POLITECNICO DI TORINO

Collegio di Ingegneria Gestionale

Corso di Laurea Magistrale in Ingegneria Gestionale

Tesi di Laurea

Application of Project Management tools

to the activities of the Advance product quality planning(APQP)

Relatore:

Prof. Anna Corinna Cagliano

Candidata:

Maria Ausilia Lupo

11/04/2018

Index

Introduction

The Advanced Product Quality Planning (APQP) is the management tool that in the automotive sector allows you to plan and monitor all phases of the product / process development process.

Initially developed for the needs of American car makers, the APQP was then and still is

used with different customizations from various car manufacturers.The thesis was developed in an EATON company based in Turin, during a quality field internship, from (06/03/2017) until (26/11/2017).

The activity was carried out in the Core Engineering team, in the Labatory, Prototype and Testing Area, to be carried out in the plants.

This activity was carried out, in advance of the audit planned by the company for the ISO-IATF 16949 qualitative certification; the quality system of the company have been revised and updated the procedures and templates of the new product development process.

During this stage, the development of a new project monitoring tool (Pro-launch) was planned to manage the different phases of the projects, from the receipt of Request for quotation (RFQ), passing through design and validation phases, up to the preparation and start-up of production series production tools; in this phase the project management tool, such as (work breakdown structure, gantt chart..) were used.

The advanced quality planning process (Pro-launch) will be aligned with the ISO-IATF requirements and used to the monitoring of the projects. The new tool will be linked to the Customer relationship management (CRM), Design Failure Mode and Effect Analysis (DFMEA) and Design verification plan e report (DVP & R).

In detail, a first theoretical chapter will follow in which the concept and instruments applied in the thesis will be defined and described.

In the second chapter will be presented the company and the entire production line, which in this specific case is addressed only to the production of valves in Turin, Germany and Poland.

In the third chapter the New product development (NPD) process will presented; the current APQP management tool and the ISO-IATF qualitative tools that will then be implemented in the fourth chapter in which it will follow the gap analysis between the current management system and the new IATF requirements of the NPD process.

Starting from gap analysis, the new Pro-launch tool was identified and built, together with the team and functional leaders, this was presented in chapter 5.

Chapter 6 contains the tools of the project management discussed in chapter one, identified in the Pro-launch engineering managment plan.

Finally, in chapter 7, it was made a benckmarking analysis between APQP and Pro launch, started to a real case (a new project in the company); this activity was made to verify the expected improvements with the use of Pro launch; after this KPIs were estimate to analized the benefit of the use of the Pro launch.

The benefit of the use of the Pro launch are monitoring of the project and organization of the quality documentation.

Chapter 1

The Project Management's tools

The issues related to project management are nowadays very topical within every organized structure, both private and public.

The growing complexity of business activities, time and increasingly limited resources,

impose on companies, as well as on public structures, the search for effective tools for

manage the projects that are activated in every business sector:

- The construction or expansion of a plant.

- The launch of a new product.

- Installation of a sofware.

- The start of a procedure.

- A staff training project.

- The organization of a convention.

they are all examples of projects that must be appropriately "governed" in order to obtain i

desired results, respecting time and costs.

1.1 What is a project?

"A project is a task of a certain importance, with a uniqueness that must be

completed respecting a deadline and a certain spending budget".

The definition of the project highlights its basic characteristics:

- consists of a set of activities;

- destined to obtain a specific finished product;

- to be performed in a certain period of time;

- by using predefined and assigned resources;

- at predetermined costs.

It is in the light of these premises that it becomes immediate to understand the importance of a methodology effective management of any type of project.

It can be internal to the company or a project for the supply to third parties of products / services. Internal projects are related to the company's needs and do not have an external customer; examples: R & D of new products, engineering of new processes, installation / replacement of plants, implementation of an information system and organizational restructuring.

The macroscopic characteristics of the project are UNICITY and TEMPORARY. On the basis of this subdivision there can be: projects as a support to the business [high uniqueness, low temporality; development of new products]; functional projects [low uniqueness and temporariness; new versions of products]; external projects such as business [low uniqueness and high temporariness; engineering, consulting]; temporary organizations in which the project is used instead of organization [high uniqueness and temporariness; start up; development of a new market].

In a project there are different levels of activity:

a) management processes (project management skills): management and control logics → similar also in different projects (eg: PERT);

b) operational processes (specific to the industrial sector in question): executive activities → specific to the project I am carrying out;

c) organizational processes: organization of resources → depending on the role I do different things.

The 3R of the project: Resources, Roles and Responsibilities.

The 3C of the project: Communication, Cooperation and Coordination.

1.2 Project Managment

Project management consists of supervising a project to ensure compliance with its objectives, quality, timing and budget .

Clearly, this activity involves the application of a working methodology which in turn is articulated in many processes.

Among the first tasks applied to a project that must be carried out by a project manager is the identification of the area in which the work will have to take place.

It is a management / organizational technique that serves to integrate business and inter-company activities. It is used for complex projects, consisting of different activities, with specific, unique, non-repetitive objectives and with established times / costs.

Some definition:

Program is a set of related projects managed together in a coordinated way to obtain benefits and control not available from managing them individually.

Project Portfolio is a collection of projects and programs grouped together to facilitate effective management of their work in order to meet a business' strategic objectives. The projects and programs in the project portfolio may not necessarily be interdependent or directly related.

Portfolio Manager is the responsible for facilitating the decision-making and overall organization-level execution & reporting processes for the projects/programs in a business. Interfaces with Program Managers, Project Managers and DGCs to perform organization-level portfolio processes, ensure overall business objectives are achieved, and the value of the portfolio is maximized. The Portfolio Manager facilitates these processes. Key portfolio decisions are made by the leadership team of the business.

Project Manager is the person responsible for leading a project from its inception to execution. This includes planning, execution and managing the people, resources and scope of the project. Project managers must have the discipline to create clear and attainable objectives and to see them through to successful completion. The project manager has full responsibility and authority to complete the assigned project. A project manager's position may end with the completion of the assigned project, or it may be a semipermanent position for a limited time or until a predetermined point in the project's schedule or stage of completion.

1.2.1 The phases of the project management

Identification of the project → the idea of the project is developed, a feasibility study is carried out and its economic advantages are evaluated, see figure 1.1.

Figure 1.1 Flow of the Project Managment, *Le fasi del Project Management.*

In details follow the steps of Project Management:

- **Definition of the project** → identify the characteristic parameters of the project, starting from market evaluations and customer requests. The PM and the work team are appointed. Job specifications are detailed. The specific organizational and management modalities of the project are defined.
- **Project planning** → identify all the project activities and the logical links that interconnect them; the durations are estimated and the resources necessary for their completion are allocated. The PM and the project team must establish, in detail, what needs to be done, who is responsible for each operational activity and how it intends to operate. The output of the planning phase will become the input of the next programming phase.

  The WBS (Work Breakdown Structure, or PBS) is an analytical representation of the project, which divides the activities level by level up to the level of detail necessary for adequate planning and control. (The detail must go down to a level sufficient to identify our scope of work).

The WBS is a hierarchical structure, in the form of a tree, of the project that must include all the elements that are the object of supply to the customer (components, machinery, services, documentation, etc.), as well as the main functional tasks to realize these elements.

At the end of the hierarchical decomposition of the project the work packages are obtained: clearly identifiable work packages and univocally attributable to a company function or work center or third party.

These must have a detail that allows the definition of the related: costs, time, constraints and progress (both in terms of quantity and costs).

Basically, the WBS allows you to define what, how and with what.

Main activities for the execution of the WBS:

- hierarchically structure the parts of the project;
- identify known and repetitive tasks that are considered work packages;
- assign the work packages to the centers of responsibility, identifying activities;
- quantify necessary activities and resources;
- allocate resources and budgets

The WBS is the equivalent of the BOM in the decomposition of a product and also allows to monitor the progress of the work, linking the execution time to the individual activities.

- **Assignment of resources** → human, financial, material.
  The OBS (Organization Breakdown Structure) is the identification of the participants (with their hierarchical relationships) or of the company functions within the organizational structure of the project.The OBS allows you to identify the roles and assign responsibilities.
  If instead of the organizational units we replace the specific personnel resources we speak of RBS (Resource Breakdown Structure).
  The WBS / OBS crossing matrix originates from a task / responsibility matrix, which answers the question who does what, assigning the work packages to their respective responsibility centers.

Once the general WBS / OBS of the project has been defined, each responsible function will develop the assigned work packages in detail.

The activities defined in this way are then used for planning the contract, identifying for each one the necessary resources and execution times.

- **Budgeting** → The breakdown of the project can be extended to the economic exploitation of the individual activities. This allows you to create an additional tree structure called CBS.

  In CBS are considered the cost items directly related to the project or easily assimilated to the project (do not include the general costs of the company, unless you consider a hourly cost with the hours dressed).

- **Programming** → scheduling of all the activities included in the project in order to reach the project objectives within a reasonable time frame. Often the objectives are conflicting (time VS costs). Programming includes analysis of resource availability and scheduling techniques.

  The programming tools are:

  a) Planning and / or lists of activities: the items / activities of the WBS are taken back and, based on the estimates of the resources used, the execution times of each activity are quantified; this valuation can be performed in absolute terms (simple durations of the activities) or with reference to calendars. The durations are then subjected to periodic checks, in order to evaluate the deviations (positive or negative) from the original values to the estimate.

  b) Bar charts (Gantt): each activity of the WBS is represented by segments of length proportional to their duration, so that their sequence respects the real development of the works over time. Advantages: immediate visual comprehension, simple and understandable. Disadvantages: updating difficulties (if an activity slips, it is not said that they must slip all subsequent ones, but they do not have the certainty), interdependencies are not represented among the activities (it is not clear if the fulfillment of an activity is necessary or not for the beginning of another). Except for particularly small or repetitive projects, the construction of Gantt diagrams should follow programming using reticular techniques.

c) Reticular techniques (CPM - Critical Path Method, PERT - Program Evalutation Review Technique, PDM - Precedence Diagrammino Method).

- **Monitoring of the project** (from this point onwards the job order can start) → it is part of the control of a project in which: the criteria for the control are determined, the performance indicators are defined; the project performance is measured by comparing it with the initial objectives; the critical variations between expected and realized performances are identified and the impact on the whole project is defined.
- **Reporting of the project** (lasts for the entire contract) → summary presentation of the measurements of the parameters considered significant, presented in graphical and / or tabular form.
- **Risk Management**

  It is the systematic process of identification, analysis and response to the risks of the project.

  Maximizes the probability of positive events and minimizes the probability of adverse events to the project objective.

  Yesterday was exclusively aimed at projects of enormous size and environmental impact in the fields: military, aeronautical, space and nuclear.

  Today it has been theoretically extended to all projects due to:

  • stricter limits to the project budgets,

  • time to market / competition,

  • sudden changes in technology.

  The Risk Management processes interact with the other management processes during the project life cycle (conception, planning, control, closure) described by the Project Management discipline.

  Project management differs from risk management in that it focuses on the risks that have become visible and which have therefore taken the form of problems.
- **Project control** → collection and processing of information to define the state of evolution achieved at a certain date; comparison of data with pre-established references in order to identify any deviations and relative causes; adoption of appropriate corrective measures.

1. contain the project within the initial objectives or understand the causes / origins of variations

or take the appropriate corrective and preventive actions;

2. reprogram the project and define the new objectives.

- **Closure of the project** → transfer of skills and responsibilities from those who built the work to those who commissioned it (client), acceptance of the project by the client, resolution of all the contractual relationships that were established with the project.

1.3 Organizational structures for companies

The organizational structure is the set of modalities that regulate the placement of the single functions in the company organization chart, the lines of authority that interconnect the functions and the information channels through which the information flows in a proceduralized way.

There are different kinds of organizational structures: functional structure, divisional structure and matrix structure.

In this company there is an organizational matrix structure, the so-called matrix structure is a mix of the previous ones and tries to overcome the disadvantages. In practice, the matrix structure develops on both dimensions: one typically functional and another business specification, for example by product / service line or by market. A typical example of matrix organization is that of providing more "project managers" (or "product managers", or "market managers", etc.) who are responsible for a specific portion of business in a horizontal sense, and which draw time and resources.

1.4 New Product Developmemt

Innovation and new product development (NPD) are becoming more important as strategic initiatives. Yet, innovation creates challenges for most existing organisations, thus leading to the emergence of new ventures (NVs) as vehicles to deliver innovation. NVs present owners and management with unique opportunities and challenges. On one hand, the NV can focus its attention on specific innovation(s) without having to compete with other goals and departments for resource access. Resources are critical to the successful development and launch of new products and can come from financial lenders and/or suppliers. However, because they are new and because their only asset of worth is the highly risky innovation, NVs are at a strong disadvantage in securing access to these resources. This study explores the effectiveness of using personal equity investments as a strategy for securing access and for enhancing NPD success. Using signalling theory as the theoretical framework and data from 745 NPD projects representing manufacturing innovations, this study finds that equity investment is particularly successful in its NPD impact although not impactful with suppliers. As a signal, it can be argued that equity is a strong, high-quality signal. Reasons for these findings and directions for future research are provided(Yemisi A.Bolumole, novembre2014).

In order to stay successful in the face of maturing products, companies have to obtain new ones by a carefully executed new product development process. But they face a problem: although they must develop new products, the odds weigh heavily against success. Of thousands of products entering the process, only a handful reach the market. Therefore, it is of crucial importance to understand consumers, markets, and competitors in order to develop products that deliver superior value to customers. In other words, there is no way around a systematic, customer-driven new product development process for finding and growing new products. We will go into the eight major steps in the new product development process, see figure 1.2.

Figure 1.2 NPD steps.

The 8 steps in the New Product Development Proces are:

1) **Idea generation**

The new product development process starts with idea generation. Idea generation refers to the systematic search for new-product ideas. Typically, a company generates hundreds of ideas, maybe even thousands, to find a handful of good ones in the end. Two sources of new ideas can be identified:

- Internal idea sources: the company finds new ideas internally. That means R&D, but also contributions from employees.
- External idea sources: the company finds new ideas externally. This refers to all kinds of external sources, e.g. distributors and suppliers, but also competitors. The most important external source are customers, because the new product development process should focus on creating customer value.

2) **Idea screening**

The next step in the new product development process is idea screening. Idea screening means nothing else than filtering the ideas to pick out good ones. In other words, all ideas generated are screened to spot good ones and drop poor ones as soon as possible. While the purpose of idea generation was to create a large number of ideas, the purpose of the succeeding stages is to reduce that number. The reason is that product development costs rise greatly in later stages. Therefore, the company would like to go ahead only with those product ideas that will turn into profitable products. Dropping the poor ideas as soon as possible is, consequently, of crucial importance.

3) **Concept development and Testing**

To go on in the new product development process, attractive ideas must be developed into a product concept. A product concept is a detailed version of the new-product idea stated in meaningful consumer terms.

4) **Concept development**

Imagine a car manufacturer that has developed an all-electric car. The idea has passed the idea screening and must now be developed into a concept. The marketer’s task is to develop this new product into alternative product concepts.

5) **Concept testing**

New product concepts, such as those given above, need to be tested with groups of target consumers. The concepts can be presented to consumers either symbolically or physically. The question is always: does the particular concept have strong consumer appeal? For some concept tests, a word or picture description might be sufficient. However, to increase the reliability of the test, a more concrete and physical presentation of the product concept may be needed. After exposing the concept to the group of target consumers, they will be asked to answer questions in order to find out the consumer appeal and customer value of each concept.

6) **Marketing strategy development**

The next step in the new product development process is the marketing strategy development. When a promising concept has been developed and tested, it is time to design an initial marketing strategy for the new product based on the product concept for introducing this new product to the market.

7) **Business analysis**

Once decided upon a product concept and marketing strategy, management can evaluate the business attractiveness of the proposed new product. The fifth step in the new product development process involves a review of the sales, costs and profit projections for the new product to find out whether these factors satisfy the company's objectives. If they do, the product can be moved on to the product development stage.

8) **Product development**

The new product development process goes on with the actual product development. Up to this point, for many new product concepts, there may exist only a word description, a drawing or perhaps a rough prototype. But if the product concept passes the business test, it must be developed into a physical product to ensure that the product idea can be turned into a workable market offering. The problem is, though, that at this stage, R&D and engineering costs cause a huge jump in investment.

The R&D department will develop and test one or more physical versions of the product concept. Developing a successful prototype, however, can take days, weeks, months or even years, depending on the product and prototype methods.

9) **Test marketing**

The last stage before commercialisation in the new product development process is test marketing. In this stage of the new product development process, the product and its proposed marketing programme are tested in realistic market settings. Therefore, test marketing gives the marketer experience with marketing the product before going to the great expense of full introduction. In fact, it allows the company to test the product and its entire marketing programme, including targeting and positioning strategy, advertising, distributions, packaging etc. before the full investment is made.

10) **Commercialisation**

Test marketing has given management the information needed to make the final decision: launch or do not launch the new product. The final stage in the new product development process is commercialisation. Commercialisation means nothing else than introducing a new product into the market. At this point, the highest costs are incurred: the company may need to build or rent a manufacturing facility. Large amounts may be spent on advertising, sales promotion and other marketing efforts in the first year.

There is a need for project management methods that can handle NPD. The problem of course is that some forms of NPD, especially those involving a high degree of innovation, are notoriously difficult to manage. Many NPD projects use project management tools, at least elements thereof. However, these are not always fully satisfactory, and the formal project management method in its entirety is not a complete solution for the management of all NPD projects [1].

1.5 Advanced Product Quality Planning

General theory of systems gives general principles of study and reinstatement (design) of all types and varieties of systems. From this point of view, it is possible to identify common design principles of technical and management systems. For designing, understanding and mastering product quality planning the Advanced Product Quality Planning (APQP)-concept is often employed. This concept belongs to standardized quality management in automotive industry (QS 9000 demands). This contribution is an attempt to elaborate an analogy – with APQP-concept – in design and implementation of quality management systems (QMS). The required phases and processes of design methodology are identified along with the possibility for employment of computer-aided tools for automatic design (M.Bobrek, 02.2005).

Complex products and supply chains present plenty of possibilities for failure, especially when new products are being launched. AQPQ is a structured process aimed at ensuring customer satisfaction with new products or processes.

APQP has existed for decades in many forms and practices. Originally referred to as Advanced Quality Planning (AQP), APQP is used by progressive companies to assure quality and performance through planning. Ford Motor Company published the first Advanced Quality Planning handbook for suppliers in the early 1980's. APQP helped Ford suppliers develop appropriate prevention and detection controls for new products supporting the corporate quality effort. With lessons learned from Ford AQP, the North American Automotive OEM's collectively created the APQP process in 1994 and then later updated in 2008. APQP is intended to aggregate the common planning activities all automotive OEM's require into one process. Suppliers utilize APQP to bring new products and processes to successful validation and drive continuous improvement.

Chapter 2

Presentation of Eaton

Eaton "is a global technology leader in power management solutions that make electrical, hydraulic and mechanical power operate more efficiently, reliably, safely and sustainably"(Eaton 2016).

Because of the pivotal role they play, Eaton is committed to creating and maintaining powerful customer relationships built on a foundation of excellence. From the products they manufacture to their dedicated customer service and support, they know what's important. The company and its production line will be presented in this chapter.

2.1 The Company

Eaton generates business in more than 170 countries worldwide, with about one-third of revenues originated outside the United States, 19 percent in Europe and about 6 percent each in Latin America and the Asia-Pacific region. 2015 sales have been of $20.9 billion. With its unique selling proposition (USP) claiming the concept of "Attracting, developing, and keeping a diverse work force", the company has approximately 95,000 employees spread over 60 countries.

It works in different industries, diversifying among electrical, vehicle, hydraulics and aerospace segments.

The company, through its mission, claims the will to "provide safe, reliable, efficient and sustainable power management solutions for their global customers". Main purposes are to power a global and digital world, to reduce their environmental footprint, to meet regulations and lower risk, to provide cost-efficient energy solutions and finally to make power more intelligent and efficient.

The markets are both private and public sectors, ranging from Construction, to Transportation, Industrial and Machinery, Information Technology, Infrastructure, Energy and Utilities.

For Construction sector (residential, healthcare, commercial, airports, retail, public sector), Eaton offers electrical distribution solutions for power delivery, power metering and monitoring to add intelligence and save costs, engineering services to design, build and support it all.

For the Transportation sector (aerospace, commercial vehicles, passenger and performance cars, high-speed rail, marine, military defense) it offers automotive and commercial vehicle technology for light fuel-efficient vehicles; manual and automated transmissions for improved fleet performance and fuel economy; superchargers to raise performance; hybrid power systems to reduce fuel consumption and CO_2 emissions; hydraulic, fuel, electrical & conveyance systems for more efficient and eco-friendly aircraft; onboard controls and electrical charging infrastructure for hybrid & electric vehicles.

For Infrastructure sector (airports, highways, Mass transit, water and wastewater treatment plants, lock and dams), Eaton candidates for complete backup power systems for airports to ensure continuous system operation; high-speed refueling systems for reliable airport refueling; hydraulic system solutions and technical services; filtration, hydraulic and electrical products for safe drinking water; hybrid power systems for municipal transit buses.

For the Industrial and Machinery sector (manufacturing, agriculture, mining and metals, processing, material handling) the company proposes electro-hydraulic systems; electrical distribution equipment to deliver power throughout the enterprise; control & automation and power quality equipment for more productive operations; power and motion control products and hydraulics technology to optimize productivity, reliability, safety, and operator comfort.

For Energy and Utilities sector (renewable energy such as solar, wind and hydropower; traditional energy such as oil and gas, nuclear energy, smart grid), the offer includes electrical balance of system and turnkey services for residential and commercial solar installations; power distribution equipment, control components and system installation services for wind farms; network power grid technology for intelligent data, lower costs and crew/public safety; turnkey services for electrical utility substations; and others.

For Information Technology sector (data centers, telecommunications networks, computer rooms) the company proposes UPSs to reduce footprint and save energy; local service and support for quick response; power metering and monitoring to diagnose problems and lower costs.

Regarding recent financial and operating results, the Eaton Annual Report (2015) shows that the company posted sales of 20.9$ billion, down 7½ percent from 2014, and operating earnings were $2.0 billion, a decrease of 10 percent from 2014. The company generated $2.4 billion in cash from operations, repaying $1 billion of the debt that was borrowed to finance the Cooper Industries acquisition. The Annual Report (2015) claims that the company strengthened its commitment to sustainability by reducing emissions and environmental footprint in waste to landfill and water consumption, while expanding efforts to build safer and healthier workplaces and communities, for example reducing their recordable incident rate by 6 percent from the previous year. In spite of all these accomplishments, total return to shareholders was a negative 21 percent over 2015, in a context in which anyway global equity returns were broadly disappointing; the company's markets declined and currency translation further decreased revenues by approximately $1.2 billion. A breakdown of net sales per region as geographic destination of sales, the result is 11,396 billion $ is for US, 0,969 for Canada, $1,726 for Latin America, $4,379 Europe, $2,385 for Asia Pacific

2.2 Historical Overview

Eaton was founded in 1911 in Bloomfield, New Jersey by Joseph O. Eaton, Henning O. Taube and Viggo V. Torbensen, set to manufacture Torbensen's patented internal-gear truck axle. In 1914, the company moved to Cleveland, Ohio, to be closer to its core business, the automotive industry, and incorporated in 1916.

A year later, Republic Motor Truck Company, Torbensen's largest customer bought out the company, but Eaton and Torbensen retreated it to form the Eaton Axle Company. The company became international by opening a manufacturing plant in Canada in 1958. Named president of Eaton in that same year, John C. Virden, strong believer in "divisional autonomy" ensured that Eaton's subsidiaries and divisions maintained a large degree of managerial independence and made Eaton accomplish 23 major acquisitions between 1958 and 1973.

Eaton, having started as a pioneering auto supplier, grew quickly also in other businesses. Main acquisitions have been Fuller Manufacturing (1958); Yale & Towne Manufacturing Co (1963); Samuel Moore & Company, manufacturer of hydraulic motors and transmissions (1978); Kenway, a company specializing in robotic warehouse storage systems (1978), the important electronics company Cutler-Hammer (1978); Westinghouse Electric Corporation's (1994); Aeroquip-Vickers Inc., producer of industrial hydraulic equipment (1999), Powereware corporation, market leader for power quality related products such as uninterruptible power supplies (2004). In 1998 instead, the company's truck axle and brake business, its founding business, was sold to Dana Corporation.

The company’s name changed to the current Eaton Corporation in 1971, and continued to expand geographically and organically in addition to the strategic growth, targeting Brazil, China, South Korea and India for the foreign growth.

