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TECHNOLOGY ROADMAPS – AN AEROSPACE APPLICATION

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ABSTRACT

In aerospace sector, product life cycle and technology development periods are longer than those in most of the other sectors. Technology intensity of products is also high. Therefore to make a connection between these technologies and to manage this period, technology roadmaps are used. In this study, some information about technology roadmaps and the relevant technology management activities such as technology acquisition planning in TAI (Turkish Aerospace Industries Inc.) have been presented as an example.

Key Words: Technology Management, Technology Roadmap, Technology Acquisition

1. INTRODUCTION

In aerospace sector, product life cycle subject is intensely used which contains Research, technology development, product (goods/services) development, production and after sale activities. According to research activities, new scientific information and implementation knowledge with technology development studies are created. According to product development activities, a prototype is generated and manufacturing process is started. After that, mass production is started. After sale activities contains sustaining created values and after use activities. This product life cycle approach is shown in Figure-1. In this cycle, Research, technology development and product development activities are also called research and experimental development.

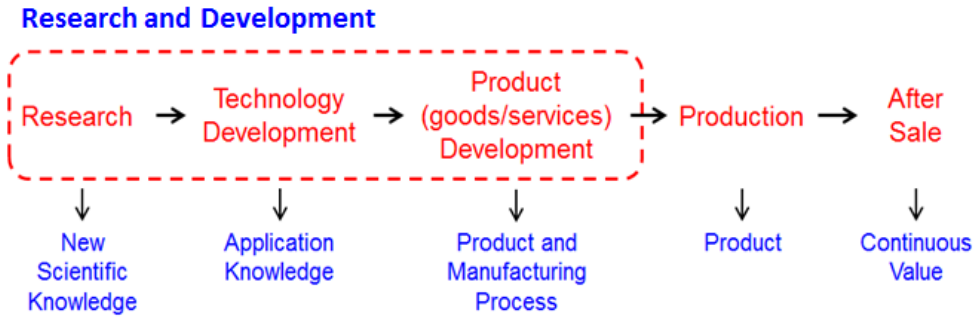

Figure-1 Product Life Cycle

With the aim of managing the product life cycle well, handling R&D projects, technology development or acquisition, product development and offering these products to the market are required to be integrated. From this point of view, a multi-layer roadmap is used as a process management tool. This tool contains some layers which are resource plans, R&D roadmaps, technology roadmaps, product roadmaps and market roadmaps. This multi-layer roadmap is in Figure-2.

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The bottom level of these layers is called resource which contains capital investment, finance, supply chain, staff, skills and etc. according to these resources' allowing, R&D projects are planned and initiated. These R&D projects can be performed independently or one after the others.

Technology development activities are generated after R&D projects successfully ended up and create some tangible outputs. In parallel, product development process is started and mature technologies are integrated into the product. At the last level of these layers, marketing activities are generated.

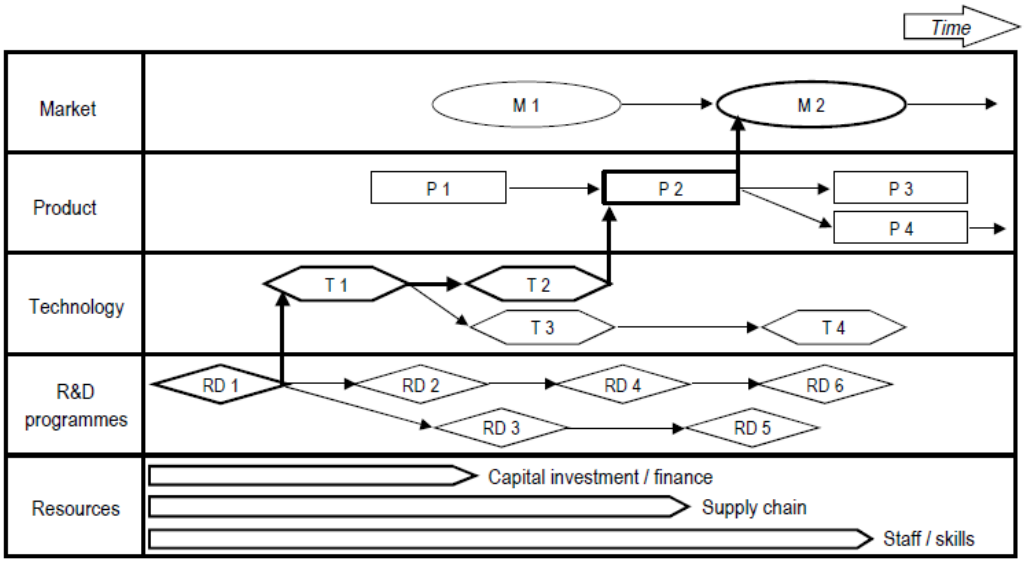

Figure-2 Multi-layer roadmap form for integration and alignment of strategic plans [Phaal, Farrukh, Probert, 2001]

According to previous assessments, technology roadmap is only a part of multi-layer roadmap. But technology roadmaps are so important because of technologies bring competitive edge in products and also has critical facts. Technology roadmaps are crucial tools that support product life cycles.

