research to solve engineering problems or develop new processes, products, or technologies
- Development – activities that take existing engineering knowledge - processes, technologies, techniques, etc. - and applying them to develop new products

Furthermore, research activities can be classified in:

- Applied Research, defined as the activities aimed at solving a specific problem or meeting a specific commercial objective
- Basic Research, defined as the activities aimed at acquiring new knowledge or understanding of a technical issue, without specific immediate commercial application or use

Unlike Sustaining Engineering or Design Engineering, the R&D activities require a large amount of creativity and exhibit a large number of unknowns that need to be solved. Here, not only the answers to the problems are not known, but it is also not 100% certain that the problems can be solved in the first place. In some cases, the "problem" is challenging to be even formulated rationally.

Various economists recognized that in today's economy, innovative knowledge is depreciating at a faster pace than before due to a steady information flow towards the developing countries[ii]. This, in turn, pushes companies to invest more in the R&D activities and innovation in general, to stay ahead of the competition. It has been shown that companies with a well-defined R&D strategy outperform those with an irregular or

no R&D investment program[iii]. It is generally known that US companies invest, on average, 5% of their annual revenues in R&D activities[iv]. Depending on industries, this fraction can be higher, reaching up to 14%-15% in the case of pharmaceutical companies, or lower, which is the case of maintenance companies whose business model is based on service rather than a product.

The importance of the human factor in the R&D projects is reflected by the fact that of the $1.2 trillion spent each year globally on R&D activities across corporations and academia, 40 percent—by far the largest share—pays for people.[v] Having the right people with the right mix of skills and tools is a critical factor in the success of R&D activities.

Given the particularities of the research projects, specialized engineering and managerial tools need to be employed that help bringing them to fruition. When properly used, those tools help with successfully managing the R&D personnel, defining the project strategy and tactics, improving the technical creativity, and culminate with delivery of the R&D project sooner and with fewer headaches. This course will attempt to put a structure in the process of managing the R&D projects and will present several tools to help to manage those processes.

1.1 Terminology

The “Analyst” is the person tasked with finding a creative solution to a problem. He/she can be an engineer, scientist, technician, etc., or even a person with enough general technical knowledge, education, and relevant experience to solve the problem at hand.

The “Engineering manager” is the person that manages the Engineering Department tasked with the R&D work. Typically he/she leads a team of analysts, engineers, scientists, drafters, technicians, etc. that together are affecting the R&D work.

The “Development Team” is the team that is tasked with working on the R&D project. This team is not exclusive to the Engineering Department. It includes not only engineering personnel but any other personnel inside the company that can affect the

success of the project. For this reason, the Development Team may be a collection of people or teams from the Engineering Department, Manufacturing Department, project Management Department, Marketing Department, Finance Department, etc.

The “Decision Team” is the team that has the power to make decisions related to the current R&D project. It includes at least a member of the company’s management team (who can be the primary sponsor of the project). Besides the Engineering manager, it can also include senior personnel familiar with the Sales and Marketing activities, Operations, Technical Support, etc.

The “product” is the product itself that is developed by the company that requires some creative work to become marketable. In the engineering world, this can be a component, a machine, or a process. Note that the technical feasibility of the product is known only with a degree of certainty, less than 100%.

2 The R&D project

In the vast majority of cases, the R&D project starts with an idea, typically a bold one (“what if we were to do X to our flagship product?” or “I wonder if implementing Y would improve the α process”). Then, that idea is taken through the development process, and if everything goes well, culminates with a product being brought to the market for sale and delivering the expected financial returns. The product can be a tangible item (component, machine, apparatus, etc.) or an intangible item, such as a service, a process, etc. In the engineering context, the product is most of the times a tangible product or a process. The sheer novelty of that product implies the existence of many unknowns that the R&D process needs to solve. Every step of the product's development that in other circumstances might be viewed as a “straight forward step” may need to experience additional investigation and be adjusted to serve the needs of the product in question. This adds significant time in the process that cannot be predicted with 100% accuracy. Old standards accepted by the industry hold that the R&D process takes between 1 to 5 and even up to 10 years, depending on their complexity. However, in recent years those time frames have shortened due to advances in technology and to the increased competition[vi].

The R&D processes do not only require engineering creativity, but they may also include a certain amount of inventiveness in other areas such as marketing and finance, supply chain management, and every other activity performed by the company, and that can affect the final product. The locus of the technical creativity may be the Engineering Department, but successfully bringing the product to market will require the full cooperation of the other departments in the company. The company's management needs to be fully involved in the development process to release resources for use as required, or the product may never see full maturity.

It should be recognized that not every R&D project is successful. Research shows that an estimated 46% of the resources that companies devote to the conception, development, and launch of new products go to projects that do not succeed—they fail in the marketplace or never even make it to market[vii]. This represents a tremendous amount of resources that some may view as wasted. In reality, the failed projects add to the overall knowledge of the company and increase the chances of success for future R&D projects. While the intrinsic nature of the R&D processes dictate that failures cannot be avoided, proper planning and management of those processes should allow the mitigation of the adverse factors and either minimize the number of crashes or reduce the amount of money spent before an R&D project is determined not to be feasible.

Small & medium companies and large corporations handle R&D projects differently. Small and medium companies have fewer resources available to them, which makes them more likely to engage in activities that pose lower risks. They typically participate in R&D projects that they know apriori they will succeed, with a high degree of certitude. They cannot risk investing in a project that has low odds of success. The typical R&D project workflow in small and medium companies is more streamlined and tends to have fewer go/no-go litmus tests in the process. It is not that there are fewer such tests, but in reality, they tend to be placed at the beginning of the project, when the decision-makers have enough practical experience in that particular technical area to "know what they are doing" when allowing the project to start. Moreover, the critical decisions are made by those who are typically very familiar with the market details of that particular market segment, with the company's abilities and also know

very well apriori what is needed to develop an R&D project in general. This compels the small and medium companies to engage only in R&D projects that tend to be small to medium in size and complexity and that exhibit a small, tolerable amount of uncertainties.

One exception to this rule is small companies established, especially to perform R&D activities. Those companies are either funded by venture capital or are a spin-off of a larger company. In the latter case, they may still be connected with the parent company thru administrative or other routine tasks (like purchasing), while being freed from typical corporate cumbersome work processes. This allows them to focus on creative activities entirely.

Large companies benefit from a larger pool of resources, not only financially, but also people-wise, as they tend to attract a more significant number of highly specialized personnel. Moreover, due to their reputation and access to more funds, they are more likely to collaborate with other R&D institutions (such as universities, etc.). They can tolerate a more significant number of failures; hence they can engage in a more substantial amount of projects that pose more ca risks. They can afford to interpret a failed R&D pro an just a "failure." Since they can take high ls.

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