In the recent history, important events have been the $13 billion acquisition of Cooper, American worldwide electrical products manufacturer in 2002 and the establishment of the registered head office in Dublin, Ireland, still maintaining operational headquarters in Ohio.

2.3 The Business Group

As already mentioned, the company is related to an Industrial Sector and an Electrical one, with a division in 4 different Business Groups. Electrical Products make up around the 35% of sales, Electrical Systems and Services 26%, Hydraulics 13%, Aerospace 8%, and Vehicle Segment 18%, see figure 2.1.

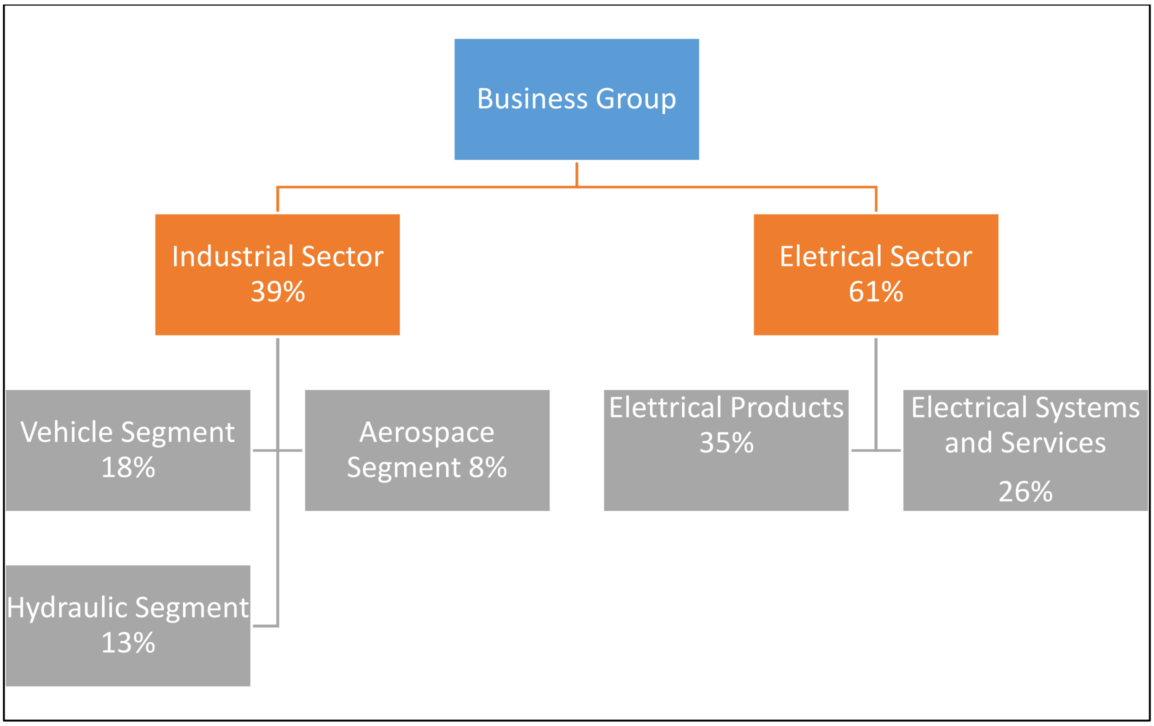


Figure 2.1 Business Groups division (*Eaton* 2016)

Following, a brief overlook over the Groups is given, starting then a focus on Vehicle Group, since the topics and project described in this thesis are related to Valve Train Product Line of Vehicle Group.

2.3.1 Electrical Products & Electrical Systems and Services Segments

The Electrical Sector is a global leader in power distribution, power quality, industrial automation and power control products and services. The Electrical Products segment consists of electrical components, industrial components, residential products, single phase power quality, emergency lighting, fire detection, wiring devices, structural support systems, circuit protection, and lighting products, see figure 2.2.

These products are used wherever there is a demand for electrical power in commercial buildings, data centers, residences, apartment and office buildings, hospitals, factories and utilities.

Figure 2.2 Electrical Products*, (Eaton* 2016).

The segments share several common global customers, but a large number of customers are located regionally. Sales are made directly to original equipment manufacturers, utilities, and certain other end users, as well as through distributors, resellers, and manufacturers' representatives.

Net sales of electrical segment in 2015 accounted for 61% (13$ B) operating profit for 1156 $ B (61%).

2.3.2 Hydraulic Segment

The Hydraulic segment offers hydraulic components and systems to use in mobile and industrial markets. The company offers a range of power products, including pumps, motors and hydraulic power units; a range of controls and sensing products, including valves, cylinders and electronic controls; a range of fluid conveyance products, including industrial and hydraulic hose, fittings, and assemblies, thermoplastic hose and tubing, couplings, connectors, and assembly equipment; filtration systems solutions; heavy-duty drum and disc brakes; and golf grips, see figure 2.3.

Figure 2.3 Hydraulic Products,(*Eaton* 2016)

The Hydraulics group also includes Eaton's Filtration, Golf Grip and Airflex industrial clutch and brake businesses.

The principal market segments for Hydraulics include oil and gas, renewable energy, marine, agriculture, construction, mining, forestry, utility, material handling, truck and bus, machine tools, molding, primary metals and power generation

The Hydraulic segment is a global leader in hydraulics components, systems and services for industrial and mobile equipment. Eaton offers a wide range of power products including pumps, motors and hydraulic power units; a broad range of controls and sensing products including valves, cylinders and electronic controls; a full range of fluid conveyance products including industrial and hydraulic hose, fittings, and assemblies, thermoplastic hose and tubing, couplings, connectors, and assembly equipment; filtration systems solutions; industrial drum and disc brakes; and golf grips. The principal markets for the Hydraulics segment include oil and gas, renewable energy, marine, agriculture, construction, mining, forestry, utility, material handling, truck and bus, machine tools, molding, primary metals, and power generation. Key manufacturing customers in these markets and other customers are located globally. Products are sold and serviced through a variety of channels

Eaton is a manufacturer of systems and components for use in mobile and industrial applications.

Markets include agriculture, construction, mining, forestry, utility, material handling, machine tools, molding, power generation, primary metals, and oil and gas.

Net sales of hydraulic segment in 2015 accounted for 11.7% (2,5$ B) operating profit for 776 $ B (7.85%).

Revenues of this Group in 2015 declined by 10 percent, excluding the effect of currency translation, as the global commodity cycles in oil and gas, agriculture, and mining were compounded by continued weakness in construction equipment markets. New technology, such as new lines of modular control load sense and distributed control meter advanced mobile valves, highlighted a robust year of new product introductions.

2.3.3 Aerospace Segment

The Aerospace segment is a supplier to the commercial and military aviation and aerospace industries. Products include hydraulic power generation systems for aerospace applications including pumps, motors, hydraulic power units, hose and fittings, electro-hydraulic pumps and power and load management systems; controls and sensing products, including valves, cylinders, electronic controls, electromechanical actuators, sensors, displays and panels, aircraft flap and slat systems and nose wheel steering systems; fluid conveyance products, including hose, thermoplastic tubing, fittings, adapters, couplings, sealing and ducting; and fuel systems, including fuel pumps, sensors, valves, adapters and regulators, see figure 2.4.

Figure 2.4 Aerospace Products, (*Eaton 2016)*

The principal markets for the Aerospace segment are manufacturers of commercial and military aircraft and related after-market customers.

Net sales of aerospace segment in 2015 accounted for 8.6% (1,8$ B) operating profit for 246 $ B (9.9%). The aerospace business performed strongly during 2015, growing revenues by 1 percent, excluding the effect of currency translation. New technology developments, such as our fuel pump for the GE9X engine that is designed to meet the demanding fuel efficiency requirements of the new Boeing 777X platform, continue to meet customers’ heightened expectations for performance.

2.3.4 Vehicle Segment

Vehicle Group presents 40 facilities on 6 continents, 4 regional Innovation Centers in USA, Czech Republic, China and India, approximately 14,500 employees worldwide. Looking closer at Europe, Middle East, and Africa (EMEA) regions, there are plants in Brierley Hill, UK; Alcalà in Spain; Bielsko Biala and Tzcew, Poland; Baden-Baden, Nordhausen and Rastatt, Germany; Chomutov in Czech Republik; Rivarolo, Monfalcone and Bosconero in Italy and sales, engineering and administration offices are also located in Turin and Dublin.

The Vehicle Group comprises the company's truck and automotive segments.

The Truck segment engages in the design, manufacture, and marketing of a line of powertrain systems and components for commercial vehicles. Its products include transmissions, clutches and hybrid electric power systems.

The Automotive segment is a supplier of critical components that reduce emissions and fuel consumption and improve stability and performance of cars, light trucks and commercial vehicles. Products include superchargers, engine valves and valve actuation systems, cylinder heads, locking and limited slip differentials, transmission controls, engine controls, fuel vapor components, compressor control clutches for mobile refrigeration, fluid connectors and hoses for air conditioning and power steering, decorative spoilers, under hood plastic components, fluid conveyance products including, hose, thermoplastic tubing, fittings, adapters, couplings, and sealing products to the global automotive industry, see figure 2.5.

Figure 2.5 Vehicle Products, (*Eaton 2016)*

The principal markets for Vehicle Group are original equipment manufacturers (OEM) and after-market customers of heavy-, medium- and light-duty trucks, Sport Utility Vehicle (SUVs), Crossover Utility Vehicle (CUVs), passenger cars and agricultural equipment. These manufacturers and other customers are located globally, and most sales of these products are made directly to these customers.

Customers are main automotive companies. Top ten customers, making Eaton realize 72% of revenues of the Group are Daimler, Paccar, Volkswagen, GM; Ford Motor, Navistar, Volvo, American Axle & MFG, FCA, Cummins Engine.

Figure 2.6 displays the revenue (M USD) realized per each of the mentioned customers, distinguishing between the two segments' proportions.

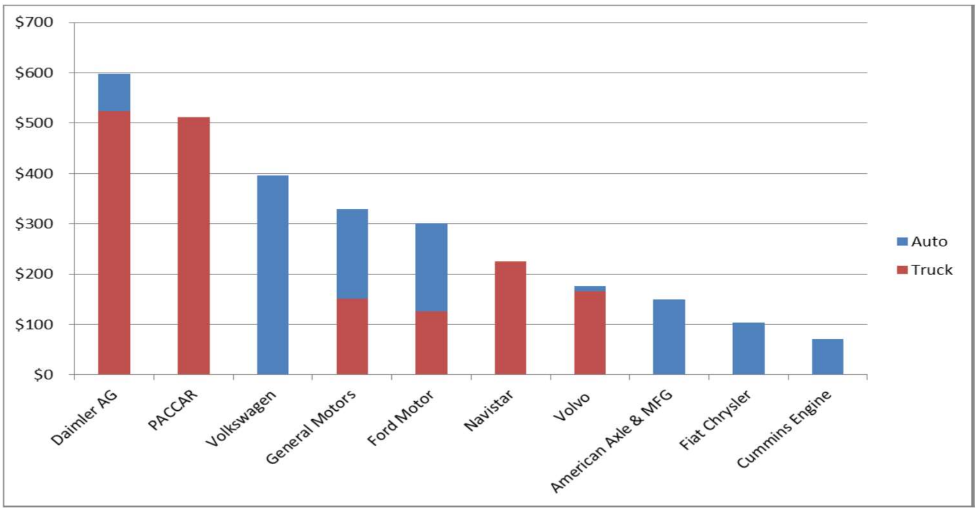


Figure 2.6 Revenues per customer, (*Eaton* 2016)

The Group has been recently re-organized according to a matrix structure in order to facilitate the horizontal flow of skills and information. Employees report about their day-to-day performance to Product Manager, whose authority has a flows horizontally across the divisions. In addition to a multiple command and control structure, this matrix, organized both per Product Line and per region, necessitates new support mechanisms, organizational culture, and behaviour patterns.
Regions of activities are APAC (Asia and Pacific), South America, North America and EMEA (Europe, Middle East and Africa), even if in Middle East and Africa there are almost no activities of Vehicle Group). The project hereinafter exposed in this work has been developed referring to EMEA activities, even if oriented to be developed as a second step by the parallel teams of the other regions, following the same logic implemented in EMEA.
To have an immediate overlook over the activities of the regions, the following diagram displays the amount of sales per geographic region of Vehicle Group. North America accounts for the largest part with around half of total sales of the group, while the second most active region is EMEA with around 20%.
Focusing now on EMEA region, Eaton Annual Report (2015) claims that total sales 2015 have been 685 $M. It is possible to analyse how sales are distributed to customers around the world, considering both OEM and aftermarket. In 2015, 86% to Europe and the rest divided between APAC 6%, NAFTA 4%, Russia 0,8%, Middle East 1,7%, SA 0,4% and Africa 1%. Inside Middle East main markets are Qatar with 6,5 $M sales and Turkey, 4,3 $M.

APAC market, main destination countries are Japan with 23,9 $M, China 5,7 $M and South Korea with 6,4 $M. To visualize a proportional relation between the Product Lines, let's consider a trend over last years of the sales that different products lines gained globally. Greater sales are obtained by Valve Train (around 41% of total sales), Fluid Control Division and Super Charge (around 20%), followed by Truck Transmissions, Turbo Control Product division and Cylinder Heads.
According to the financial and operating result of 2015 of Vehicle Group (Eaton Annual Report 2015) operating profit 645 M$, overall flat, excluding the effect of currency translation, as strength in the U.S. offset weakness in South America.
The focus on fuel economy, safety and emissions is paying off, and the Group launched the new engine brake for commercial trucks, which will go into production in early 2017.

Regarding trends during 2016, the Finance department analysis observed lower market growth and foreign exchanges that continued to impact. EU market continues to grow at slower pace (1.8%) while China and Russia markets are having an important negative impact. Main strategies of the company are to increase content of the mix with higher added value (e.g. Engine Break, DCDA, PACCS, Clutch), power capacity and competitiveness on Valve Train since valve market price is decreasing year over year, invest on bus segment, develop presence in other regions (Russia, Middle East, Africa). Strategies regard also operation excellence, for example implementing “world-class” manufacturing techniques and putting effort in the so called “Zero Incident Culture” to improve safety during operations.

2.4 Product Line of Vehicle Group focusing on the Valve Train

This elaboration was developed at the Torino HQ Eaton, it is a division of Bosconero.

The area involved is Product Engineering, in collaboration with the Quality, where project development takes place for response to customer requests.

Valve train projects are developed in this specific area.

It is important to understand what kind of products this is, as a new management tool for these products will be developed in the following paperwork and, thanks to the simplicity of these products, the process will ultimately be simplified.

Eaton entered the Valve Train business acquiring Wilcox-Rich, leader in manufacturing sodium filled hollow valves and hydraulic lifters in 1930.

Regarding EMEA region, the company started valve production in Rivarolo, Italy, in 1961 and established its first European valve actuation plant in Massa, Italy. In Italy Bosconero plant was established too, for manufacturing of both truck and passenger car valves. In 1991 Nordhausen plant was opened in Germany and the opening of Bielsko Biala plant followed in 1996, producing both valves and valve actuations.

A Valve Train is a mechanical system that controls operation of the valves in an internal combustion engine, in which a sequence of components transmits motion throughout the assembly.

The combustion cycles of so-called 4 stroke engines consists of 4 main phases: compression & ignition, expansion (the 'power stroke'), exhaust and intake. These are described in the Figure 2.7. The force produced during the power stroke makes the crankshaft spin which, through mechanical couplings, drives the wheels of the vehicle.

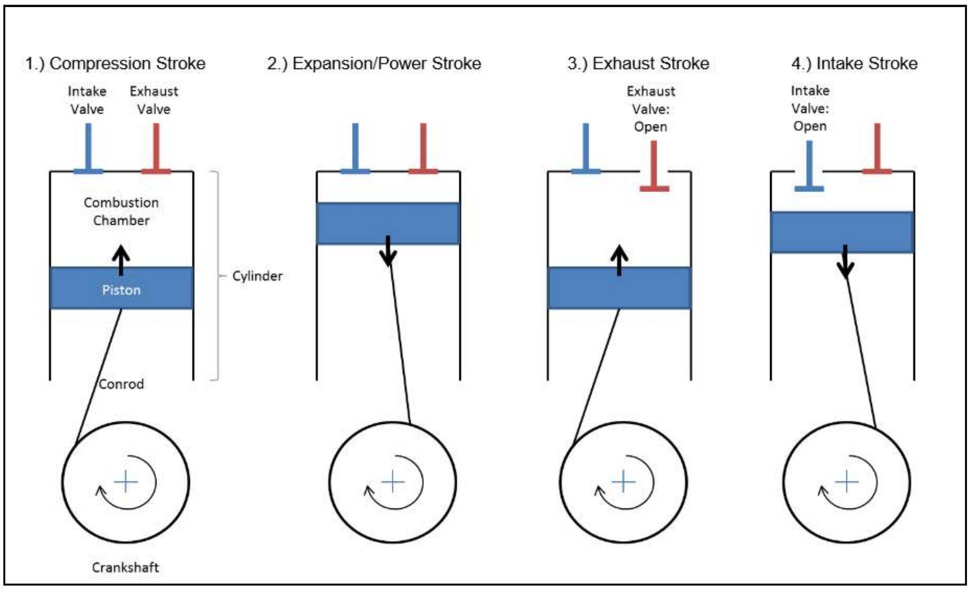


Figure 2.7 The combustion cycles, (Eaton 2016)

1. **Compression Stroke** : with all valves closed, the piston is forced upwards in the cylinder such that it compresses the air/fuel mixture. When near maximum compression (Top-Dead Centre, TDC), the mixture is ignited, which increases the temperature and pressure of the gas.

2. **Expansion/Power Stroke** : the high pressure of the combustion gases forces the piston downward and adds rotational energy to the crankshaft. This is known therefore as the 'power stroke'. As the combustion gases expand, their temperature and pressure are decreased until the piston's lowest position (Bottom dead centre, BDC) is reached.

3. **Exhaust Stroke:** the exhaust valves are opened and, as the piston moves upwards due to the rotation of the crankshaft, the combustion gas is forced out of the combustion chamber. When the piston reaches approximately TDC, the exhaust valve is closed.

4. **Intake Stroke**: the intake valve is opened and fresh air and fuel are drawn into the combustion chamber as the piston moves downwards. Near BDC, the intake valve closes and process 1 can begin again, thus completing the combustion.

The mission of Valve train is to seal the combustion chamber, open and close the intake and exhaust valves at the appropriate time and give consistent operation throughout the life of the engine.

Different engines have a different number of cylinders and usually, engines have 4 valves per cylinder. As a common example, a four cylinder engine comprises 16 valves; 8 intake and 8 exhaust valves.

The generally accepted classification distinguishes between five types of Valve Train, as represented in Figure 2.8.

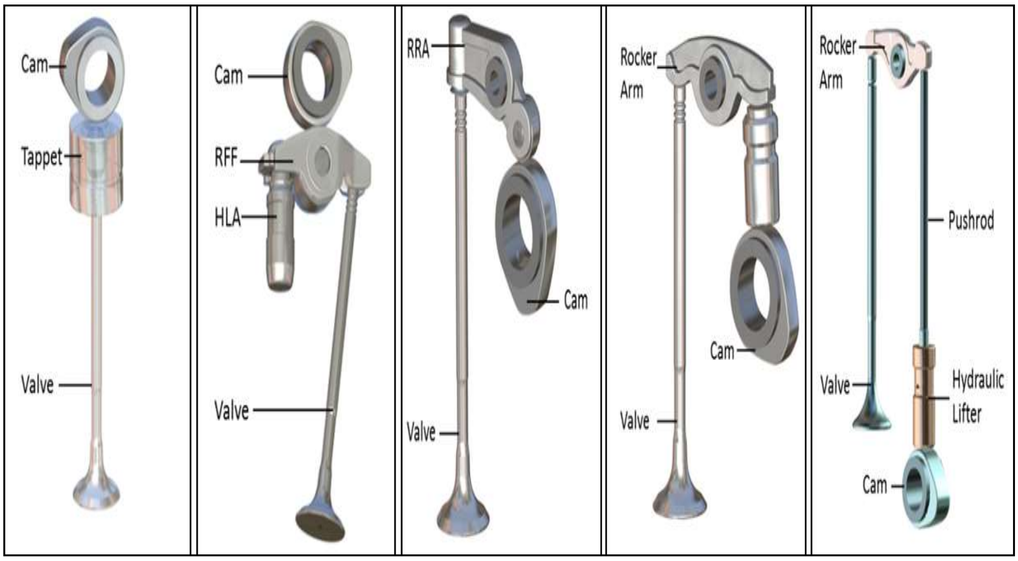


Figure 2.8 Five Types of Valve Train in Eaton, (Eaton 2014).

The Valve Train consists of intake valve and exhaust valve, rocker arms, pushrods, lifters, and camshaft(s). Valve Train opening/closing and duration, as well as the geometry of the

Valve Train, controls the amount of air and fuel entering the combustion chamber at any given point in time. The mission of it is sealing combustion chamber, opening and closing at appropriate time, and ensuring effective operating condition throughout the engine lifetime.

2.4.1 Valve

Depending on application and according to size and dimensions, most of the global production of Eaton engine valves can be used for:

1) Light Vehicle (Passenger Car);
2) Heavy Duty (Truck);

According to their usage in the engine, valves can be:

1) Intake;
2) Exhaust.

Engine valve designs are commonly grouped as per following families:

1) One piece (monolithic) valves;
2) Two pieces (bimetallic) valves;
3) Seat welded valves;
4) Hollow valves.

The figure 2.9 describes parts and terminology for an engine valve.

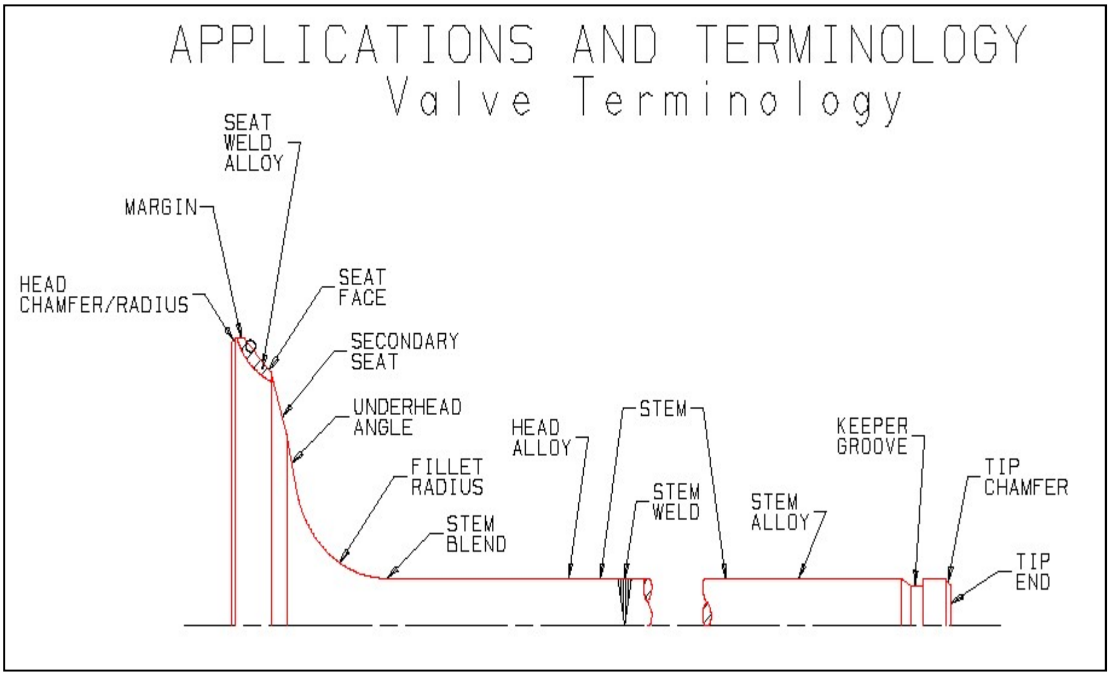


Figure 2.9 Area and terminology of Valve, (Eaton 2016)

Engine valves are located in the cylinder head and their main function is to let air in (the intake) and out (the exhaust) of the cylinders. That air is used to burn the fuel which will drive the pistons up and down. The more air you can move in and out of the engine the more power the engine will deliver. This is why the engine valve plays a pretty critical role in an engine's performance.