Technology roadmaps are used for following technological enhancements and changes, describing, selecting and developing critical technology alternatives to fulfill product requirements. [Phaal, Farrukh, Probert, 2001], [Bray, 1997].

This roadmap provides to handle short, middle and long plans more efficiently which are about technology development activities. Technology roadmaps help firms to reach their strategic aims, to use the resources more effectively, to increase speed of access to market and to increase product variety [Bray, 1997].

Separating Technology Developing and Product Developing Processes

In aerospace sector, as a sector with a high technology level [ISIC, 2011], product development periods take quite long. Because of this technology development and process development processes must be separated from each other [Albert HUSNIAUX, 2012]. In Figure-3 shows DoD's Defense System Acquisition Cycle can be seen where these two processes are separated from each other.

According to this figure, material solution and analysis, which can also be called describing requirements and research, technology development, engineering and manufacturing development,

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production and deployment and finally operations and support activities are generated. From the beginning point to mile stone A there are R&D activities, from A mile stone to B mile stone there are technology development activities and from mile stone B to mile stone C there are product development activities are performed.

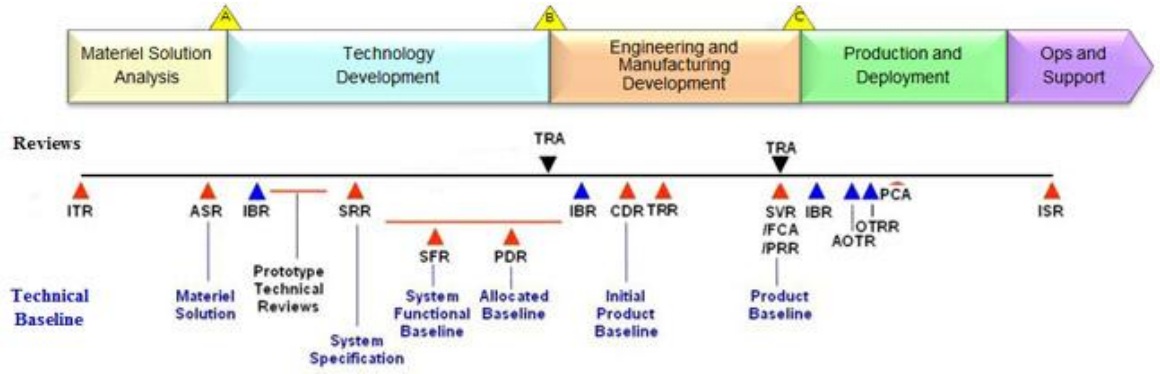

Figure-3 Defense System Acquisition Cycle

In the document, if technologies are not mature enough, there can be seen delays and incremental costs in programs. To avoid this situation, when product development process reaches PDR phase, technologies have to be greater than readiness level of 7 (TRL 7) [GAO, 1999].

According to these assessments, TAI also perform some activities related to technology management and technology roadmaps.

2. TAI TECHNOLOGY ROADMAPPING ACTIVITIES

Technology subject is examined into two titles in TAI; one of is Technologies are used in products and the second one is Technologies are use in product development process. Technologies are used in products mean all subsystems. For example, a landing gear in an aircraft is a technology like that. Technologies are used in product development process are also break up three. They are Technologies that are used in production activities, development activities and test activities. For example to technologies related to production activities is additive manufacturing technology. For example to technologies are related to development activities are design and analyze technologies. Also for example to technologies related to test activities are wind tunnel and structural test technologies.

Process Operation

TAI deals with a wide range of development, production, modernization, system integration and life cycle support activities of manned and unmanned, fixed and rotary wing aircraft, satellite systems and also, aerospace structural components. Technology roadmap method is used, as a planning tool, for successfully managing these activities, removing uncertainties and carrying out technology acquisition period, technology roadmap method is used.

Technology road mapping period has basically two activities; market pull and technology push. The steps of these activities are shown in Figure-4.