The intake valve is exposed to lower temperature and stress, therefore both the design and the process treatments are less complex than for a general exhaust. Usually the raw material is martensitic steel and it is one-piece construction (monolithic valve). The exhaust valve, exposed to very high temperatures (more than 800 degrees Celsius) and stress, needs more complex design and process and nobler materials. It is composed by two pieces, made by both martensitic steel and austenitic steel (bimetallic valve). The austenitic steel contains 16 to 26 percent chromium and up to 35 percent nickel, and usually has the highest corrosion resistance. Martensitic material is generally used for the "stem", whereas austenitic material, with its relative higher performances, is used for the "head", the part that is subject to more stress and to higher temperatures. If generally intake valves are monolithic and exhaust bimetallic for passenger cars applications, for truck applications this is often not true, and also intake valves are bimetallic given that they are subjected to higher stress than for pass cars. Depending on the customer's request different treatments such as chrome plating, nitriding and seat welding with stellite powder are executed to improve resistance and hardness.

The exhaust valve can also be manufactured as "hollow", that means they execute an internal hole containing sodium to lower valve temperature. The hollow valves are distinguished between the so called "Top-of-Head" and "Tube-to-Solid" depending on whether sodium cavity is drilled respectively from the head or from the tip.

The materials are selected depending on different considerations such as predicted valve operating conditions (temperature, stress levels, wear resistance requirements, corrosive environment), fuel consumption, weight, cost. The primary criteria is the so called "adequate high temperature fatigue strength".

In the design of the valve key considerations that are generally taken into account are that:

- the head area impacts on combustion chamber volume and on flexibility;
- the seat area has a functional contact (sealing) with the cylinder assembly;
- the stem area has instead a functional contact with the valve guide;
- the tip area has a functional contact with the valve actuation system;
- the grooves are essential for the clamping.

2.4.2 Valve Actuator

Some types of Valve Train need a valve actuation, that stands for a mechanism for the opening and closing of the valves in the internal combustion engine.

An actuator in its broadest definition is a device that produces linear or rotary motion from a source of power under the action of a source of control. Actuators take fluid, electric or some other source of power and convert it through a motor, piston or other device to perform work. They are used to move valves to either fully opened or fully closed positions.

The valve actuation system is composed by a lash adjuster and a rocker arm.

<u>Hydraulic Lash Adjuster</u>

Lash adjusters work thanks to a mechanical or hydraulic mechanism but in the market hydraulic lash adjuster are much more spread, given that they are suitable for type II Valve Train that has established as the most common type for passenger cars during last years.

Eaton produces valve actuation system in which the lash adjuster is based on an hydraulic mechanism, therefore in this work this component will be always indicated as hydraulic lash adjuster (HLA) or eventually mini lash adjuster (MLA), referring to the same product. The hydraulic lash adjuster is a device for maintaining zero valve clearance between rocker arm and valve. Conventional solid valve lifters require regular adjusting to maintain a small clearance between the valve and its rocker or cam follower. This space prevents the parts from binding as they expand with the engine's heat, but can also lead to noisy operation and increased wear as the parts rattle against one another until they reach operating temperature.

The lash adjuster was designed to eliminate this gap, allowing the Valve Train to operate with zero clearance, leading to quieter operation, longer engine life, and eliminating the need for periodic adjustment of valve clearance.

The figure 2.10 helps visualizing the parts of the product before going through a brief explanation of its functioning and of how the production in Eaton EMEA occurs.

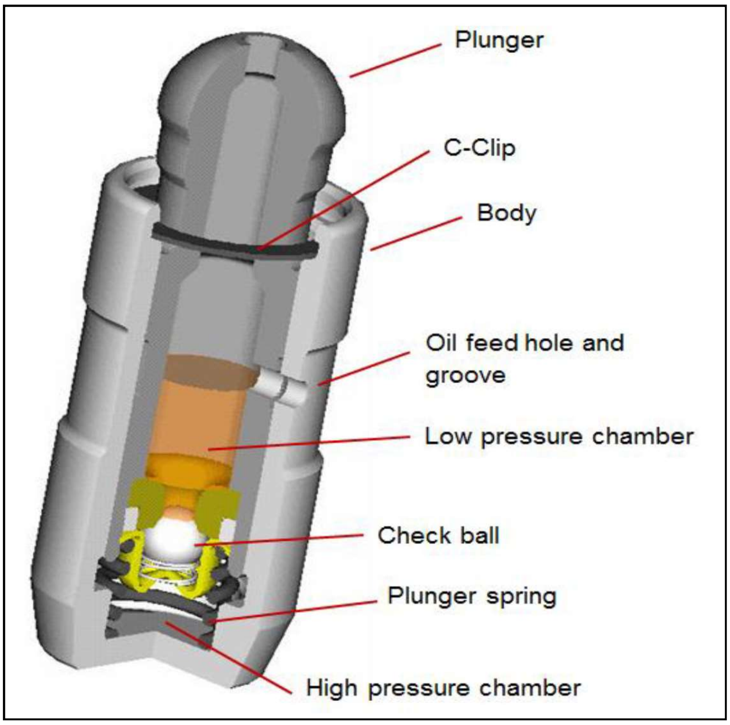


Figure 2.10 Example of lash adjuster decomposition

The hydraulic lash adjuster works according to two modes:

During the load bearing mode the external load is applied, the plunger collapses at controlled velocity (leak down time), the oil leaks through controlled clearance, check valve is closed and in the chamber there is high pressure due to the load.

During the lash recovery mode there is no external load, plunger moves up rapidly, the oil flows into high pressure chamber through the check ball, the check valve is opened and plunger spring pushes up the plunger.

In the assembly operation, bodies and plungers are measured and selected in categories according to outer and/or inner diameter, leak down time is measured on a 100% basis and parts are filled with leak down fluid.

Eaton produces and commercializes two different designs HLAs that have exactly the same functionality but different plunger's designs. One is the so called "Teflon ring" configuration, and the second is the "Net shape" configuration. Net shape plungers are typically coming from a cold forming process, whereas Teflon ring plunger design is typically used when plunger is manufactured by turning operation and it is an exclusive design/process of Eaton.

Roller Rocker Arm

The rocker arm is an oscillating lever that conveys cam lobe rotational movement into linear movement at the poppet valve to open it. One end is raised and lowered by a rotating lobe of the camshaft (either directly or via a tappet (lifter) and pushrod) while the other end acts on the valve stem.

The roller rocker arm (RRA) in particular is a rocker arm that uses bearings instead of metal sliding contact surface against cam.

In the RRA for type II Valve Train, when the camshaft lobe push on the roller, the RRA pad presses down on the valve stem, opening the valve until maximum lift; then valve spring push back valve against RRA pad and so roller follows cam lobe profile until valve closing.

The figure 2.11 illustrates what are the subcomponents of the product and how the assembly generally looks like.

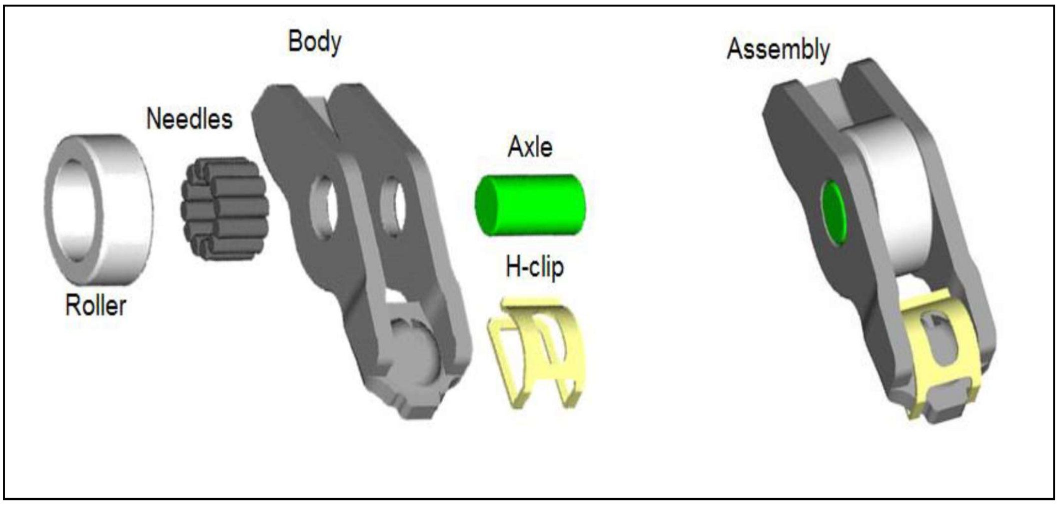


Figure 2.11 Roller Rocker Arm’s components and assembly

In the analysis of rocker arm structure and process, different configurations are considered. They have distinct peculiarities both regarding the typology of subcomponents to acquire and regarding the in-house process that is executed. For the development of the project, four main configurations are considered depending on how the axle is stuck in the product: RRA with hard axle staking (with needles or without), RRA with staked axle, RRA with clipped axle.

Chapter 3

Definition of the process NPD & ISO-IATF

After contextualizing the product and the company under consideration, this chapter presents the Eaton project to help Valve Train project management process be quick and effective.

The products required by the customer are generally new products, or existing products that undergo some modification. That's why it will talk about new product development.

3.1 New Product Development

New Product Development, also called new product management, is a series of steps that includes the conceptualization, design, development and marketing of newly created or newly rebranded goods or services. The objective of product development is to cultivate, maintain and increase a company's market share by satisfying a consumer demand. Not every product will appeal to every customer or client base, so defining the target market for a product is a critical component that must take place early in the product development process. Quantitative market research should be conducted at all phases of the design process, including before the product or service is conceived, while the product is being designed and after the product has been launched.

When a vehicle manufacturer devises launching a new model and starts the activities of planning and product and process design and development, it also starts dealing with components conceptualization and suppliers evaluation.

The automaker will selects one or more supplier(s) for each component, ensuring as much as possible the quality of the component and its ability to respect the specifications, in addition to the capacity and the robustness of the manufacturing process that will provide on time and efficiently the requested volumes for years to come. The official selection of a supplier, and its relative market share, occurs during the process that goes from the Request for Quotation (RFQ) to the Start of Production (SOP) when an open order, in effect until it is either cancelled by the customer or expires by contract, is issued.

The process of NPD includes different phases, that in some respects vary depending on the type of component, the automaker company and the supplier. They are anyway overall disciplined by the ISO/TS 16949, and in particular by the Advanced Product Quality Planning (APQP) procedures and techniques provided for in the ISO, that serve as a guide in the development process and as a standard to share results between suppliers and automakers.

For a launch of a new product, the ISO/TS 16949 specification is an ISO(International Organization for Standardization) technical specification applied throughout the supply chain in the automotive industry aimed at the development of quality management system.

ISO/TS 16949 introduced a set of techniques and methods for common product and process development for automotive manufacturing worldwide.

It was jointly developed by the International Automotive Task Force (IATF) members and submitted to the ISO for approval and publication. The document is a common automotive quality system requirements catalog based on ISO 9001: 2008, and specific requirements from the automotive sector. This document, coupled with customer-specific requirements defines quality system requirements for use in the automotive supply chain.

The IATF has developed a common registration scheme for supplier 3rd party registration to the ISO/TS 16949. The recording scheme includes third party auditor qualifications and common rules for consistent global registration.

The certification pursuant to ISO/TS 16949 is intended to build up or enforce the confidence of a (potential) customer towards the system and process quality of a (potential) supplier.

Today, a supplier without a valid certificate has little chance of supplying a car manufacturer with standard parts.

In particular, the ISO specification emphasizes: continuous improvement through defect prevention and the reduction of variability and losses in the supply chain (very useful application of the method Six Sigma[1]; the need to ensure the control on outsourced processes; preparation of **Failure Mode And Effects Analysis** (FMEA) for critical phases of the process; need of approval of the final customer for all the plant and document changes that may impact on the quality of the finished product; the need to establish a monitoring plan for product and process.

Tier 1 suppliers typically required to be audited and registered to ISO/TS 16949 are required to follow APQP procedures and techniques.

3.2 Advanced Product Quality Planning, APQP

Complex products and supply chains present plenty of possibilities for failure, especially when new products are being launched.

As introduced in the section 1.5, APQP is a structured process aimed at ensuring customer satisfaction with new products or processes, it used by EATON Core team for new products.

3.2.1 APQP Definition

APQP has existed for decades in many forms and practices. Originally referred to as Advanced Quality Planning (AQP), APQP is used by progressive companies to assure quality and performance through planning. Ford Motor Company published the first Advanced Quality Planning handbook for suppliers in the early 1980's. APQP helped Ford suppliers develop appropriate prevention and detection controls for new products supporting the corporate quality effort. With lessons learned from Ford AQP, the North American Automotive, Original equipment manufacturer (OEM) collectively created the APQP process in 1994 and then later updated in 2008.

APQP is intended to aggregate the common planning activities all automotive OEM's require into one process. Suppliers utilize APQP to bring new products and processes to successful validation and drive continuous improvement.

The goals of APQP are to:

- plan before acting;
- anticipate and prevent issues ;
- validate before moving forward;
- facilitate communication.

In the figure 3.1 can see the flow of information in the APQP.

[1][Six Sigma in many organizations simply means a quality measure that strives for almost perfection. Six Sigma is a disciplined and data-driven approach and methodology to eliminate defects in any process - from production to sales and from product to service].

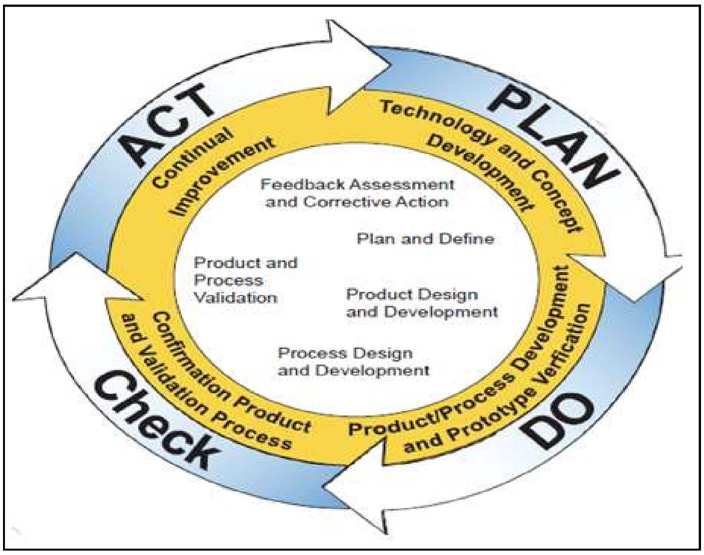


Figure 3.1 Product quality planning cycle, (Eaton website)

There are numerous tools and techniques described within APQP. Each tool has potential value when applied in the correct timing. Tools that have the greatest impact on product and process success are called the Core Tools. The Core Tools are expected to be used for compliance to IATF 16949.

There are five basic Core Tools detailed in separate guideline handbooks, including APQP:

- Advanced Product Quality Planning (APQP) is a framework of procedures and techniques used to develop products in industry, particularly the automotive industry.
- Failure Mode and Effects Analysis (FMEA) is one of the first highly structured, systematic techniques for failure analysis. An FMEA is often the first step of a system reliability study. It involves reviewing as many components, assemblies, and subsystems as possible to identify failure modes, and their causes and effects. For each component, the failure modes and their resulting effects on the rest of the system are recorded in a specific FMEA worksheet. There are numerous variations of such worksheets. An FMEA can be a qualitative analysis, but may be put on a quantitative basis when mathematical failure rate models are combined with a statistical failure mode ratio database.
- Measurement Systems Analysis (MSA) is a thorough assessment of a measurement process, and typically includes a specially designed experiment that seeks to identify the

components of variation in that measurement process. Just as processes that produce a product may vary, the process of obtaining measurements and data may also have variation and produce incorrect results. A measurement systems analysis evaluates the test method, measuring instruments, and the entire process of obtaining measurements to ensure the integrity of data used for analysis (usually quality analysis) and to understand the implications of measurement error for decisions made about a product or process.

- Statistical Process Control (SPC) is a method of quality control which employs statistical methods to monitor and control a process. This helps ensure the process operates efficiently, producing more specification-conforming product with less waste (rework or scrap). SPC can be applied to any process where the "conforming product" (product meeting specifications) output can be measured. Key tools used in SPC include run charts, control charts, a focus on continuous improvement, and the design of experiments. An example of a process where SPC is applied is manufacturing lines.
- Production Part Approval Process (PPAP) is used in the automotive supply chain for establishing confidence in component suppliers and their production processes. The PPAP process is designed to demonstrate that the component supplier has developed their design and production process to meet the client's requirements, minimizing the risk of failure by effective use of APQP. Requests for part approval must therefore be supported in official PPAP format and with documented results when needed.

APQP is a structured approach to product and process design. This framework is a standardized set of quality requirements that enable suppliers to design a product that satisfies the customer.

The primary goal of product quality planning is to facilitate communication and collaboration between engineering activities. A Cross Functional Team (CFT), involving marketing, product design, procurement, manufacturing and distribution, is used in the APQP process. APQP ensures the Voice of the Customer (VOC) is clearly understood, translated into requirements, technical specifications and special characteristics. The product or process benefits are designed through prevention.

APQP supports the early identification of change, both intentional and incidental. These changes can result in exciting new innovation supporting customer delight. When not managed well they translate to failure and customer dissatisfaction.

The focus of APQP is the utilization of tools and methods for mitigating the risks associated with change in the new product or process. APQP supports the never ending pursuit of continuous improvement. The first three sections of APQP focus on planning and prevention and make up 80% of the APQP process. The fourth and fifth sections support the remaining 20% of APQP and focus on validation and evidence. The fifth section specifically allows an organization to communicate learnings and provide feedback to develop standard work and processes.

Some APQP benefits are:

- Directing resources by defining the vital few items from the trivial many;
- Promote early identification of change: Intentional (what is being changed on purpose to bring value to the customer) & Incidental (environments, customer usage, degradation and interfaces);
- Avoid late changes (post release) by anticipating failure and preventing it : fewer design and process changes later in the product development process;
- On-time quality product at lowest cost;
- Multiple options for mitigating the risk when found earlier;
- Higher capability of verification and validation of a change;
- Improved collaboration between Design of the Product and Process;
- Improved Design for Manufacturing and Assembly (DFM/A);
- Lower cost solutions selected earlier in the process;
- Legacy capture and reuse, advancement of Tribal Knowledge [2] and standard work creation and utilization.

3.2.2 Use of APQP

Just said that EATON Core team use APQP for the new product. APQP facilitates communication between the supply chain and the organization / customer. Requirements that translate into more detailed specifications are clarified and decomposed to more detail as the process continues.

In general, APQP is used in 2 ways:

1. **New Product Introduction** (NPI) Support: APQP supplements product development processes by adding a focus on risk as a substitute for failure. This allows the team to take action on the risk instead of having to wait for failure to occur in testing or worse, in the hands of the customer. APQP utilizes risk based tools that focus on all aspects of product and process design, service, process quality control, packaging and continuous improvement. Each application of APQP may be unique to a previous application because of the percentage of new content, changes to current off-the-shelf technology or past failure history.

2. **Product or Process Change** (Post Release): APQP follows a product or process change outside of Product Development and assures the risk of change is managed successfully by preventing problems created by the change.

Eaton Core team non simplify the APQP, so for the description of this can use a general definition.

3.2.3 Structure of APQP

APQP comprises five phases that go through development, industrialization until start of production. They are planning, product design and development, process

design and development, product and process validation, production.

Every phase is associated with continuous feedback assessment and corrective actions, see figure 3.2.

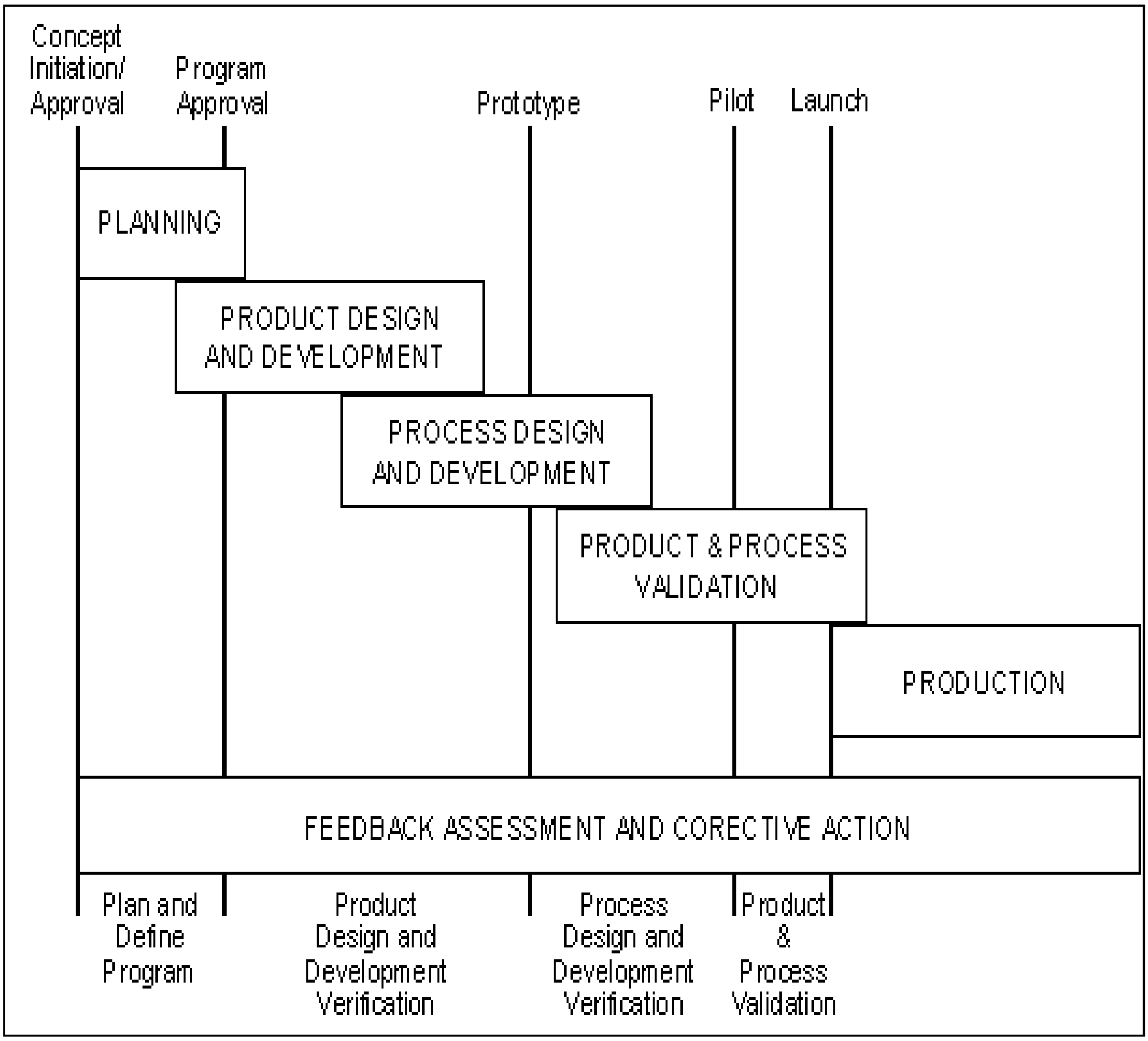


Figure 3.2 APQP phases

1) The planning

Based on the market intelligence information to take into account the historical warranty and quality information. The output of the phase is setting out the design goals, reliability and quality goals, cost of non-conformance (CONC) targets, create preliminary Bill of materials (BOMs) and process flows, but the most important thing is making sure that the customers need and expectations are understood.

2) The product design and development

The elements of the planning process during which design features are developed into a final form. The Product Quality Planning Team should consider all design factors in the planning process even if the design is owned by the customer or shared.

Product Engineering should consider all design factors in the planning process even if the customer give the drawing done. The steps include prototype built to verify that the product or service meets the objectives of the VOC.

A feasible design must permit meeting production volumes and schedules, and be consistent with the ability to meet engineering requirements, along with quality, reliability, investment cost, weight, unit cost and timing objectives. At this stage of the process, a preliminary feasibility analysis will be made to assess the potential problems that could occur during manufacturing. Main outputs of this phase are:

- A disciplined analytical technique that assesses the probability of failure as well as the effects of such failure.
- A simultaneous engineering process designed to optimize the relationship between design function, manufacturability, and ease of assembly.
- Design verification that the product design meets the customer requirements derived from the activities before.
- Design review are regularly scheduled meetings led by Product Engineering and it must include other affected areas, for example Pricing, Quality, etc. The design review is an effective method to prevent problems and misunderstandings; it also provides a mechanism to monitor progress, report to management, and obtain customer approval as required.
- Prototype Build - Control Plan, that is the description of the dimensional measurements and material and functional tests that will occur during prototype build. The Product Quality Planning Team should ensure that a prototype control plan is prepared. The manufacture of prototype parts provides an excellent opportunity for the team and the

customer to evaluate how well the product meets VOC objectives and eventually communicate any concerns, deviations, and/or cost impact to the customer.

- Material Specifications should be reviewed for special characteristics relating to physical properties, performance, environmental, handling, and storage requirements.
- Team Feasibility Commitment and Management Support: the team must be satisfied that the proposed design can be manufactured, assembled, tested, packaged, and delivered in sufficient quantity, at an acceptable cost to the customer on schedule.
- Engineering Drawings (Including Math Data), since customer designs do not preclude the planning team's responsibility to review engineering drawings. They may include special (governmental regulatory and safety) characteristics that must be shown on the control plan. Control or datum surfaces/locators should be clearly identified so that appropriate functional gages and equipment can be designed for ongoing controls. Dimensions should be evaluated to assure feasibility and compatibility with industry manufacturing and measuring standards. If appropriate, the team should assure that math data is compatible with the customer's system for effective two-way communications.

3) Process Design and Development

It is designed to ensure the comprehensive development of an effective manufacturing system that assures that customer requirements, needs and expectations are met. The phase is addressed by process and or manufacturing engineering. Main outputs of this phase are:

Process Flow Chart that is a schematic representation of the current or proposed process flow. It can be used to analyze sources of variations of machines, materials, methods, and manpower from the beginning to end of a manufacturing or assembly process.

Process Failure Mode and Effects Analysis (PFMEA) that is a disciplined review and analysis of a new/revised process conducted before beginning production to anticipate, resolve, or monitor potential process problems for a new product program.

Preliminary Process Capability Study and Pre-Launch Control Plan is a description of the dimensional measurements and material and functional tests that will occur after prototype and before full production. The process instructions for standard operating procedures should be posted and should include set-up parameters such as: machine speeds, feeds, cycle times, etc., and should be accessible to the operators and supervisors.

4)Product and Process Validation

The major features of validating the manufacturing process through an evaluation of a production trial run. During a production trial run, the Product Quality Planning Team should validate that the control plan and process flow chart are being followed and the products meet customer requirements. Main output of this section are:

- Production Trial Run, which the validation of the effectiveness of the manufacturing process begins. It must be conducted using production tooling, equipment, environment (including production operators), facility, and cycle time, with a minimum quantity of product for a production trial run that is usually set by the customer.
- Production Validation Testing refers to engineering tests that validate that products made from production tools and processes meet engineering standards.
- Production Control Plan is a living document with a written description of the systems for controlling parts and processes, to be updated when needed. Management support is necessary prior to the quality planning sign-off (A review and commitment by the Product Quality Planning Team that all planned controls and processes are being followed). The team should be able to show that all planning requirements are met or concerns documented and schedule a management review. The purpose of this review is to inform upper management of program status and gain their commitment to assist in any open issues.

5)Quality planning

It is the component manufacturing stage where output can be evaluated when all special and common causes of variation are present. Main outputs of this section are:

- Reduced Variation: control charts and other statistical techniques should be used as tools to identify process variation, and analysis and corrective actions should be used to reduce variation. Proposals should be developed including costs, timing, and anticipated improvement for customer review. Often the reduction or elimination of a common cause results in lower costs, therefore suppliers should not be reluctant to prepare proposals based on value analysis, reduction of variation, etc. The decision to implement, negotiate, or progress to the next product design level is the customer's prerogative.
- Customer Satisfaction: related to correct working of the component in the customer environment and in the right assembly module. The product usage stage requires supplier participation. It is in this stage where the most can be learned by both the supplier and customer, they must be partners in making the changes necessary to correct deficiencies to achieve customer satisfaction.
- Delivery and Service: the supplier-customer partnership continuous in solving problems and continual improvement. Failure to correct a problem the first time always damages the supplier's reputation and customer partnership. The experience gained in this stage provides the customer and supplier with the necessary knowledge to recommend price reductions achieved by reducing process, inventory, and quality costs and to provide the right component or system for the next product.

Let summarize methodically how does the process for the supplying company occur when going from the initial Request For Quotation (RFQ) to the achievement (or not) of new business.

First customer's buyer deals with supplier's sales department to invite suppliers to participate in the bidding process for a specific component.

The Sales express the customer RFQ in CRM, assign the activities and initiate the Costing Tool file, to the Product Strategy.

This happens through an RFQ, as an opportunity for potential suppliers to competitively cost the final chosen solution or through an Request For Proposal (RFP), a business requirements-based request for specific solutions to the sourcing problem.

The RFQ come together with the Statement of Requirements (SOR); in the SOR, the customer gives technical information, technical drawings, 3D models.

Technical drawings are redesigned according to the supplier codes and language and a part number according to the supplier classification is issued for the specific product. The engineering team analyzes customer requirements, makes various project revisions, and changes the design in case the customer changes the specifications.

A technical discussion to review the request takes place between the supplier engineering team and the customer product development team.

Product feasibility is analyzed. The supplier purchasing department works with sub-suppliers for having information about sub-components such as needed tooling and equipment, to select a sub-supplier and in turn quoting or at least estimating unitary price.

Manufacturing and process engineering analyze the process feasibility. After considering all estimated future production costs, the desired margin and strategic considerations, a price is proposed and the customer can accept, refuse, or counteroffer, until a dealing is reached. A technical discussion continues between supplier and customer about innovation, material, product design.

An order to prototype department is issued. The customer verifies the prototype production, and according to it some modifications, re-designs, drawing optimization can be executed.

This process, that involves the five phases described by the APQP, must comply with the APQP method and with ISO/TS regulation, providing PPAP documents that are requested by the customer in order to define the approval process for new or revised parts.

3.3 ISO – IATF definitions

Just said that APQP is the acronym for Advanced Product Quality Planning. It is a quality planning methodology that is required in the automotive industry (ISO / TS 16949: 2002) and is used for planning of process and product development.

Eaton now will start to implemented the new standard ISO-IATF 16949, that plays an essential role in ensuring quality requirements are met, thus reducing the risk of product and service failure for automotive production, service and/or accessory parts organizations. Certification to IATF 16949 is mandatory for organizations who wish to manufacture parts for the automotive industry.

Some of the benefits of the IATF registration scheme include:

- improved product and process quality;
- additional confidence for global sourcing;
- reassignment of supplier resources to quality improvement;
- common quality system approach in the supply chain for supplier/subcontractor development and consistency;
- reduction in multiple 3rd party registrations.

IATF 16949 fully supports these changes in ISO 9001:2015 with additional requirements that better meet automotive industry needs. Alignment with the ISO 9001:2015 structure makes it easier for organizations that need to implement more than one quality management system standard. If IATF 16949 is implemented and properly managed, an organization will:

- Receive recognition from regulatory authorities;
- Produce safer and more reliable products;
- Meet or exceed customer requirements;
- Improve processes and documentation system.

Unlike ISO/TS 16949 and some other industry-specific standards, IATF 16949 does not contain the ISO 9001:2015 text. The document contains only the automotive-specific additional requirements; however, the organization is still required to comply with ISO 9001:2015. IATF 16949 clarifies that it is a supplement to be used in conjunction with ISO 9001:2015.

IATF 16949 shares the same general section headings and clause structure as ISO 9001:2015, without reciting the text. This ensures all IATF 16949 requirements are fully aligned with the ISO 9001:2015 high level structure.

IATF requirements are:

1) Risk based thinking vs preventive

Risk mitigation takes center stage in IATF 16949, as it does in ISO 9001:2015. IATF 16949 adds a number of specific risk-related requirements to minimize the likelihood of failure during new program development and to maximize the potential realization of planned activities. These additions are the result of industry best practices intended to make businesses safer and more stable by identifying and mitigating risk.

To ensure risk-based thinking is pervasive throughout the organization, top management needs to be actively engaged. Responsibilities include:

- conducting contingency planning reviews;
- identifying and supporting process owners;
- product safety;
- ensuring achievement of customer performance targets and quality objectives;
- implementing corporate responsibility initiatives including an anti-bribery policy, an employee code of conduct, and an ethics escalation policy (“whistle-blowing policy”).

IATF 16949 requires that “organizations shall ensure conformance of all products and processes, including service parts and those that are outsourced.” This use of the word “ensure” implies that the organization needs to establish and maintain a system that mitigates the risk of non-conformance throughout the supply chain. The organization is ultimately responsible for all conformity and must cascade all applicable requirements down the supply chain to the point of manufacture.

The standard reinforces the concept of a “multidisciplinary approach” throughout the product lifecycle, and particularly during design and development planning activities. IATF 16949 adds additional controls for the management of development projects throughout the cycle, which eventually concludes with a product approval process. As well, the automotive standard adds a large number of requirements to specifically address the development of manufacturing processes. Manufacturing processes may have the same output requirements as those specified for the product; however, customers often require the use of specific Automotive Core Tools, such as capturing and analyzing risk via a PFMEA. These sorts of considerations are included in IATF 16949 in an attempt to mitigate risk even before manufacturing the product or installing machinery.

Survival in the automotive industry requires continuous change to address internal and external issues. Organizations need to adopt a process to assess the risk of changes and take appropriate action. IATF 16949 requirements to manage changes include:

- Assessing manufacturing feasibility for changes to existing operations.
- Evaluating design changes after initial product approval.
- Reviewing control plans for changes affecting product, manufacturing process, measurement, logistics, supply sources, production volume changes, or risk analysis.
- Controlling and reacting to changes that impact product realization, including changes caused by the organization, the customer, or any supplier. This includes both permanent and temporary changes.
- Adjusting the frequency of internal audits based on occurrence of process changes.

Other sources of risk, such as how to deal with nonconforming outputs, are covered in more detail to ensure suppliers are aligned with their customers.

2) Integration of customer-specific requirements

IATF 16949 integrates many common industry practices previously found in customer-specific requirements. Integrating these common practices as requirements encourages commonality throughout the industry and aims to reduce the need for extensive customer-specific requirements in these areas.

Also important is the clear distinction between customer requirements and customer-specific requirements (CSRs). In IATF 16949, these two terms are defined as follows:

- Customer Requirements: All requirements specified by the customer (e.g., technical, commercial, product and manufacturing process-related requirements, general terms and conditions, customer-specific requirements, etc.);

- Customer-Specific Requirements: Interpretations of or supplemental requirements linked to a specific clause(s) of this Automotive QMS Standard.

The new standard more clearly defines these two terms to reduce misunderstandings, and to facilitate the sampling of customer-specific quality management system requirements for effective implementation.

For example, the organization needs to review and agree with customer requirements such as packaging manuals and manufacturing process guidelines. However, for customer-specific requirements, organizations need to review and agree after considering the impact on their entire QMS.

Here are some examples of areas that were previously customer-specific requirements that are now included in more detail in IATF 16949:

- Second-party audits, see point 3 *First and second party auditor competency*;
- Manufacturing feasibility, see point 5 Manufacturing Feasibility;
- Warranty management, see point *6 Warranty Management*.

3) First and second party auditor competency

IATF 16949 adds additional requirements for both first and second-party auditors, which include:

- Organizations shall have a documented process to verify internal auditor competency.
- When training internal auditors, documented information shall be retained to demonstrate trainer's competency with the additional requirements.
- Organizations shall demonstrate the competency of second-party auditors, and second-party auditors shall meet customer-specific requirements for auditor qualification.

First and second party auditor competency also outlines the minimum competencies for auditors, which include:

- Automotive process approach for auditing, including risk- based thinking, see point 1.
- Applicable core tools requirements, see point 1.
- Applicable customer-specific requirements, see point 2.
- Software development assessment methodologies, if applicable.

- These changes may require a competence gap analysis followed by additional auditor training and development activities.

4) Product Safety

Product safety is an entirely new section in the IATF standard, and the organization must have documented processes for the management of product-safety related products and manufacturing processes. New requirements related to product safety include, where applicable:

- Special approval of control plans and FMEAs.
- Training identified by the organization or customer for personnel involved in product-safety related products and associated manufacturing processes.
- Transfer of requirements with regard to product safety throughout the supply chain, including customer- designated sources (particular safety requirement that are in the request of the customer).

This clause highlights the fact that a product should perform to its designed or intended purpose without causing unacceptable harm or damage. Organizations must have processes in place to ensure product safety throughout the entire product lifecycle.

5) Manufacturing Feasibility

In the new standard, an organization is required to assess if they are capable of achieving the performance and timing targets specified by the customer, otherwise known as manufacturing feasibility. While ISO/TS 16949 did require this kind of manufacturing feasibility analysis, it did not impose specific requirements. The new standard's specific requirements include:

- Using a multidisciplinary approach, that involves drawing appropriately from multiple academic disciplines to redefine problems outside normal boundaries and reach solutions based on a new understanding of complex situations.
- Performing the analysis for any new manufacturing or product technology and for any changed manufacturing process or product design.

- Validating their ability to make product specifications at the required rate through production runs, benchmarking studies or other appropriate methods.

6) Warranty Management

Based on the increasing importance of warranty management, a new requirement has been added to IATF 16949. When an organization is required to provide warranty for its product(s), the warranty management process must address and integrate all applicable customer-specific requirements and warranty party analysis procedures to validate No Trouble Found (NTF).

Decisions should be agreed upon by the customer, when applicable.

7) Development Of Products With Embedded Software

This standard have reference to the computer software, it is a computer software written to control machines or devices that are not typically thought of as computers. It is typically specialized for the particular hardware that it runs on and has time and memory constraints. Not applicable for Valve.

Chapter 4
Gap Analysis

After defining the APQP process and the ISO-IATF norms, the next step of this thesis is to define the strengths and weaknesses of the current APQP, thanks to the help of a Gap Analysis.
Then it will proceed with the identification of the new tool that will replace the current APQP and fill the critical points.

4.1 Gap Analysis of APQP

Start to the study and analysis of the NPD process and ISO-IATF standards; the current procedures and templates were taken and a gap analysis was conducted; in collaboration with the Core team, under the supervision of the quality manager of Eaton Torino.
In particular, by comparing the procedures, templates and WI of the current APQP with the new regulations and interaction with the team, it was possible to analyse
modules, templates and ISO-IATF requirements in parallel and to focus on the critical and strong points of the current APQP.

This work lasted about three months, it was not easy to compare many documents that had not been updated for some time with the demands of the new standards.
In order to focus the gap analysis, an excel file was used, first of all, in which the information that emerged from the comparison was reported step by step.
An Excel matrix was used, which allowed traceability of these critics.

Gap analysis consisted to determine Work Process Matrix Tab:

- **Column A:** Clauses of ISO 9001:2015 and IATF 16949:2016 are listed.
  Note: Cells with a white background represent clauses from ISO 9001:2015, and cells with a blue background represent clauses from IATF 16949:2016.
- **Column B:**Indicate whether the clause is a new requirement.
- **Column C:** List applicable processes.
- **Column D:** it assess the current level of implementation of the affected process on a scale of 1-3 with 1 representing fully implemented and 3 representing nothing in place. Not every process will have the same values.

- **Column E:** Indicate the rationale behind the assigned value in the previous column, level of current implementation.
- **Column F:** it was assess the level of difficulty associated with implementation of the affected process on a scale of 1-3 with 1 representing not difficult and 3 representing very difficult. Again, not every process will have the same values.
- **Column G: it was** indicate the rationale behind the assigned value in the
- **Column H: it was** indicate the level of complexity to implement each process. The value for the level of complexity is the result of multiplying the values listed in columns D and F for each process. This value is automatically generated by tool. Level of complexity can range from 1-3 with 1 being the lowest level of complexity to implement and 3 being the highest level of complexity to implement.

  Green, yellow and red colors are used to provide a visual understanding of the level of complexity.

  1 = (green) fully compliant (relation between actual APQP process and ISO-IATF). In the comment section, cite the evidence and/or explanation.

  2 = (yellow)partially compliant/ some gaps/ work-in-progress. In the comment section, should cite the rational or the elements needed to develop.

  3 = (red) major gaps/ unknown. In the comment section, should cite the issues and gap.

  This value can be used to identify in which processes the implementation project should focus and will also assist in the determination of the resources needed.
- **Column I:** it was identify what activities need to be performed to close the gap.
- **Column J:** it was identify what resources are needed to perform the activities.

Due to professional secrecy it is not possible to show the table used for gap analysis; so the Figure 4.1 represents an example of Work Process matrix tab**.**

ISO-IATF			NOTES: EVIDENCE OR GAPS	AQP	PRO-launch	Document Process Required
1	**4.4.1.1 - Conformance of products and processes** The organization SHALL ensure conformance of all products and processes, including service parts and those that are outsourced, to all applicable customer, statutory, and regulatory requirements (see 8.4.2.2)	1	Eaton does not design and sell a final product to the market but a component that is part of a bigger system (engine or car) developed by the customer.	Procedure XXX and quality form YYYY	○ Design for Environment (DfE) Scorecard	

Figure 4.1 Example of Work Process matrix tab.

4.2 Strengths and weakness of the APQP

From this list it was possible to identify the strengths and weaknesses of the current APQP, in particular:

APQP Strengths:

- Directing resources by defining the vital few items from the trivial many;
- Promote early identification of change: Intentional (what is being changed on purpose to bring value to the customer) & Incidental (environments, customer usage, degradation and interfaces);
- Avoid late changes (post release) by anticipating failure and preventing it : fewer design and process changes later in the product development process;
- On-time quality product at lowest cost;

- Multiple options for mitigating the risk when found earlier;
- Higher capability of verification and validation of a change;
- Improved collaboration between Design of the Product and Process;
- Improved Design for Manufacturing and Assembly (DFM/A);
- Lower cost solutions selected earlier in the process.

Due to professional secrecy it is not possible to show the all APQP weakness, so some of these are:

- Procedures are not aligned with the new ISO-IATF, so procedures and templates need to be addressed on the basis of ISO-IATF requirements; quality requirements/references must be included;
- there is no tool for monitoring the project by the team;
- in some procedures, the responsibility for issuing and updating the form has not been defined, so the documents are not up to date;
- Few project management tools are used (WBS, OBS ect missing).

Starting from these lists, together with the team and some of the program managers, it decided to implement a new tool, it's a EATON tool, just used to the other division.

It is taken and will implemented in EATON Torino HQ, and it will be used by the Core Team. Thanks to the new tool, it will fill the weaknesses of the APQP and ensure compliance with the new ISO-IATF.

4.3 Implementation of the tool: PRO launch NPD

After doing the gap analysis, starting from the results of this, Product Engineering together with the Quality Manager, decided that to solve and eliminate the emerging criticalities it was necessary to implement a new management tool. As defined in Chapter 2, the valve process is a very simple and straightforward process; Eaton has been in the industry for so many years and knows how he should go for projects of this level. This is why it chose to implement a Pro Launch, the Eaton proprietary tool, adapting it to the process, thus simplifying it.

4.3.1 Definition of PRO-launch

PRO Launch is Eaton's integrated system used for the management of all projects, programs and project portfolios within the Corporation. The name PRO Launch is derived from: Profitable, Reliable, On-time Launch (i.e., completion) of projects and programs.

PRO Launch processes are structured, disciplined and repeatable frameworks, its provide a comprehensive management and control system and enable cross-functional teams to produce high quality solutions, on-time and to target costs.

Different types of PRO launch can be found, summaries in figure 4.2:

- **PRO Launch-Acquisition Integration Framework** (PRO Launch AIF)is used to manage the integration of all newly acquired businesses into Eaton.
- **PRO Launch-Business Processes and Services** (PRO Launch-BPS),used to manage the development and deployment of new or appropriate changes to existing business process and services.
- **PRO Launch-New Product/Process Development** (PRO launch-NPD),used to manage the development and launch of entirely new and appropriate changes to products and/or their associated manufacturing processes.
- **PRO Launch-Standard Transition Process** (PRO Launch-STP),used to manage transitions from one manufacturing location to another, as well as moves within a plant of production, as appropriate. It applies to transitions of entire products as well as component or sub-assembly transitions, both internal and external to Eaton.
- **PRO Launch-Information Technology** (PRO Launch-IT), used to manage information technology projects in Eaton.

Initiative Characteristic	PROLaunch Type/Process					
	AIF	BPS	NPD	STP	Program	Portfolio
Developing an entirely new product?			●			
Development and deploying a new business process or service?		●				
Integrating a newly acquired business into Eaton?	●					
Managing a set of related projects together in a coordinated way?					●	
Moving a Line or cell Plant-to-Plant?				●		
Developing an entirely new manufacturing process?			●			
Insourcing a Major Component that involves moving Equipment from Supplier to Eaton?				●		
Managing collections of projects/programs to achieve overall business strategic objectives?						●

Figure 4.2 Different types of PRO launch

In the present case, it will be using the NPD launcher, because the Core Team that uses the tool deals with New Product Development, and then Pro launch NPD will include the activities that are best done and are done in the present case.

Chapter 5

Pro launch NPD

PRO Launch is a process to manage all aspects of the project domain, it processes:

- Are structured, disciplined and repeatable frameworks.
- Provide a comprehensive management & control system.

Enable cross-functional teams to produce high quality solutions, on-time and to target costs. In this chapter can analyze the Phases of NPD process in the Pro launch and the Activity Matrix, used for manage the process.

5.1 – Phases of PRO launch

Start to the APQP structure with the Program Manager, the first step was to divide the NPD process of seven phases, which represent the process from the beginning to the end. The seven phases are as follows, figure 5.1:

- Phase 0 Initiation

At the beginning, data is processed to determine the potential and profitability of a project, becoming a first financial analysis; in this phase can found an evaluation of opportunities, first financial analysis, initial strategic alignment and first risk assessment.

- Phase 1 Concept

At the second moment there is an analysis of commerciality and feasibility and compare the implementation options; develop a preliminary business plan and project plan.

In particular an economic and technical evaluation, with an analysis of customer requirements and identification and development of the package (it is a group of related tasks within a project) to be proposed in the future to the customer.

- Phase 2 Definition

Then you can define the product and project plan sufficiently to ensure the development of all products to finalize the business plan and the product specifications. Main activities carried out at this phase:

1) review and establish the basic lines of the project;

2) the Application Eng. start to customer requirements complete a matrix with the technical requirements;

3) define product requirements and specifications;

4) develop a global project plan.

- Phase3 Design & Development

From customer requirements or market analysis, the design of the product is defined, completed and verified, and the manufacturing process is planned.

- Phase 4 Validation

Prior to the launch, the product process and the requirements are validated; install production processes, equipment and gauges; also it will conduct verification tests for validation.

- Phase 5 Launch

An analysis of product delivery and customer satisfaction is carried out using limited production quantities; in this phase will evaluate product delivery and customer satisfaction with limited production quality.

- Phase 6 Project Close

In this moment of the process, the project performs closing activities; expected activities will be to create a technical support service, review the latest requirements, verify financial results, and develop an improvement plan.

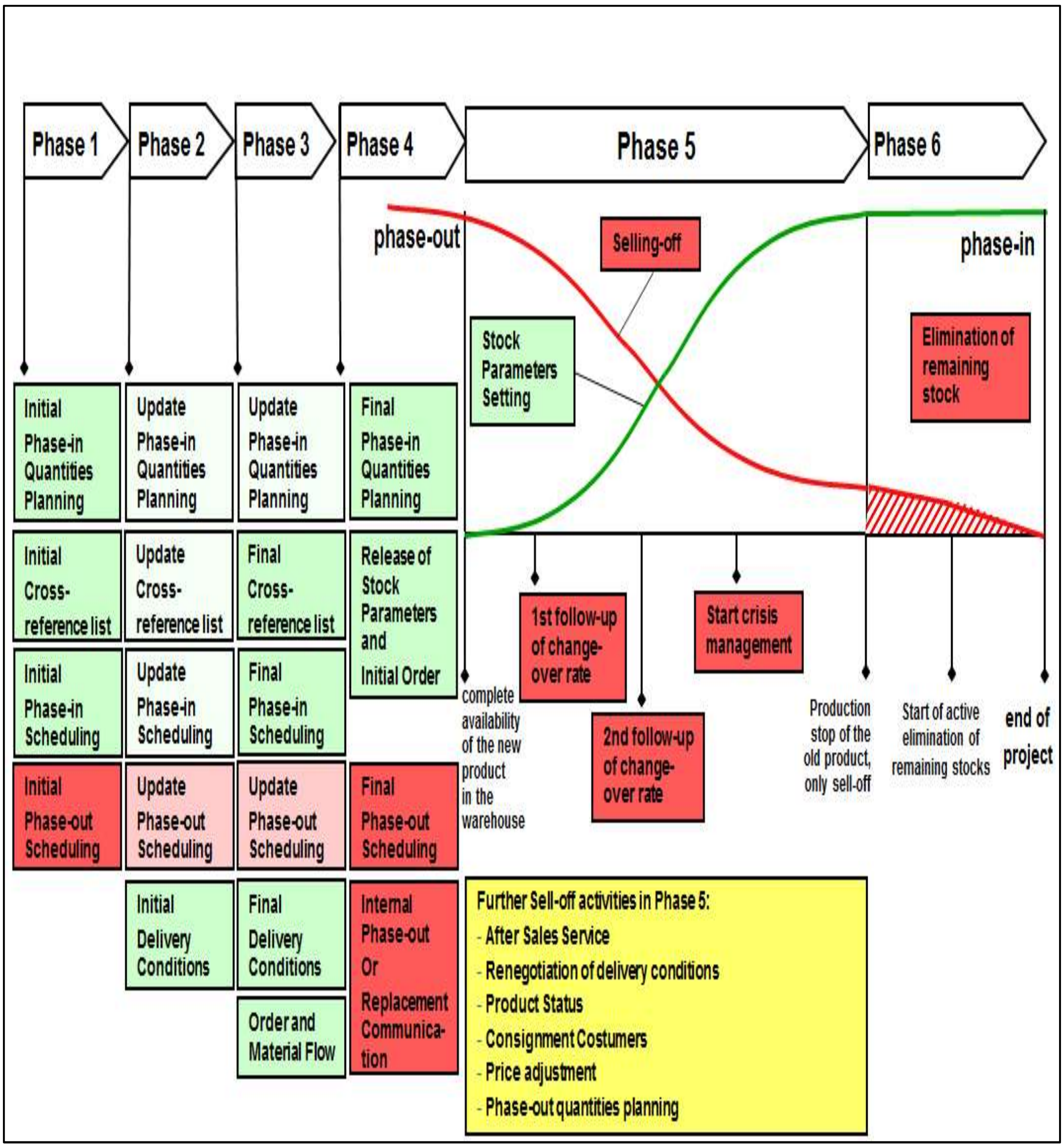


Figure 5.1 Phases of the PRO launch NPD, (Eaton website)

With the help of the Product Engineer (PE) was identificated the flow of activities, in the figure 5.2, can see the flow of information in the different phases of Pro launch.