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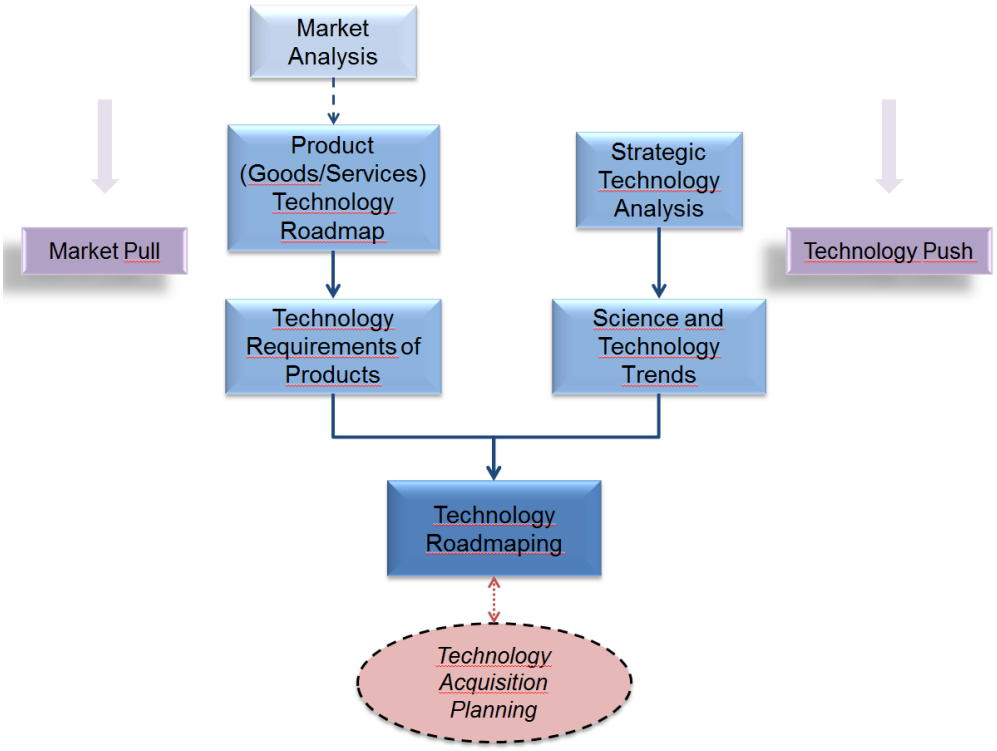

Figure-4 Technology Road Mapping Process

In market pull activities, first of all market analysis study is generated which are related to assess aims and forecasts which are took part in Strategic Plans, to examine potential markets and trends and also to identify potential investments and resource demands. In the light of these data, products' technology roadmaps are created. In this phase products are thought as product blocks. Current and intended technologies are identified which provide performance targets for each product block.

Parallel to activities which are expressed previous paragraph, related to technology push activities, there are strategic technology studies that cover short, middle and long technology development targets of TAI. In this phase, some strategic decisions are taken about identifying technologies and acquisition plans. These technologies are not related to current product needs but are related to future products. Also, some analyses are done to identify capability levels of technologies. Last phase of this step is assessing technology trends and following scientific publishes and conferences. Also some consultancies can be taken.

The last step of technology road mapping process is integrating the data which are obtained from market pull and technology push activities. Milestones and acquisition plans which are take part in product block development process are also stated in this technology roadmap.

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3. TECHNOLOGY ACQUISITION PLANNING

The last step of final and comprehensive technology road mapping process is technology acquisition planning. In this part, there are some data mining activities with TAI's relevant groups to designate technology acquisition method. These data can be express like below;

- Current product blocks
  It means product blocks which technologies are used in today.

- Future product blocks
  It means product blocks which technologies are thought to be used in future.

- Dependency to export license and restricting international regulations
  It means when technologies want to be exported, there is any restricting regulations or not.

- Technology acquisition method
  It means developing Technologies with R&D in-house, with cooperation, know-how transfer or directly buys.

- Supporting with academic studies
  Technology development activities are supported by personnel theses and also universities' teaching staff.

- Critical
  There are four criteria to assess critical Technologies [TUBITAK, 2003]. There can be seen below;
  I. Does the technology meet the national security Requirements?
  II. Does the technology create globally competition, collaboration or mutual dependence power?
  III. Does the technology support national science and technology for developing infrastructure?
  IV. Does the technology support sectorial settlement for social prosperity?

- Current infrastructure and needs
  According to develop technologies current infrastructures and needs and also needed investments are tried to identify.

- Competition forecast
  The competitive effects that technologies create when are used in products.

- Dual-use characteristic
  Other sectors that technologies can be used.

- TRL
  TRL means a kind of maturity of Technologies. It is modified to TAI. TRL definitions are shown in Figure-5.

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TRL	Definition
1	Basic principles observed and reported
2	Technology concept and/or application formulated
3	Analytical and experimental critical function and/or characteristic proof of concept
4	Component and/or breadboard validation in laboratory environment
5	Component and/or breadboard validation in relevant environment
6	System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)
7	System prototype demonstration in an operational (space) environment
8	Actual system completed and (flight) qualified through test and demonstration (Ground and Space)
9	Actual system (flight) proven through successful mission operations

Table-1 TRL Definitions [NASA]

4. RESULTS

Technology road mapping method, actually, is a useful planning and technology management tool for aerospace sector as in many other sectors. Within this context, TAI technology road mapping process and technology acquisition activities are presented as an example of implementation.

By this implementation;

- institutionalization and deepening technological capabilities
- R&D projects are planned more ease and rapid within aims of technology development
- preventing duplications
- establishing weak areas

are examined. TAI technology road mapping activities will continue to be updated within strategic aims and action plans and also to follow advancements.

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