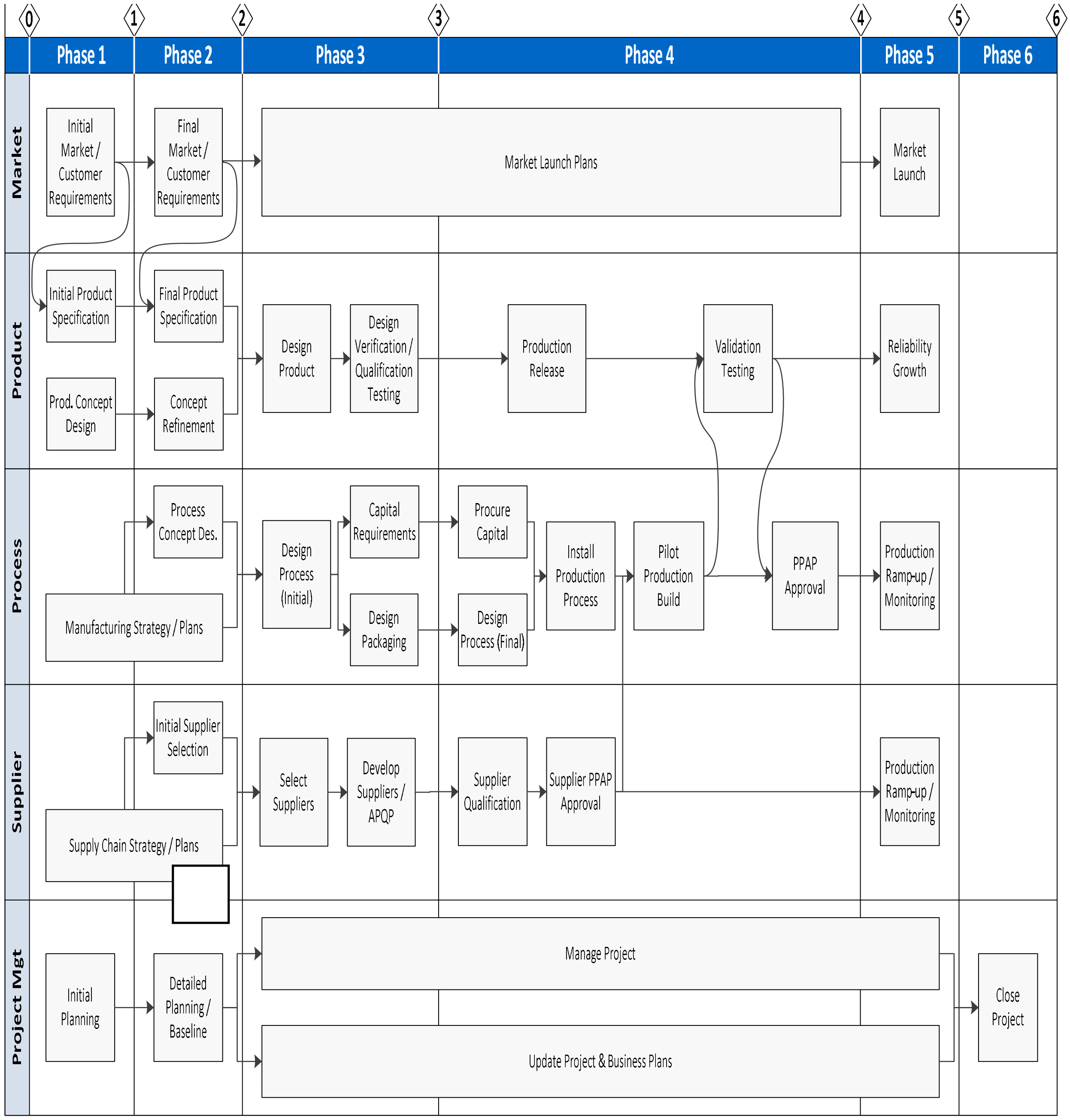


Figure 5.2 Overview NPD process for phases

In the figure you can see how the information travels in the phases of the pro launch, and also how to make references to the APQP tool activity. This figure represents a schedule of workpackages at various stages, from the beginning phase when the customer request arrives at the final stage of production.

5.2 Structure of the Activity Matrix

For organizing the activities and the documentation in the Pro launch, it will be use the Activity Matrix; it is an Excel matrix that will ensure the perfect monitoring and control of the project.

An Activity Matrix will be used for each phase, as can be seen in Figure 5.3, where can see the phase 1 of Activity Matrix.

Within each matrix there will be 2 areas:

1. In the first column, the list of activities and subsequent columns for each activity will be defined:
   - Activities must / should do.
   - Guide for compile the template.
   - Template, form to compile in each activities with the informations of these.
   - Responsibility, for each activity.
   - Timing of the project.
   - Activity progress status.

2. A table that includes:
   - Parameters that monitor the phase are the Decisions Gate (see 4.4 paragraph);
   - Risk analysis of the project phase.

ACTIVITY OUTPUTS BY CLASSIFICATION & RESPONSIBILITY			Reference Documents		RISK CLASS				RESPONSIBILITIES													TIMING			Status of Activit
Activity Numbering	Legend: Risk Class: R= Required S= Should Responsibilities: ● = Lead, (accountable) ○ = Support (provides input as required)	ACTIVITY LEAD:	TEMPLATES:	GUIDES:	Alien/Stranger	Major Repeater	Minor Repeater	Runner	Sales	Product Strategy	Marketing / Communication	Product Engineering	Supply Chain Management	Supplier Development	Materials Management	Manufacturing	Quality	Aftermarket / Service	Finance	Human Resources	Program Manager	Target Date	Actual Date	Completed on Time (y / n)	G Y R
	Phase 1: CONCEPT																								
1,1	*Market Analysis/VOC*																								
1.1.1	Environmental Regulatory Landscape		CS-01093-T		R	R	R	R	○	●		○									○				
1.1.2	Market Analysis		CS-01009-T		R	R	S	S	○	●	○	○						○	○		○				
1.1.3	Market/Customer Requirements (MCR) / Customer Compliance Requirements for Suppliers		CS-01043-T		R	R	R	R	○	●	○	○	○	○	○	○	○	○	○	○	○				
1.1.4	Customer Satisfaction / Market Acceptance Evaluation				R	R	S	S	○	●	○	○	○	○	○	○	○	○	○	○	○				
1,3	*Product Design*																								
1.3.1	*Requirements/Plans*																								
1.3.1.1	Product, Reliability, Service Specifications		CS-01032-T	IEEE Standard	R	R	R	R	○	○	○	●	○	○	○	○	○	○	○	○	○				
1.3.1.2	Design for Environment (DfE) Scorecard		CS-01083-T	CS-01083-G	R	R	R	R	○	○		●	○		○	○	○	○			○				
1.3.1.3	Design Critical to Quality Characteristics (CTQs) on Product Design Scorecard		CTQ Tools	EQS Manual	R	R	S	S	○	○		●	○	○		○	○	○			○				

Figure 5.3 Activity Matrix example.

It could opt for an Agile type, where don't found a sheet for every phases but all phases are represent in one sheet and it's simplify the view of the project. In the figure 5.4 can see the different between the two Activity Matrix.

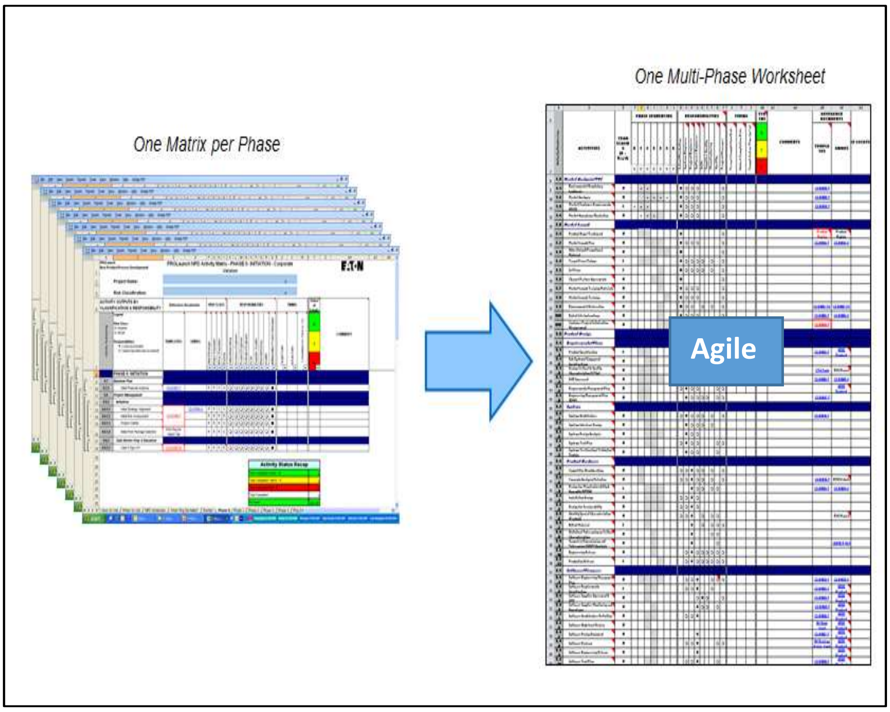


Figure 5.4 Type of Activity Matrix

The Agile Activity Matrix structure that allowed to:

1. **Flexibility and scalability** – add mechanisms to ensure only value-added work gets done at the appropriate time according to program needs.

2. **Quick-hitting lean outs** – Continuous Improvement perspective.

3. **Software development** – define how to execute Scrum (it is a management and control process that cuts through complexity to focus on building products that meet business needs) methodologies for software/firmware under PRO Launch-NPD.

4. **Strengthen key sub-processes** – improve Decision Gate and Work Package Approvals to reduce bottlenecks and improve quality of execution.

At first, it was thought about the one matrix for phase structure, and then it was decided to use the Agile structure to handle a single Excel tab and to have a better view of the progress of the project.

5.3 Defining the List of activities

For business reasons, the list of assets is not listed but it will describe how the activities were selected.

Starting from the Activity Matrix, all the elements that make up it will be defined below: at first, it is necessary to define the list of Activities of the process. Start with the gap analysis, see in the chapter 4, it is a list of activities that is aligned with the activities proposed by the Pro launch and aligned with the ISO-IATF standard. The Pro Launch activities that could meet the standards have been selected by comparing with the current APQP activities.

In particular starting from the list of activities planned for Pro Launch, a continuous comparison was made between the activities of this list and those of the current APQP, then the Gap Analysis matrix was taken and it was verified whether the selected activities also mirrored ISO - IATF standards.

This was the part that took more time because it was not easy to define a list of activities that could meet different aspects. It was necessary to compare with all those who work in

the NPD process, both with teams and with who works / supports the Engineering. It was important to have clear how the process works, how the inputs come and how to get output, and understand the flow of information between the various divisions to understand the associations to do.
Recalling that this is a very simplified process, the NPD case for Valve and Valve Actuator sees the combination of some activities and the elimination of others.
Frequent meetings were held with people interested in specific activities to see if they were doing the right thing. Once the activities have been identified and have been classified in required / should, standard / not standard; so every person responsible for that activity sees whether that activity must always be done or if it can not be done if not required.

In a second moment, it decided to organize these activities in packages.

5.1.3 Work packages selected

A key part of PRO Launch is the set of 'Work Packages' (figure 5.5) that contain the activities that are executed as a project progresses. These activities also indicate collaboration across the functions during execution by identifying lead and support roles. The set of activities of the process represent the typical or common work content. Every project is unique and requires careful planning and consideration of the value added activities that apply.

The work packages are groups of related tasks within a project. Because they look like projects themselves, they are often thought of as sub-projects within a larger project. Work packages are the smallest unit of work that a project can be broken down to when creating Work Breakdown Structure (WBS.

Tasks are typically grouped into work packages based on geographical area, engineering discipline, technology, or the time needed to accomplish them. Here, the Work Packages have been selected based on the type of work done for the NPD process.

In the figure, the work packages selected are these that were analyze in the project in the company.

Work Packages
1.0 Market Analysis/VOC
2.0 Market Launch
3.0 Product Design
3.1 Requirements/Plans
3.2 System
3.3 Product Hardware
3.4 Software/Firmware
3.5 Analysis
3.6 Test
4.0 Process Design
5.0 Process Validation
6.0 Supplier
8.0 Business Plan
9.0 Project Management

Figure 5.5 Work packages of the NPD process

This work packages include all the activities of the NPD process, start to the *Marketing analysis* (what represents the marketing analysis is basically a business plan that presents information regarding the market in which are operating) to the Process validation (what represents the end of the NPD process and the start of the production of the new product).

This thesis includes only the *"Product Design*" work package because it was develop in the Product Engineering team.

Product design is the detailed specification of the parts of a manufactured item and their relationship to the whole. A product design needs to take into account how the item will perform its intended functionality in an efficient, safe and reliable manner. It includes drawings, analysis and test what P.E. made to the development of the new product. The product also needs to be capable of being made economically and to be attractive to targeted consumers.

As it can be seen some Work Packages are present in several phases, this means there are some activities that will start at one stage and end up in the next one.
In addition, each area will be responsible for one of the Work Package, in fact these operate in parallel (ie the area of Product Engineering does not cover the Work Package "Business Plan" but only the Work Package "Product Design"; in some phases, the two work packages operate in parallel).

The Pro launch will be implemented first for project management by Product Engineering, and will then be implemented in all areas of the NPD so as to allow a variety of areas and departments to optimize data sharing and data exchange.

In Figure 5.6 can see the Work packeges in the six phase of the process.

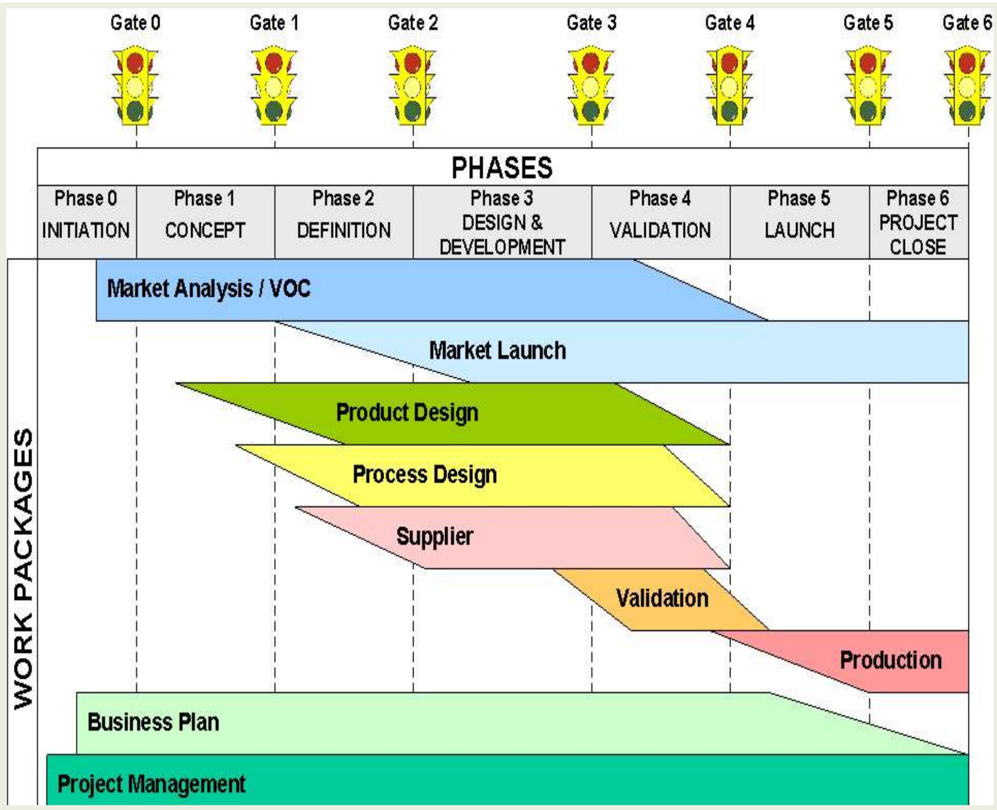


Figure 5.6 Work Packages of PRO launch NPD

5.3.2 Reorganization of the documentation

Now it will analyze the session of the documentation that will be included in the activities of Pro launch; the documentation refers to ISO quality standards.

In the past the old APQP tool referred to the ISO TS, now the procedures have been updated on the basis of the new ISO- IATF standards.

In the current APQP for each activity, a procedure / work instruction were formulated, and each activity was linked by modules / templates that were compiled for each project and left the traceability of the activities carried out during the NPD process.

According with the quality management, the documents of the APQP were aligned with the ISO 9001.

Some of the obstacles that can interfere with successful ISO 9000 Quality Management System implementation and that must be avoided can include, unrealistic time frames, resistance to change, lack of management commitment, insufficient training, or subjective interpretation of the standards. The areas most frequently resulting in Non-Certification by companies to date have been in document control, design control, purchasing, inspection and testing, quality systems, process control and inspection, or measuring and test equipment. Although all areas of the company's quality assurance program are required to be in compliance with the standard, management should perform extra reviews to ascertain compliance in these above areas.

The appropriate personnel under the direction of management should review the standards and develop, implement and maintain a minimum set of quality systems and procedures to satisfy the ISO 9000 standard.

Further, these personnel will provide confidence to management that the intended quality is being achieved and is:

- Documented;
- Demonstrable;
- Effective;
- Maintained.

Each document is encoded and kept accessible to anyone who has access, include Procedure, Work instruction and Template.

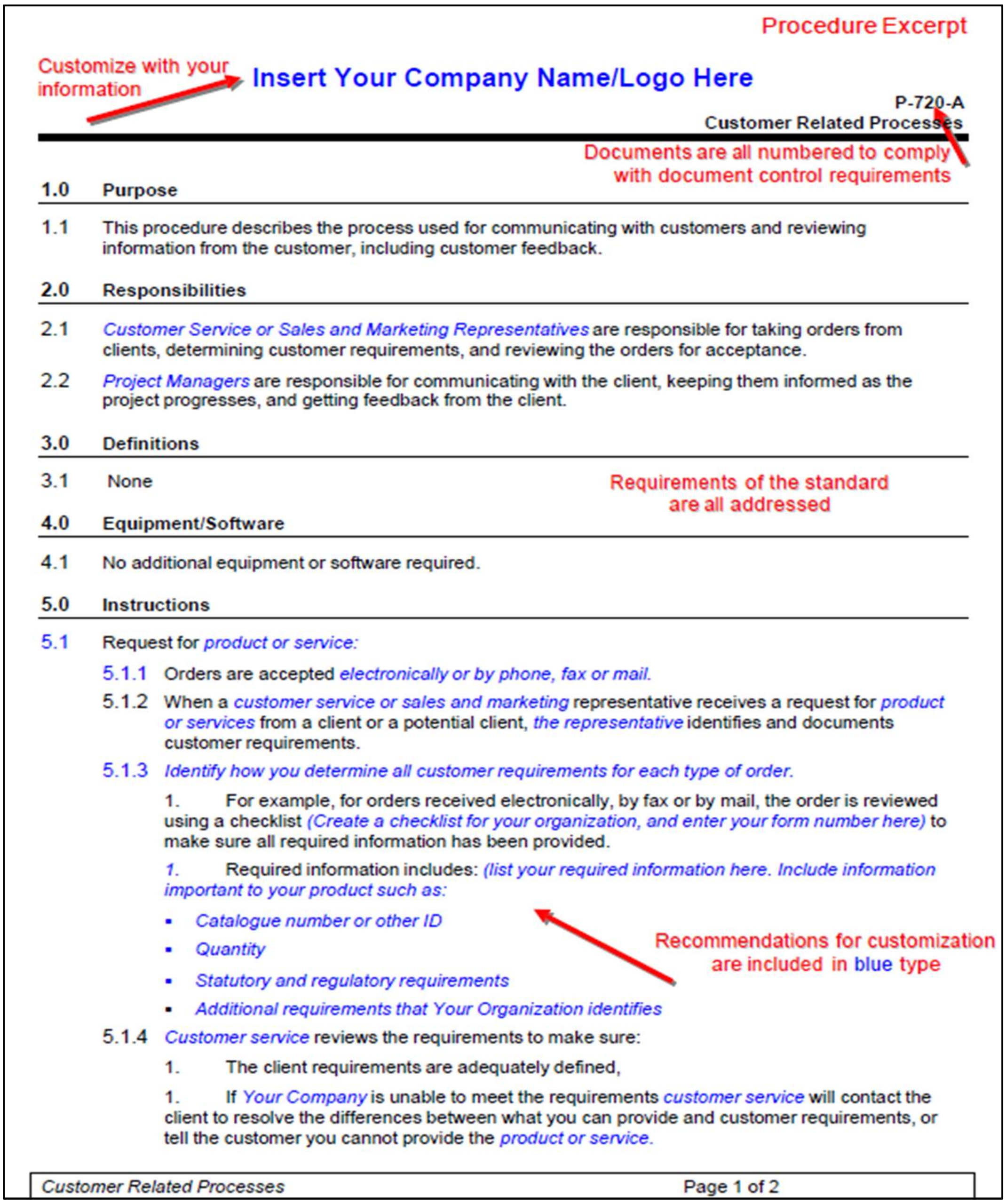
Procedure

A procedure outlines how to perform a process, in the procedure can found:

- Who performs what action;
- What sequence they perform the steps in the task;
- The criteria (standard) they must meet.

The procedures (along with your ISO 9001 quality manual and required forms) make up the quality management system (QMS). The procedures will describe how you operate and control business and meet the ISO 9001 requirements. Procedures are used for all of the Quality System Processes. All companies need to have all of the ISO 9001 required Procedures to ensure that the quality management system or QMS runs correctly and consistently, see example in the figures 5.7 and 5.8.

NOTE: In the figure can see an example from web of standard procedure.



Procedure Excerpt

Customize with your information

Insert Your Company Name/Logo Here

P-720-A

Customer Related Processes

Documents are all numbered to comply with document control requirements

1.0 Purpose

1.1 This procedure describes the process used for communicating with customers and reviewing information from the customer, including customer feedback.

2.0 Responsibilities

2.1 *Customer Service or Sales and Marketing Representatives* are responsible for taking orders from clients, determining customer requirements, and reviewing the orders for acceptance.

2.2 *Project Managers* are responsible for communicating with the client, keeping them informed as the project progresses, and getting feedback from the client.

3.0 Definitions

3.1 None

Requirements of the standard are all addressed

4.0 Equipment/Software

4.1 No additional equipment or software required.

5.0 Instructions

5.1 Request for *product or service:*

5.1.1 Orders are accepted *electronically or by phone, fax or mail.*

5.1.2 When a *customer service or sales and marketing* representative receives a request for *product or services* from a client or a potential client, *the representative* identifies and documents customer requirements.

5.1.3 *Identify how you determine all customer requirements for each type of order.*

1. For example, for orders received electronically, by fax or by mail, the order is reviewed using a checklist *(Create a checklist for your organization, and enter your form number here)* to make sure all required information has been provided.

1. Required information includes: *(list your required information here. Include information important to your product such as:*

- *Catalogue number or other ID*
- *Quantity*
- *Statutory and regulatory requirements*
- *Additional requirements that Your Organization identifies*

Recommendations for customization are included in blue type

5.1.4 *Customer service* reviews the requirements to make sure:

1. The client requirements are adequately defined,

1. If *Your Company* is unable to meet the requirements *customer service* will contact the client to resolve the differences between what you can provide and customer requirements, or tell the customer you cannot provide the *product or service.*

Customer Related Processes Page 1 of 2

Figure 5.7 Example of Procedure pag 1, *Procedure Excerpt*

Documents in MS Word for easy Editing

Insert Your Company Name/Logo Here

P-720-A
Customer Related Processes

During the early review stages and while assessing the customer requirements, you can document their needs on a Client assessment memo, F-720-001.

5.1.5 If *Your Company* is able to meet the requirements, accept the *order, contract or project.*

5.1.6 *If a confirmation will be sent to the customer describe the steps here.*

1. necessary. If it is, he or she initiates a corrective action request.

1. Customer feedback is requested from clients by using scheduled customer surveys and routine calls to the customer.
   - *Project managers make routine calls to the customer as the project requires, and at the end of the project to ask the customer if requirements were met or exceeded.*

1. Customer feedback, including complaints is measured and analyzed according to the Monitoring, Measuring and Analysis of Customer Feedback procedure (P-821).

6.0 Forms and Records

6.1 *Customer feedback spreadsheet*

6.2 *Order forms*

6.3 *Customer Inquiry Form*

6.4 *Client assessment memo, F-720-001*

7.0 Attachments

7.1 None

8.0 Related Documents

8.1 P-821 Monitoring, Measuring and Analysis of Customer Feedback

8.2 P-852 Corrective Action

8.3 P-853 Preventive Action

Related forms, records and documents are referenced to comply with document control requirements.

9.0 References

9.1 None

10.0 Revisions

Revision	Date	Section	Paragraph	Summary of change	Authorized by
A				**Initial issue**	

Customer Related Processes Page 2 of 2

Date printed 2/16/12 1:17 PM

Figure 5.8 Example of Procedure pag 2, *Procedure Excerpt*

Work Instructions - WI

A work instruction describes how to perform a task, which is a more detailed portion of the procedure.

It may need more detail than that described in the procedures. Many businesses include work instructions to aid in training, to reduce mistakes, a point of reference for jobs, etc.

Processes, procedures and work instructions are all part of the general ISO requirements package. The 9000 Store provides a complete set of the required ISO 9001 procedures. We also have general information such as ISO training, ISO standards and more. ISO requirements, , see example in the figures 5.9, 5.10 and 5.11.

NOTE: In the figure can see an example from web of standard procedure.

TITLE of ELEMENT Fabrication Procedure

WORK INSTRUCTION WI-750-001	Revision: 121510 Initial Trial	Page 1 of 3

Blue text is used as an example.

1.0 PURPOSE

1.1 (What is the reason for writing this work instruction) Start with the following statement: "The purpose of this document is to provide instructions for - - - - - - - - - ."

This work instruction describes the basic flow of an unpainted product through a milling machine.

1.2 Be as specific as you need to be to define the purpose of the document.

The Purpose of this procedure is to control the fabrication processes. This procedure provides for the communication of customer requirements to the shop, and inspection of product to the customer requirements.

2.0 SCOPE

2.1 (Define the area or process that this instruction applies to)

Cutting, drilling, fitting, and welding operations before sending to painting.

3.0 RECORDS

3.1 (Indicate specific type of records to be maintained and where they will be maintained)

Record machine hours on the traveler (F-750-001) to track usage until calibration.

4.0 ASSOCIATED DOCUMENTS

4.1 (Reference upward to the procedures that the work instruction is controlled by and reference forms by control number used to create records. Also, reference other documents, standards or information that are relevant.)

F-750-001 Traveler, MP-750 Control of Production and Service Provision, "Rejected" Tag, Customer Drawing, etc.

5.0 DEFINITIONS

5.1 (Define any terms and phrases that might be unique to this instruction or to this particular industry)

Appropriate drill components to match requirements.

6.0 RESPONSIBILITY

6.1 (List department(s) or functions responsible for maintaining these instructions)

It is the responsibility of the shop supervisor to maintain this procedure. The Shop supervisor is responsible to assign and train inspectors. It is the responsibility of the welder to fabricate the part to the customer drawing and to follow this procedure and not move on to another step without inspection. The inspector must inspect the parts to the customer drawing.

7.0 TOOLS, GAGES, FIXTURES

7.1 (List all unique tools required to perform tasks as indicated in this work instruction)

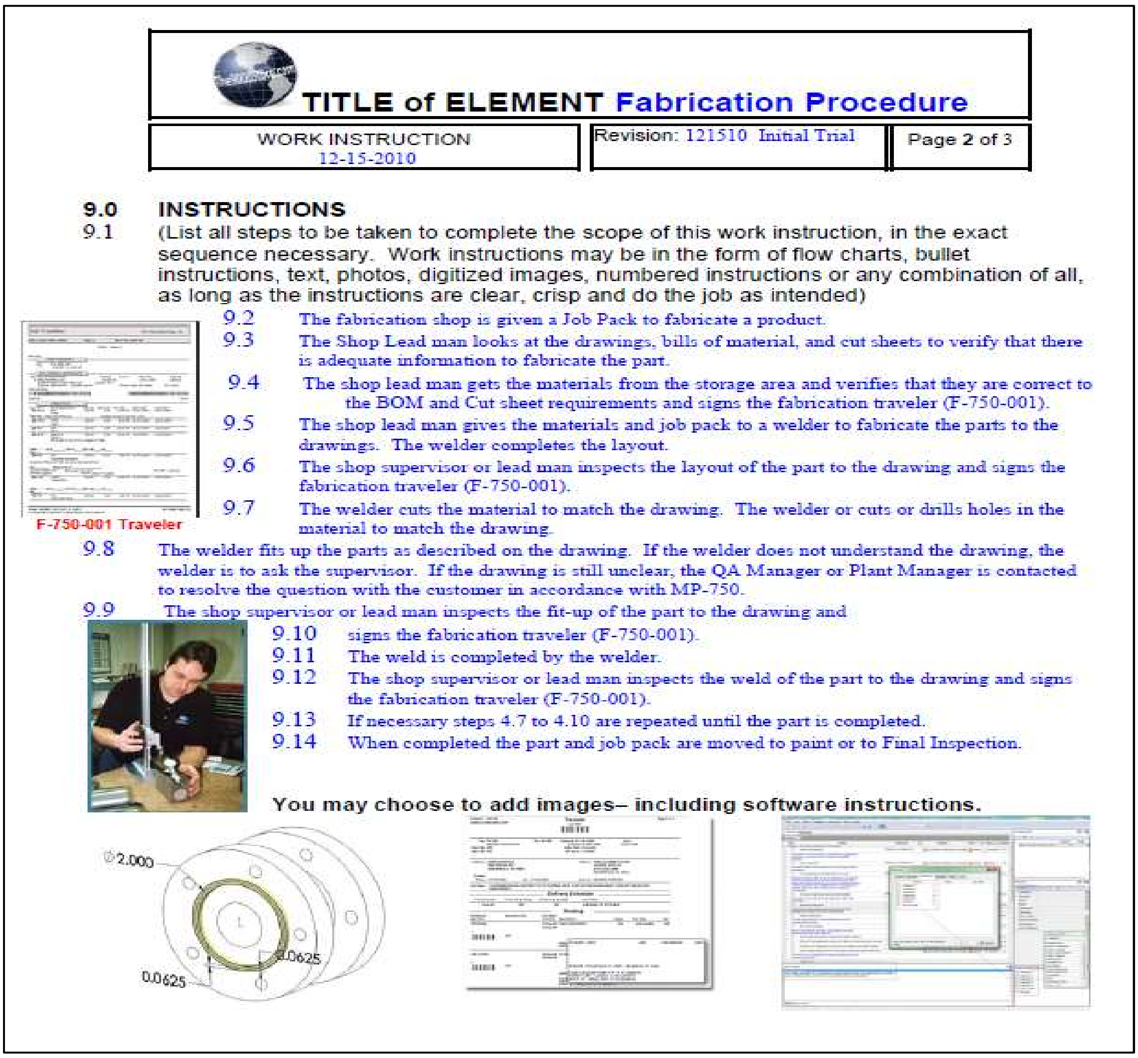
Appropriate drill components to match requirements.

8.0 SAFETY REQUIREMENTS

8.1 (List all necessary safety precautions that employees must comply with and all safety equipment that must be used while following the operations specified in this work instruction)

Safety glasses, welding shields, etc.

Figure 5.9 Example of WI pag 1, *Procedure Excerpt*



TITLE of ELEMENT Fabrication Procedure

WORK INSTRUCTION 12-15-2010	Revision: 121510 Initial Trial	Page 2 of 3

9.0 INSTRUCTIONS

9.1 (List all steps to be taken to complete the scope of this work instruction, in the exact sequence necessary. Work instructions may be in the form of flow charts, bullet instructions, text, photos, digitized images, numbered instructions or any combination of all, as long as the instructions are clear, crisp and do the job as intended)

9.2 The fabrication shop is given a Job Pack to fabricate a product.

9.3 The Shop Lead man looks at the drawings, bills of material, and cut sheets to verify that there is adequate information to fabricate the part.

9.4 The shop lead man gets the materials from the storage area and verifies that they are correct to the BOM and Cut sheet requirements and signs the fabrication traveler (F-750-001).

9.5 The shop lead man gives the materials and job pack to a welder to fabricate the parts to the drawings. The welder completes the layout.

9.6 The shop supervisor or lead man inspects the layout of the part to the drawing and signs the fabrication traveler (F-750-001).

9.7 The welder cuts the material to match the drawing. The welder or cuts or drills holes in the material to match the drawing.

F-750-001 Traveler

9.8 The welder fits up the parts as described on the drawing. If the welder does not understand the drawing, the welder is to ask the supervisor. If the drawing is still unclear, the QA Manager or Plant Manager is contacted to resolve the question with the customer in accordance with MP-750.

9.9 The shop supervisor or lead man inspects the fit-up of the part to the drawing and

9.10 signs the fabrication traveler (F-750-001).

9.11 The weld is completed by the welder.

9.12 The shop supervisor or lead man inspects the weld of the part to the drawing and signs the fabrication traveler (F-750-001).

9.13 If necessary steps 4.7 to 4.10 are repeated until the part is completed.

9.14 When completed the part and job pack are moved to paint or to Final Inspection.

You may choose to add images– including software instructions.

Figure 5.10 Example of WI pag 1, *Procedure Excerpt*

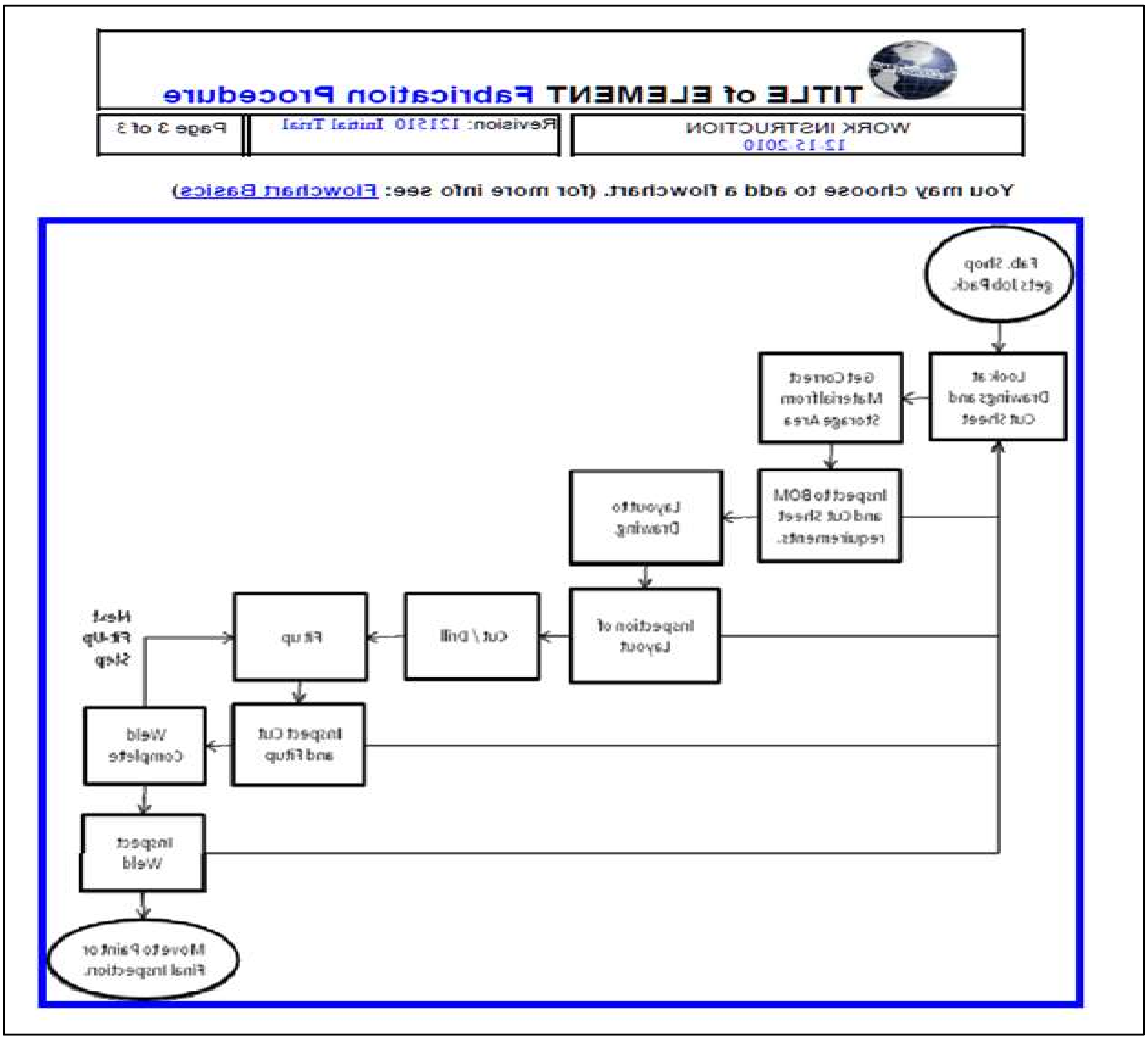


Figure 5.11 Example of WI pag 3, *Procedure Excerpt*

Template

The term template, when used in the context of word processing software, refers to a sample document that has already some details in place; those can be adapted (that is added/completed, removed or changed, differently from a fill-in-the-blank approach as in a form) either by hand or through an automated iterative process, such as with a software assistant. Once the template is completed, the user can edit, save and manage the result as an ordinary word processing document. Word processing templates enable the ability to bypass the initial setup and configuration time necessary to create standardized documents such as a resume. They also enable the automatic configuration of the user interface of the word processing software, with features such as auto completion, toolbars, thesaurus, and spelling options.

The templates occurred during the phases of the NPD process, collected information about the activities carried out. They have been updating procedures / work instructions and their templates; As the rule says, these documents must be encoded and kept in the sharpe point, so starting point was to understand how to handle all these documents.

A new form of coding has been chosen, in particular to better manage future changes, only procedures have been coded and templates have been inserted within the reference procedure; This has been done to handle fewer documents in the future and do not risk not updating them any more for a long time.

Any current procedure has been taken and critical points have been highlighted, to be eliminated or to be aggravated. All was discussed together with the team. In addition, all templates of the relevant procedures were taken, and were compared with the ISO-IATF requests, starting with the gap analysis that was conducted at the beginning.

This too has been a very long job because many procedures have not been updated for years so it is not enough to update them, but it was necessary to reconstruct the document history. Additionally, document retention schedules were updated based on the latest records retention policy.

At the end, these documents went to Core Manager, Quality Manager, Prototype Supervision, and then uploaded to the tool in the reference cell.

5.4 Monitoring of project progress

The system that will be used for project monitoring will be the *gate reviews* that will be made at the end of each phase.

The Program Manager and the Decision Gate Review will meet at the end of each phase to analyze and decide whether to continue with the next phases of the project, based on the results obtained at the current stage.

At the end of each phase they decide to 'Go', 'Go-Conditional', 'Kill', 'Hold' or 'Re-Direct' the project :

- Go: continue to the next phase.
- Go-Conditional: continue to the next phase, considerer the notes in the activities.
- Kill: end project – perform Phase 6 & close.
- Redirect: not ready to proceed. More work needs to be done in the current phase. Requires a follow-up gate review to proceed to next phase.

The gate reviews are not Design Reviews. They are business decision meetings. Focus on the Gate Purpose and Gate Key Criteria of the review. This is a meeting to decide, not to design. DGC members must attend the gate review. If circumstances result in a DGC member being unable to attend, the remaining DGC members will decide if the meeting should continue. A knowledgeable empowered substitute representative may attend for an absent member. DGC Members shall contact the project team if there are major issues prior to the meeting. DGC members should focus only on the activities in that phase or Gate.

All projects must be treated fairly and consistently. No special treatment for any projects.

Some organizations, same for EATON, have pre-defined days to conduct gate reviews. Reduces schedule conflicts because the day is 'blocked' for gate reviews by DGC members.

5.5 When use the Pro Launch

Has been defined through a flow chart when pro launch will be used, in the figure 5.13 it will explain the flow of information in PRO launch NPD; start when arrive the request by customer.

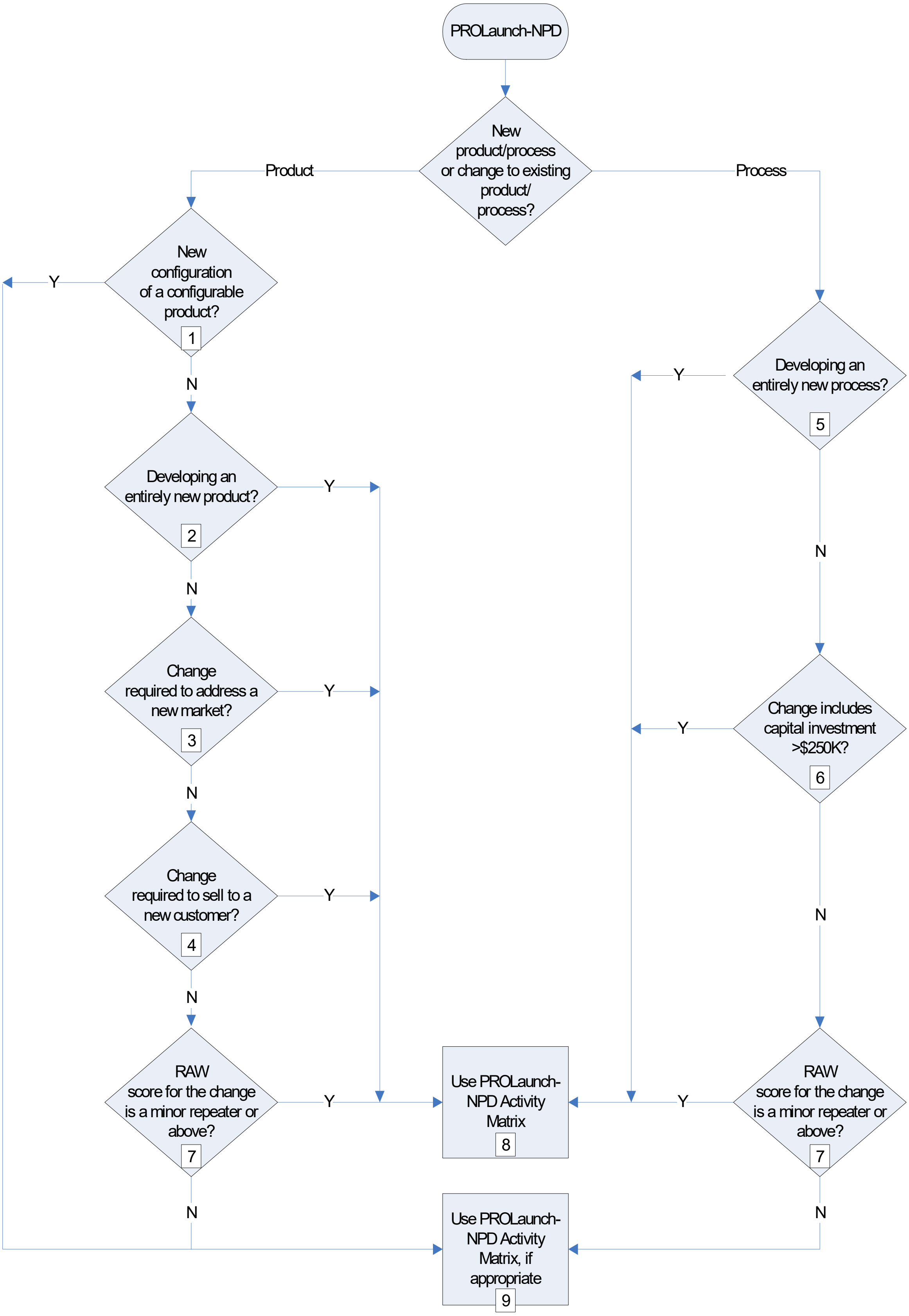


Figure 5.13 PRO launch NPD process

Referring to figure 5.13 some points are now explained to understand how the pro launch works:

- New configuration of a configurable product? The product was designed to accommodate multiple configurations in order to fit various customer use applications.
- Developing an entirely new product? New product has new features, physical characteristics, or performance characteristics different from products currently offered by the organization.
- Change required to address a new market? The product will be introduced in a new region, new customer segment, or will be used in a new and different way by existing customers or in existing regions.
- Change required to sell to a new customer? The product will be introduced and sold to a new customer that has not been essay to this particular product before.
- RAW score for the change is a minor repeater or above? Complete the Risk Assessment Worksheet (RAW) and determine if the score results in a risk classification of Minor Repeater or above. If not, you may have a PRO Launch Runner project.
- Use PRO Launch-NPD Activity Matrix, if appropriate. A change that scores a Runner on the Risk Assessment Worksheet (RAW) may be managed using the PRO Launch-NPD Activity Matrix if it is determined to be appropriate to do so by the performing organization. Otherwise, the core PRO Launch project management planning and execution activities should be used in the formal Activity Matrix phases and gates. The final decision whether or not to manage the project using the PRO Launch-NPD Activity Matrix should be confirmed by a Decision Gate Committee (DGC) through a Gate 0 review.

The Program Manager according to the customer's request, will decide whether to use the Pro launch, starting the process with the Activity Matrix. Thanks to the Activity Matrix, you can have very advanced monitoring, even if it will be used to manage very simple projects.

The Pro launch was simplifying in this case, in particular the first /two phases (phase0 and phase 1) were eliminated.

The Program Manager will compile the Gant of the project and then start all subsequent phases, assigning responsibilities and defining the timing of the various phases with a Gant. At the end of each phase, he will decide with the gate reviews, with appropriate considerations, if the project can go ahead.

Chapter 6

Project Management

In this chapter aims to represent the instruments that PRO launch uses for the management of projects. Some of the most relevant problems for the manage of project are:

- Unrealistic goals (optimistic).
- Incorrect planning.
- Insufficient resources.
- Unconditional Responsibilities.
- Unclear procedures.
- Lack of control.
- Conflicts between the subjects involved.
- Changing of the Corporation’s Tool.

For eliminating the gap it was introduced the project management instruments.
In fact thanks to help of these instruments will realize the goals of the project, start the project with a good planning of the resources.
The Project Management tools outlined in this chapter have been proposed thanks to the knowledge acquired during the Project Management course at the Polytechnic of Torino.

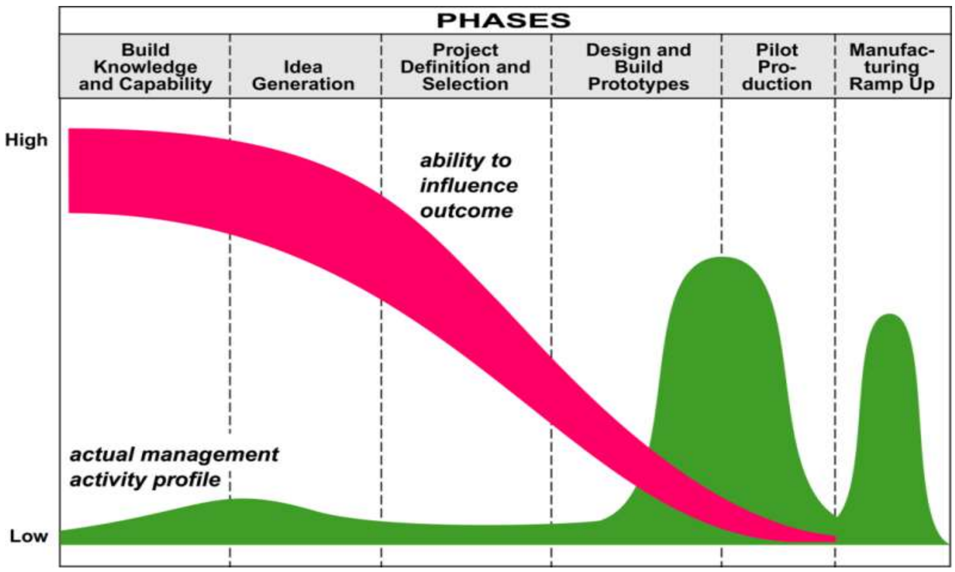


Figure 6.1 Index of attention and influence of Project Management in Pro launch (*Eaton 2016)*

In Figure 6.1 it can be seen the index that represents the use of the project management instruments in the Pro launch, it must start from the very first phases of the project. First-stage decisions are the ones that have a greater influence on the implementation of the project. This was one of the goals of this thesis project. Thanks to Pro launch and the introduction of Project Management tools, it will have a great monitoring of the projects and eliminate the risk of being late; so that the acceleration of a delayed project will result in increased costs.

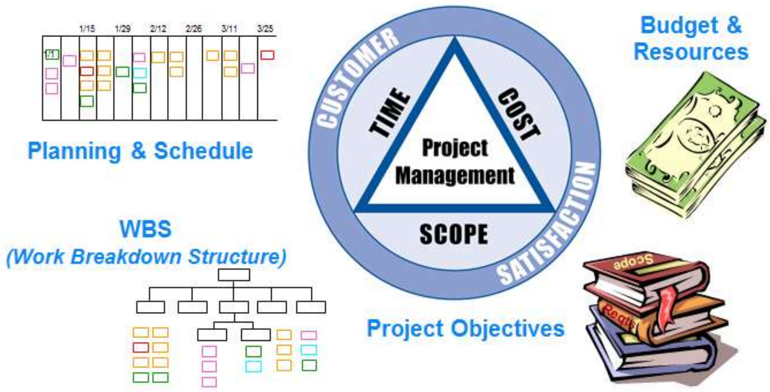


Figure 6.2 Project management instruments, (Google).

In the figure 6.2 can see some of the project management instruments can be soon.
They are divided in two phases, the planning and the control.

The planning include:

- Goodwill of resources.
- Work Breakdown Structure (WBS) of activities.
- Cost, timing, technical performance planning.
- Multi Project Planning.

The control is represented by the monitoring that it was introduced in section 5.4.

6.1 Engineering management plan

The tools of Project Management were been identified in the activity Engineering Management plan of the Pro launch.

This Engineering Management Plan (EMP) is the first step and main planning document used for controlling and conducting the technical development effort on the project. This document describes the basic engineering process for the Project. The goal of the EMP is to plan, implement and control an integrated technical effort to develop a full and robust solution that is responsive to customer requirements and objectives, and to external constraints.

The scope of the project is defined in the Project Plan. This section is not a restatement of the scope. Rather, it expands on that scope by giving a brief description of the objectives of the project from an engineering perspective and a clear description of the purpose of the product or system. Special emphasis is placed on the project's complexities and challenges that must be addressed by the engineering efforts. Therefore, it typically expands on the technical development objectives project from the original scope as contained in the Project Plan.

After a study of the use of the management tools, with the team was decided to include in the EMP:

1. WBS.
2. OBS.
3. Resources.
4. Schedule.
5. Timing e planning of the activities.
6. Gant.
7. Risk of the project.
8. Project cost & Project budget.

These will be described in the following sections.

6.1.1 Work Breakdown Structure

Work Breakdown Structure [WBS] [also included in the Project Plan] is a hierarchical list of major work elements to be performed on a project by the engineering team. The WBS may be supplemented by the following complementary and additional information:

- Leader – Person responsible (or lead person responsible) for completing the work associated with a WBS element.
- Inputs – All inputs required for each of the elements in the WBS such as requirements, interface descriptions, design decisions, equipment, test units, etc.
- Deliverables – List of the required work products for elements of the WBS including documents, software, hardware, reports, etc.
- Definition – Description of critical activities that must be satisfactorily completed before a WBS element is considered complete.
- Reviews and Meetings – List of key meetings and reviews, as appropriate and required, for completing elements of the WBS.
- Resources – Identification of resources needed for each element in the WBS, including personnel, facilities, and support equipment.

The Work Breakdown Structure was realized to analyze the flow and activity level. The WBS is an indented grouping of project elements providing an organized structure and definition of the entire scope. The structure is a decomposition of the project into increasingly detailed descriptions at each successive level.
The WBS identifies all the deliverables that must be completed to complete the project scope. The decomposition must contain the total project scope, while allowing work to be effectively managed within the organization. The WBS should preferably be a deliverable-oriented grouping of project work, which will facilitate tracking and control. Alternatively, the WBS may be based on phases or other principles, if this will result in better management within the organization.

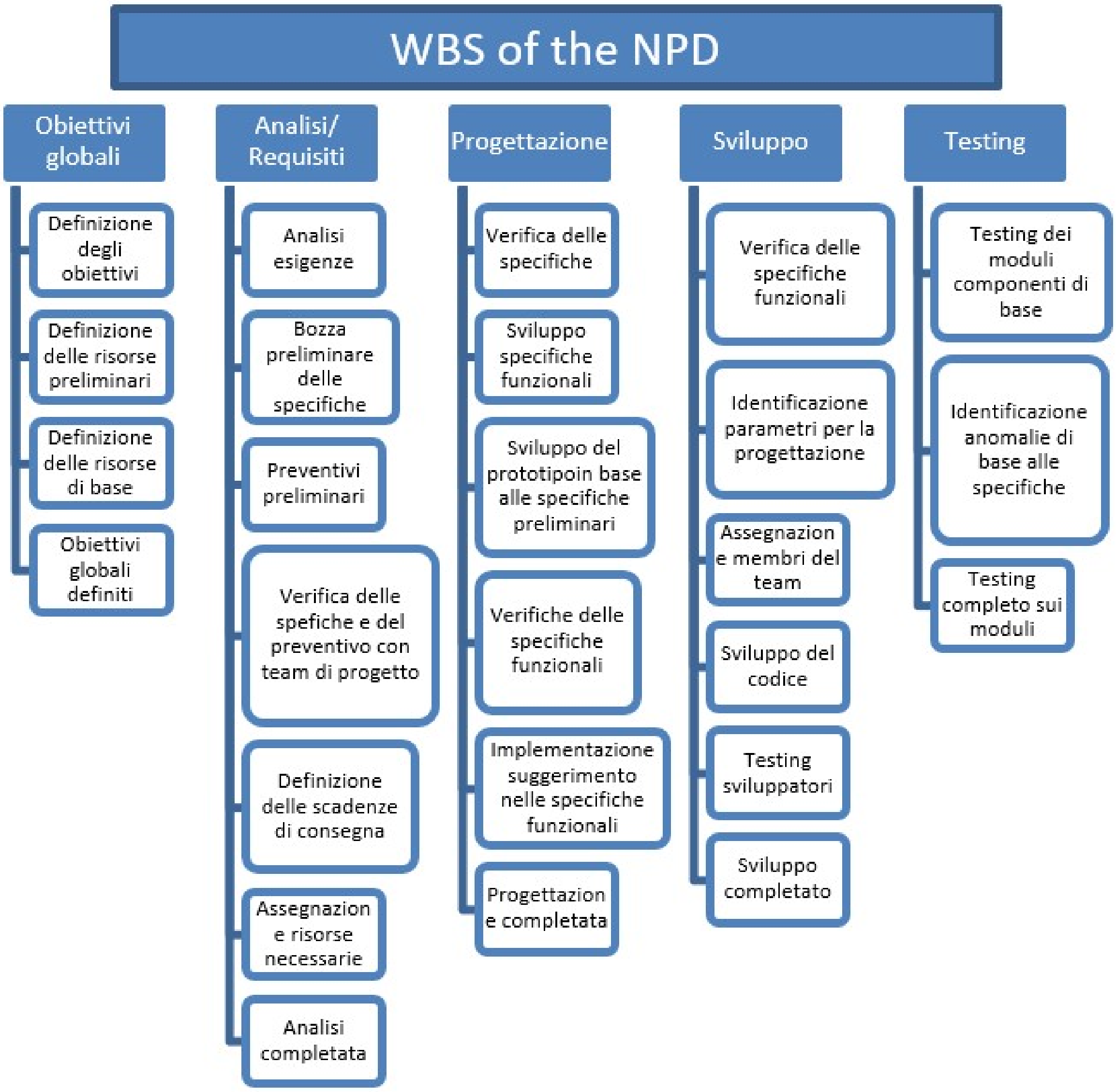


Figure 6.2 Exsample of WBS for NPD

For the team to have a schematization of the activities was a new thing; this tool gave an idea of how the activities are broken down by macro areas and what are the priorities / needs of an activity before moving on to a subsequent activity or leaving it incomplete.

This is fundamental to have the team to define the activities and think like bricks of a big chain. The WBS allowed the direct comparison of the team on activities for them ordinary. Remember that only an initial gant was compiled at the beginning of the project.

In the activity matrix, the WBS is present in the first column in which the activities in packets are grouped.

6.1.2 Organization Breakdown Structure

OBS is a hierarchical separation of the project's responsibilities, generated in order to individuate only those responsible for the various elements of the intended work.

Thanks to the OBS matrix , the team can:

1. formalize people involved in project management; this does not mean that they can not complete their task; these making the subject accountable;
2. facilitating the monitoring and coordination of activities to the Program Manager;
3. improve communication between the parties;
4. set the Project Responsibility Assignment Matrix.

In this elaboration, the OBS matrix corresponds to the core team organogram,

Knowing who does what is very important for a large organization, but also within a team. Having the OBS clear responsibilities will avoid delays and forgotten activities. In the Pro launch is present in the form of a matrix linked to each activity, in which it is highlighted who must do the activity (designer, engineer ..) and supporting functions (quality, sales..). The contribution of the team and functional leaders was necessary to define the OBS. Starting point was the company and team organization chart, an example in the figure 6.4.

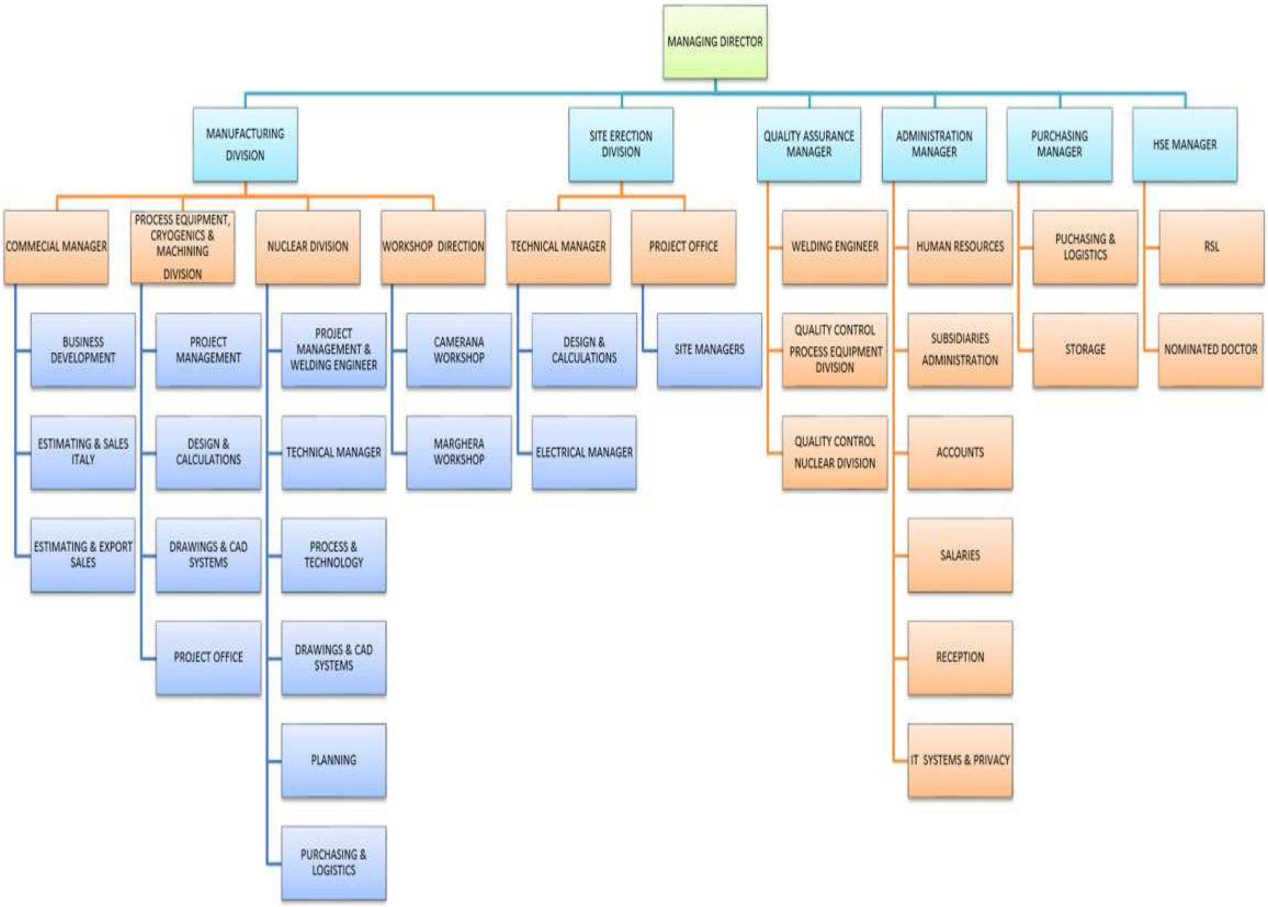


Figure 6.4 Exsample of OBS for NPD

6.1.3 Resource Plan

The resourse plan is written estimate of the key project resources (including people, equipment, facilities, and tools) required in each phase to design, develop, validate, and produce the product. Human resources should include technical, purchasing, quality, business, sales, marketing, manufacturing, testing, and internal/external suppliers.

RAM (Responsibility Assignment Matrix) is an important tool to support project planning.

It integrates the WBS and OBS information, essentially defining "who does what". In this sense it contributes to:

- to highlight immediately what needs to be done, who should do it and with what organizational role;
- it formalize the role not only of those who will actually have to do the job but also of those who will have to support them;

- It encourage better value for each activity by incorporating not only operational / executive but also supportive ones;
- Create awareness of the impact of each's work on the work of other team members;
- Create accountability among project team members;
- Encourage the commitment of resource managers involved as well.

The WBS / OBS crossing matrix originates from a task / responsibility matrix, which answers the question who does what, assigning the work packages to their respective responsibility centers.
Each intersection between a work package and a center of responsibility determines the identification of a task.
The coding adopted for the activities must be resumed in the subsequent planning and control phases (Grantt, CPM, PERT).
Once the general WBS / OBS of the project has been defined, each responsible function will develop the assigned work packages in detail.
The activities defined in this way are then used for planning the contract, identifying for each one the necessary resources and execution times, in the figure 6.5 found a exsample of RAM.

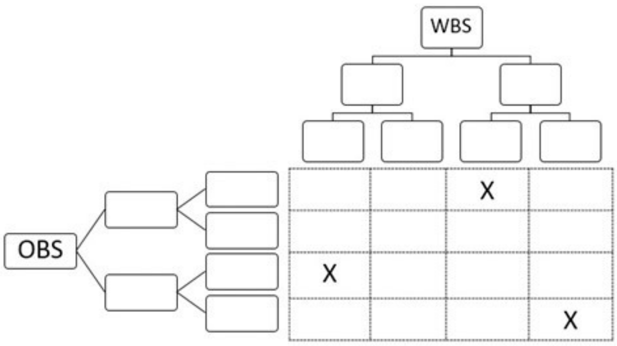


Figure 6.5 Example of RAM

In the RAM also, can stabilised the responsibilities to each activity and using OBS and WBS / OBS matrix representation. At the beginning of the project the Program Manager will identify the team and assign the responsibilities of the members, this happen in the first phase, when the project start.

All functional team members required to develop a product; may include:

- Sales/Marketing
- Systems Engineer
- Project Engineer
- Software Engineer
- SCM
- Supplier Quality
- Manufacturing
- Quality
- Responsible and accountable for the work that aligns with their function;
- Supports other functional team members to ensure a full collaborative effort.

Project Manager

- Responsible for leading /Integrating the work of the cross-functional team;
- Facilitates proper execution under PROLaunch;
- Accountable for delivering *all* project objectives and expected *business results*.

Work Package Approvers

- For Major Repeaters and above, this is the appropriate Functional Manager;
- For Minor Repeaters and Runners it is the appropriate Functional Manager or alternate approver as designated by the Functional Manager. Alternate approvers are typically supervisors or senior functional peers;
- Responsible for ensuring the quality of work within assigned work packages and its conformance to applicable standards and procedures;

- Work Package approvals precede gate reviews.

In a specific section of the activity matrix, addition to assigning responsibilities to the team, the program manager must define at the beginning of the review who is concerned with the approval, verification, and gate reviews see the follow figure 6.6.

	Phase 0		Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6	
Gate Review Target Dates														
Team Roster	Name	Title	Name	Title	Name	Title	Name	Title	Name	Title	Name	Title	Name	Title
Sales														
Princing Manager														
Application Engineering														
SCM														
Div Materials Management														
Div Manufacturing														
Div Quality														
Plant Quality Manager														
Plant manufacturing engineering														
Plant program Manager														
Advocate														
	Phase 0		Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6	
Gate Review Target Dates														
Work Package Approvers	Name	Title	Name	Title	Name	Title	Name	Title	Name	Title	Name	Title	Name	Title
Product Engineering														
Manufacturing														
Quality														
Plant program Manager														
	Phase 0		Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6	
Gate Review Target Dates														
DGC Members	Name	Title	Name	Title	Name	Title	Name	Title	Name	Title	Name	Title	Name	Title
Chief Engineer														
Manufacturing														
Plant manager														
Quality														
Plant program Manager														

Figure 6.6 Rosters Tab on Matrix

Using the guidelines and any other pre-defined guidelines or requirements defined by the business, complete the DGC Gate 0 roster and submit for approval.

Resource Management as a minimum, all required functions, skill sets and percent utilization must be defined. The Information should be submitted to the Portfolio Manager. Work with Functional Managers to get named resources assigned to project, if possible.

Resource requirements, named resources, and gaps/issues will be brought to the DGC. Gaps/Issues will need to be resolved prior to Gate 0 approval. This is usually facilitated by the Portfolio Manager and Functional Managers.

- Work Package Approvers

It is required regardless of project size, but as a minimum Functional Managers should personally review and approve the work on major project/programs; these are the

responsible for ensuring the quality of work within assigned work packages and its conformance to applicable standards and procedures: for Major Repeaters and above, this is the appropriate Functional Manager and for Minor Repeaters and Runners it is the appropriate Functional Manager or alternate approver as designated by the Functional Manager. Alternate approvers are typically supervisors or senior functional peers.

Example:

1. Work Package content . . . for quality and conformance
2. Resource availability and allocation plan . . . resources in their function
3. 'S' opt-outs for next phase . . . for concurrence in their assigned WPs
4. Completion Plans . . . for concurrence - Red and Yellow activities in their WPs
5. Scorecard . . . validate measures appropriate for their function

- DGC

The leadership team of the business must personally participate in Gate Reviews. As a minimum, deal with the major projects/programs. Gate decisions are done by consensus of the entire DGC, not made by the senior leader, sponsor, or by vote. “As go the gates, so goes the process” Robert G. Cooper.

- Project/Program Sponsor

Typically a member of the DGC, the sponsor is the “Energy Source” providing support at their level to ensure the project team has what it needs.

6.1.4 Planning of some activities

This section represents the plan and the definition of some activities of the Pro launch, the applicable documents which are inputs to the project (i.e., needed but not produced by the project). Such documents may include:

- Customer specifications and system design inputs (Request for quotation, Strategy..)
- Standards and industry specifications (Design, DFMEA..)
- External interfacing systems (Testing..)
- Internal standards and procedures (Quality..)

The EMP includes the plan of the activities such as:

1. ENGINEERING ORGANIZATION

This section describes the organizational environment in which the project will operate. It identifies the organization structures that encompass all technical development contributors. This section should include a brief description of the role to be played by each key team member. This includes ad hoc and existing work groups and multi-disciplinary technical teams that should be formed or used to support the project. Such teams are critical to reaching successful product and systems development.

2. TECHNICAL MANAGEMENT PLANS

This section lays out the plan for the engineering activities. It must be written in close synchronization with the Project Plan. Unnecessary duplication between the Project Plan and the EMP should be avoided. However, it is often necessary to put further expansion of the engineering effort into the EMP even if they are already described at a higher level in the Project Plan. Generally the elements below are incorporated into the EMP, but on occasion may be developed as separate documents.

3. PROCUREMENT & KEY SUPPORT PLANS

Procurement Plans are a list of the key procurement items associated with the project including hardware, software, development tools, prototype tools, special test equipment, etc. Key Support Plans are a list of any contracted, outsourced, or off-shore services, such as engineering design, analysis, development, test, and certification services.

4. REQUIRMENTS MANAGEMENT PLAN

The Requirements Management Plan describes the approach, facilities, tools, and processes to be used to manage the requirements defined during the project. This plan typically includes the identification of sources of requirements, requirements definition approach, and methods to cascade market requirements into specifications, and the method to cascade specifications from the system to sub-systems and to components. The process used to identify, track and manage changes to requirements should also be defined.

5. SYSTEMS DEVELOPMENT PLAN

The Systems Development Plan describes the organization structure, facilities, tools, and processes to be used to develop the systems aspect of the project, as required and as appropriate. This section addresses the integration of the multi-disciplinary organizations or teams that will be performing the systems engineering activities. Obviously, the larger the number of such organizational teams the more important the integration of their efforts is and the more critical this plan becomes.

6. PRODUCT HARDWARE DEVELOPMENT PLAN

The Product Hardware Development Plan describes the organization structure, facilities, tools, and processes to be used to produce the project's hardware. It describes the plan to produce key hardware elements and to procure commercial hardware products. In addition, it includes plans for competitive benchmarking, as appropriate. This section addresses plans for both mechanical and electrical/electronic hardware. It may include more detail in the following four sub-sections, as appropriate.

7. DESIGN FOR SIX SIGMA PLAN

Design for Six Sigma (DFSS) is a business process management method linked to the traditional Six Sigma.

It is based on the use of statistical tools such as linear regression and allows empirical research similar to those carried out in other fields, such as the social sciences. While the tools and order used in Six Sigma require a process to be in place and functioning, DFSS aims to determine customer and business needs and address these needs in the product solution that is created.

DFSS is relevant to relatively simple articles / systems. It is used for the design of products or processes as opposed to process improvement.

8. RELIABILITY PLAN

A Reliability Plan is used to document what tasks, methods, tools, analyses, and tests are required for the product or systems development on the project. The Reliability Plan typically defines the reliability goals for the product or system and the approaches to be used for making initial predictions, measuring progress, and verifying reliability at each phase of development.

9. TECHNOLOGY DEVELOPMENT PLAN

The Technology Development Plan describes the technical development and management process to apply new or untried technology. Generally, it addresses performance criteria, assessment of multiple technology solutions, and fall-back options to existing technology.

10. INTELLECTUAL PROPERTY PLAN

The Intellectual Property (IP) Plan defines what intellectual property could/should be protected and the strategy for how it will be protected. This plan would typically involve the identification and protection of any new technologies that are being developed as part of the project. The confidential aspects of the IP should not be discussed in the plan; rather it is an outline of this approach to IP protection on the project, as required. In addition, the plan should include investigation of potential patent infringement issues, as required. Eaton's IP attorneys should be consulted early in the process to support the development of this plan.

11. SAFETY PLAN

The purpose of the Safety Plan is to define the systematic approach to address product safety on the project, as required. It describes the activities necessary to ensure that safety is designed into the product and that safety is maintained throughout the product development life cycle. The particular approach to implementing safety depends on the type of product being developed and relevant standards and guidelines for the target product markets.

12. DESIGN TEST PLAN

The Design Test Plan details the types and numbers of tests to be conducted, length of tests, pass/fail criteria, the number of sample units and test equipment required. Test plans for larger projects are usually subjected to peer reviews and are typically included in design reviews. Test standards that apply to the product should be referenced in this section. Test Plans include the following types of testing:

- Engineering Verification – Using early functional prototypes, engineering verification testing may be performed to verify that the design meets preliminary or certain critical specifications and design goals. This valuable information is used to verify certain aspects of the design as is, or identify areas that need to be modified in later project phases. These tests typically consist of basic functional tests, parametric measurements, and specification verification testing.
- Design Verification – Design Verification testing verifies that the product design meets customer and/or regulatory functional, performance, environmental and dimensional requirements. In addition, it typically includes durability testing to begin to establish and verify reliability performance of the product. Design verification testing should be done with a large enough sample size to be statistically valid, based on production volume. This supports verification that the critical design parameters meet the requirements, and that the variation of these parameters presents an acceptable level of performance yield (as represented by the Z-Score on the Design Scorecard).
- Production Validation – Production validation testing refers to tests which validate that the products made from production tools and processes meet customer requirements, engineering standards and regulatory requirements. Production validation begins by building the production design using the production manufacturing processes. Since it is validating the product and the process, all production systems should be in place during the validation build, including MRP, ERP, supplier production parts, production operators, etc. Testing is typically comprehensive and may include most or all of the same test performed during Design Verification Testing.
- Product Certification – Product Certification testing is used to demonstrate and certify that a product has passed performance and quality assurance tests or qualification requirements stipulated in regulations such as a building code and nationally accredited test standards, or that it complies with a set of regulations governing quality and minimum performance requirements.

13. SUPPLIER DEVELOPMENT & MANAGEMENT PLAN

The Supplier Development and Management Plan defines the approach that will be used to develop and manage high risk or critical suppliers. Engineering often takes a lead role in the technical relationship with the supplier, whereas Supply Chain management will take a lead role in the commercial relationship.

14. CONFIGURATION MANAGEMENT PLAN

The Configuration Management Plan describes the development team's approach and methods to manage the configuration of the system's products and processes. It will also describe the change control procedures and management of the product's or system's baselines as they evolve.

15. DATA MANAGEMENT PLAN

The Data Management Plan describes how and which data will be controlled, the methods of documentation, and where the responsibilities for these processes reside.

16. DATA SECURITY PLAN

The Data Security Plan describes security and access rights to data as well as methods for controlling access to secure data.

17. TRAINING PLAN

The Training Plan should address any team training requirements that are necessary to meet the specific needs of the project.

18. CUSTOMER DELIVERABLES

All deliverables and reviews defined by the customer and their expected timing should be identified. This should extend to all contractual obligations that are the responsibility of Engineering to deliver.

In the EMP are also represent ed the constraints that impact design solutions, they may be imposed at either the project level or at the enterprise level. Examples of project specific constraints include:

- Costs.
- Team assignments and structure.
- Management decisions prior to project initiation.
- Standards, policies and procedures.
- Domain technologies.
- Physical, financial, and human resource allocations to the project.
- Public and international laws and regulations.
- Compliance requirements: Industry, environmental, international, and other general specifications, standards, and guidelines which require compliance for legal, interoperability, or other reasons.
- Capabilities of interfacing systems.

6.1.5 Project Schedule

While the Project Plan includes and high-level schedule of the overall project, the Product Design (Engineering) Schedule is a more detailed schedule of the engineering and design activities that shows the sequencing and duration of these activities. The schedule should show WBS elements, activities, deliverables, key milestones and reviews, and other details needed to control and direct the project. The schedule is an important management tool. It is used to measure the progress of the engineering team working on the project and to draw attention to work areas that may need intervention.

The planned (or eventually actual) dates for project activities or milestones. The preferred form of project schedule is a networked set of activities developed using Microsoft Project or a similar software application. Project schedules are often done in layers of increasing complexity. Typical layers are Milestone Schedules (used to keep the major stakeholders informed; targets the project's major events); Deliverable Schedules (used by the project manager and core team to monitor activities and control the project); and Task Schedules (used by deliverable leaders to manage the details of the project). Schedules should be correlated to resource plans. The initial schedules should be saved to form a baseline capturing the original targets. The Project Manager will make sure that during the development of the Schedule, the team MUST review and consider if there are any Cross-Project Dependencies (i.e. other project deliverables that must be completed prior to completing a deliverable for this project). If any Cross-Project Dependencies exist they shall be added to the projects schedule. Also, the project manager will review this question during the Gate 2 review with the DGC members.

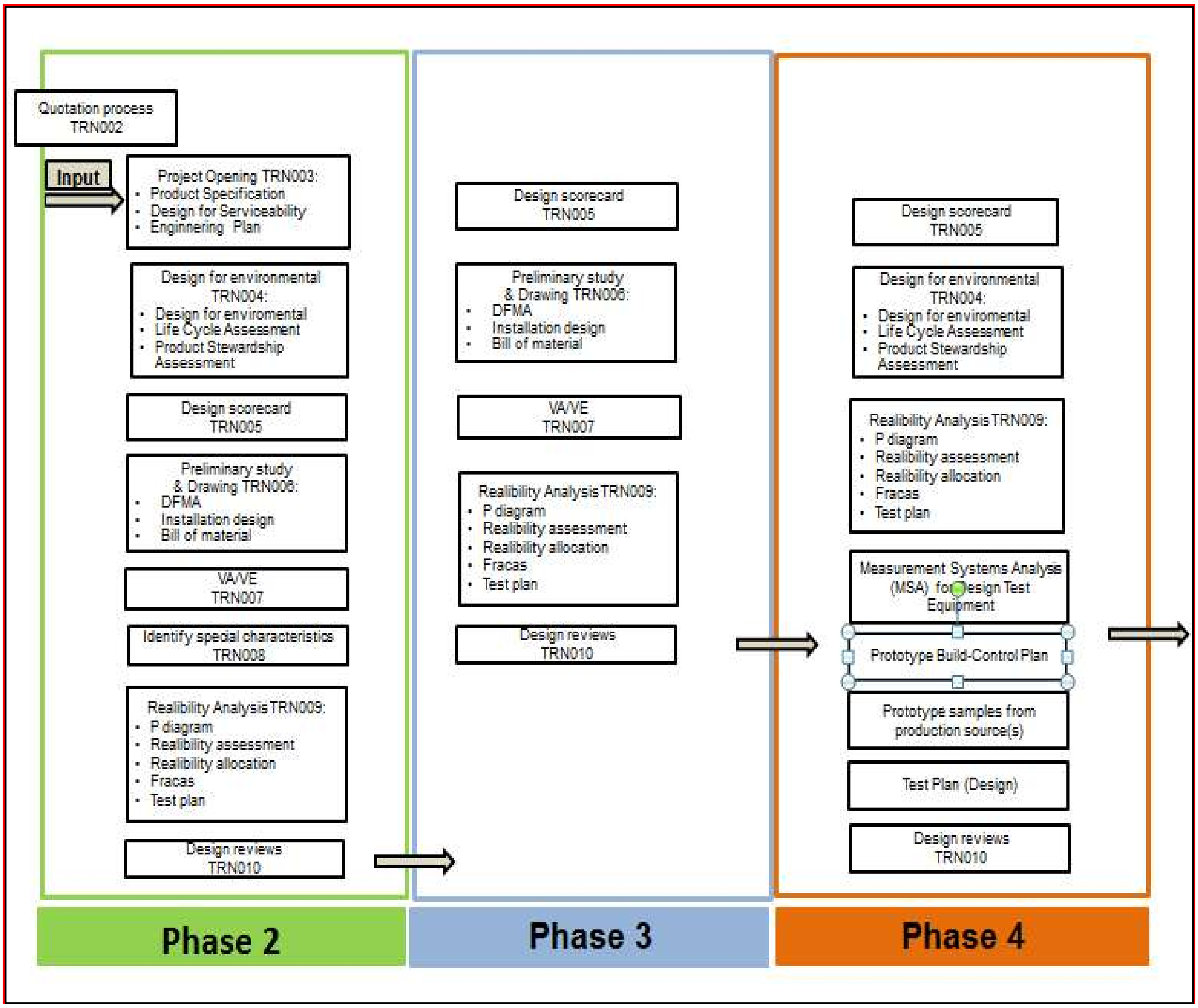


Figure 6.7 Schedule of Project

6.1.6 Risk analysis of the project

In the EMP it found the Technical Risk Management Plan addresses the processes for identifying, assessing, mitigating, and monitoring the technical risks that may be encountered during a project's life cycle. It identifies the roles & responsibilities of all participating organizations for risk management.

In addition, a Product Design (or Technical) Risk Log may be developed. While a Risk Log is developed at the project-level, a more detailed technical risk management log may be used to manage the details of product design risk.

Project **risk** is the probability of exposure to negative events and the potential impact on project scope, quality, time, and cost. Project **risk management** is the process of identifying, assessing and responding to project risk throughout the life of a project and in the best interests of the project's objectives, see figure 6.7.

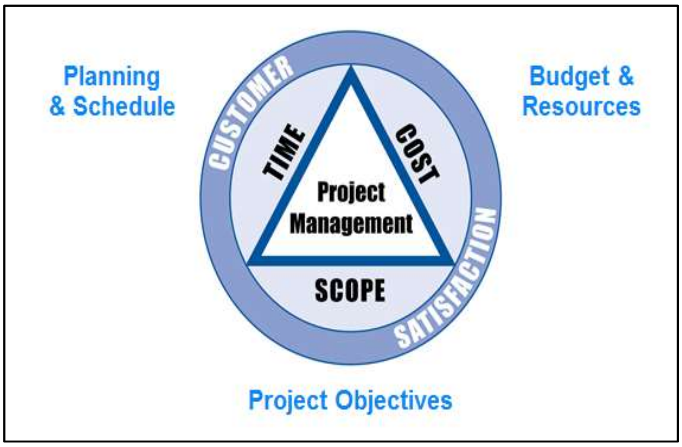


Figure 6.7 Elements of the Project, *Google*.

Key Elements of a Risk Management Plan:

- Identifying the comprehensive set of risk events associated with the project activities;
- Approaches to identifying risks: Team brainstorming, interviewing others experienced on similar projects or technologies,review records of similar projects, checklists.

In figure 6.8 can faund the flow of activity to identify the risks.

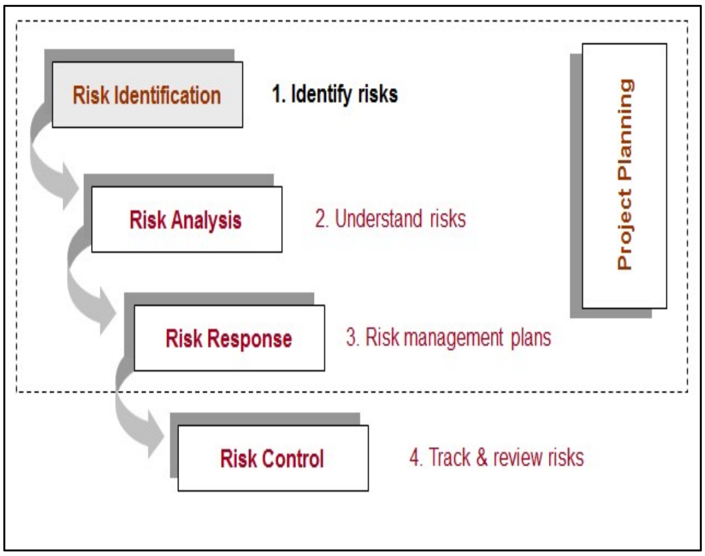


Figure 6.8 Key element of the Risk Management, *Eaton website*.

For this phase, the contribution of functional leaders was founded. First they started by identifying areas of interest / risk containment.

The risks a project can meet depend on the conditions of uncertainty in which each project is called to operate. In each operating context, different types and categories of risk can be summarized in a Risk Breakdown Structure (RBS).
A risk is an event attributable to one or more of these categories which is associated with a certain probability of occurrence and a certain impact.

Little can be done in terms of analytical assessment for unknown risks if not setting aside a monetary management reserve to address them on the spot.

Instead for risks to some extent known or prefigurable, risk assessment can be carried out both qualitatively and quantitatively as illustrated in the sections on risk management and project risk analysis.
For each project it is necessary to develop a consistent approach with the risk and the risk appetite of the various stakeholders. Communication on risks and their management must be open and honest and the identification and application of risk response strategies reflect the perceived balance of an organization between taking risks and avoiding them.

In figure 6.9, found a RBS that was used to identify the risks in a NPD process.

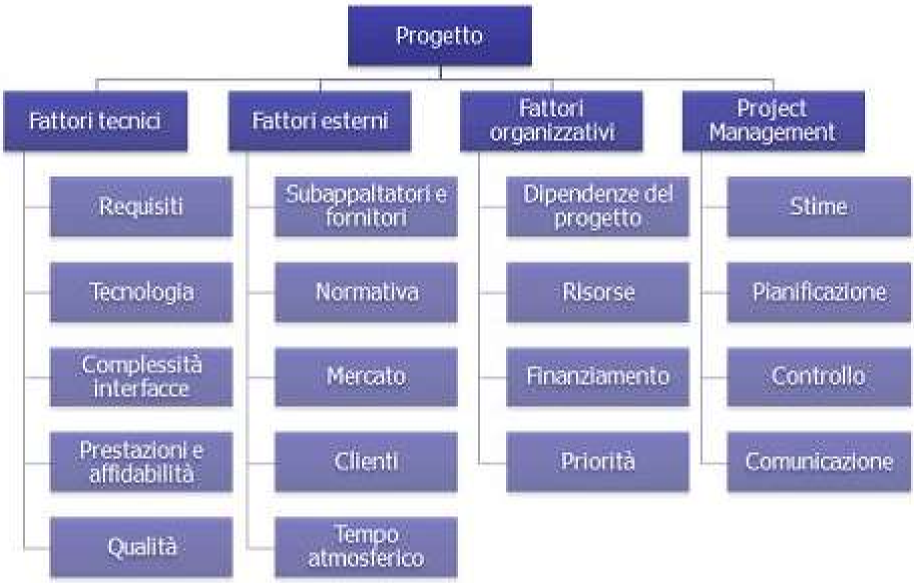


Figure 6.9 RBS for identification of risks

Starting from this, a Strenghts, Weaknesses, Opportunities e Threats analysis (SWOT analysis) was carried out with each area involved and a matrix.
The SWOT analysis of a project is an activity aimed at deepening the context conditions (internal and external) in which the project will take place: Strengths of the organization (Strengths) Weaknesses of the organization (Weaknesses) Opportunities presented by the external context (Opportunities) Threats (Threats) It is a technique developed for over 50 years to identify business strategies and operational plans in situations characterized by uncertainty and strong competitiveness. In substance, with the SWOT analysis it is possible to evaluate how: use the strengths of your organization; correct weaknesses; take advantage of the opportunities that arise; defend yourself from threats that may hinder the smooth running of the work.

The questions of a SWOT analysis were:

Strengths

- Does the company have in-house the necessary skills?
- Has a budget been set for the project?
- What are the benefits in terms of business related to the development of the project?
- Will the project require new technologies and tools?
- What is the project team's experience on similar projects?

Points of weakness

- Is there a reliable estimate of costs?
- Does the company have a contingency budget to manage the risks associated with the project?
- What are the disadvantages of the project?
- Which parts of the project should be outsourced?
- Is the proposed planning realistic?

Opportunity

- Will the project take place in a single location or multiple locations?
- Will the project also have an international articulation?
- Do competitors present weaknesses in the areas involved in the project?
- Does the project allow you to take advantage of industry trends to which it applies?
- Are there new, imminent technological developments planned?

Threats

- Is there a competition already established in the areas impacted by the project?
- Is the cost structure compatible with the value to be created and with the characteristics of the competition?
- Is the staff with the skills necessary for the project difficult to find or replace?
- Has the new technology been sufficiently tested?
- Can the national and international economic situation affect the project?

In the figure 6.10 can found an example of Swot Analysis.

Figure 6.10 Example of Swot analysis, *Google*.

Then a further analysis was conducted on the basis of the past, *lessons learned*. Lessons learned is what has been learned from projects of the same type previously carried out by a given organization. The ability to draw on historical data from past projects is essential for an organization and this requires that all project documentation be collected in a repository to be made available to project managers for future use. Knowing what happened to similar projects, what were the risks analyzed, the response strategies adopted and the unexpected outcomes is essential to ensure the success of future projects. In particular, the examination of the register of issues of similar projects already carried out may allow to identify what did not work in order to avoid the repetition of past errors.

Starting from the RBS, Swot analysis and the Lesson Learned, these possible risks have been identified:

1) Internal risks – things that the project team can control or influence (schedule, cost, changes in technology, design, performance, management);

2) External risks – things beyond the control or influence of the team (market shifts, regulatory, natural hazards);

3) Legal, Licenses, Patent Rights, Contractual.

For examples:

- Natural: floods, hurricanes, earthquakes.
- Financial: discount rate, bank rates, financial market.
- Commercial: competition prices policy, market arrival of alternative products.
- Technicians: technologies, innovative processes, equipment failure, fire, explosions, breakdowns.
- Humans: accidents, finding appropriate skills, turnover, diseases.
- Social: theft, negligence, robbery, economic recession, change of faults.
- Economic: price changes, contract renewals.
- Politicians: change of administrative / fiscal regulations, "country" risk, trade union climate.
- Legal acts: protectionist measures.
- Competitive acts: price policies.
- Miscellaneous: credit difficulties, financing, interest rate volatility.

To every risks can associate:

1. the probability of the risk event occurring;
2. impact on the project if this risk event occurs the probability and impact;
3. priority of the risk event .

To define these the lesson learned was fundamental: the probability and impact are very low, they tend to zero. In fact, since the company has been manufacturing valves for a long time, they have a lot of experience. In addition, the product is simple, but with some critical features, it was possible to put the risks of the projects in the lower area of Figure 6.11.

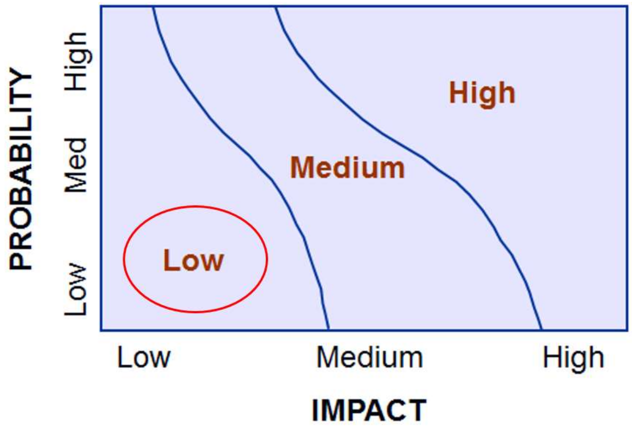


Figure 6.11 Classification of risks, *Pro launch.*

In the pro launch you can find a first risk classification of the project and a risk classification for each activity. In that project, the risk associated with each activity is almost nil. So, you can define this product runner (R), which means that it is very simple.

In the following figures can see the excerpts of the Pro launch, see Figure 6.12.

Project Risk Classification	RUNNER
Marketing	RUNNER
Technology	RUNNER
Supply Chain	RUNNER
Manufacturing	RUNNER
Project Management	RUNNER
Project Business Impact	SILVER

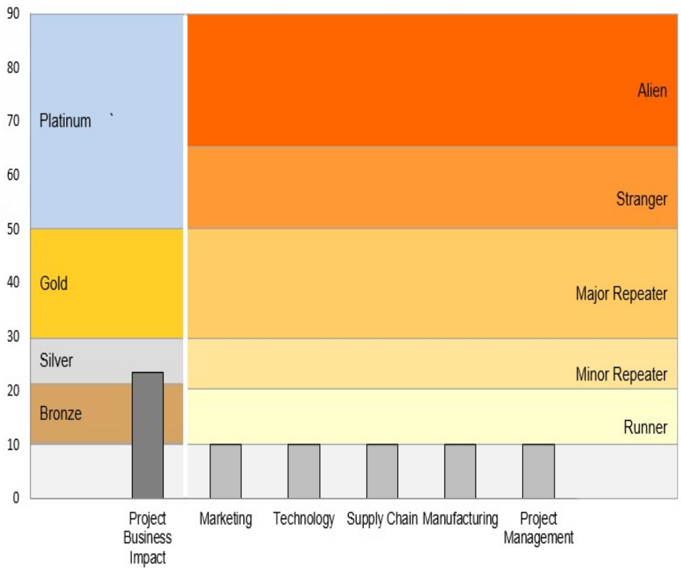


Figure 6.12 Risk classification for each activities, *Pro launch.*

6.1.7 Project Cost & Project Budget

Project costs include all costs that are associated with the project that are tracked by the performing organization. Examples of costs include: labor, material used for development, consulting, travel, etc.) If the customer is funding all or part of the development, this is the total cost excluding the customer-funded portion. At Gate 0, it is an estimate of the total project cost and at Gate 6 it is the actual total project expenditures. At all points in between it is the Estimate at Completion (EAC), which is the sum of the actual costs to-date plus the Estimate to Completion (ETC). This is input into the Business Plan model.

The target for resource expenditures for a project. Ideally the budget will be time-phased and will be subdivided for administrative convenience by functional organizations and/or cost elements (such as labor, materials, advertising, travel costs, etc.). Capital items are covered separately in the capital budget. The Project Budget is normally developed by the team and negotiated with management. Changes to the Project Budget should be controlled and should be based on changes to project scope or time requirements. The budget, actual costs, and latest projections are tracked using the budget report.

There is no economic analysis in this paper because this is not a matter of product engineering; As a result, the part of the Business Plan and Pricing are not analyzed here.

Chapter 7

APQP VS Pro launch

Subsequent to what has been seen in the previous chapters, between the APQP and the Pro launch was conducted a benchmarking analysis.

To do this, a project started in the current year has been considered and has been reported on the Pro launch.

Starting from the two versions of the project (APQP and Pro launch), this chapter has been developed, which highlights the advantageous to use of the Pro launch.

A quantitative analysis was carried out to demonstrate the benefits and disadvantages of the Pro launch with the construction of some process indicators that will allow us to quantify the efficiency and effectiveness of this new tool, based on the premises made.

7.1 Presentation of the case in exam

The starting point of this chapter was the case under examination, that is a project of a new product that could allow the comparison between the two tools (APQP and Pro launch).

This concerns the design of an exhaust valve for one of the most important customer of the company.

The product is presented as a new product due to its significant characteristics.

So the extreme case of the launch of a new product (maximum customer satisfaction and product with new features) was chosen to test the effectiveness of the Pro launch.

Since the project has already started some time ago, it had already been developed with the APQP.

In 2015 the request for quotation from the customer came after the appropriate analysis of planning, the phase based on the market intelligence information to take into account the historical warranty and quality information. The output of the phase was setting out the design goals, reliability and quality goals, CONC (cost of nonconformance) targets, create preliminary

BOMs and process flows, but the most important thing was making sure that the customer need and expectations are understood.

In 2016 was start the the product design and development phase, it was about the elements of the planning process during which design features and characteristics are developed into a near final form.

The Product Quality Planning Team considered all design factors in the planning process even if the design is owned by the customer or shared. The steps included prototype built to verify that the product or service meets the objectives of the Voice of the Customer. The team made a feasible design , that must permit meeting production volumes and schedules, and be consistent with the ability to meet engineering requirements, along with quality, reliability, investment cost, weight, unit cost and timing objectives. At this stage of the process, a preliminary feasibility analysis was made to assess the potential problems that could occur during manufacturing. Some of the output (templates , check list, mail or other documentation) of this phase were:

- Design Failure Mode and Effects Analysis that is a disciplined analytical technique that assesses the probability of failure as well as the effect of such failure.
- Design For Manufacturability and Assembly that is a Simultaneous Engineering process designed to optimize the relationship between design function, manufacturability, and ease of assembly.
- Prototype Build - Control Plan, that is the description of the dimensional measurements and material and functional tests that will occur during prototype build. The Product Quality Planning Team ensure that a prototype control plan is prepared. The manufacture of prototype parts provided an excellent opportunity for the team and the customer to evaluate how well the product meets Voice of the Customer objectives and eventually communicate any concerns, deviations, and/or cost impact to the customer.
- Engineering Drawings (Including Math Data), since customer designs do not preclude the planning team’s responsibility to review engineering drawings. They include special (governmental regulatory and safety) characteristics that must be shown on the control plan. Control or datum surfaces/locators should be clearly identified so that appropriate functional gages and equipment can be designed for ongoing controls. Dimensions

should be evaluated to assure feasibility and compatibility with industry manufacturing and measuring standards. In that case the team assured that math data was compatible with the customer's system for effective two-way communications.

- Material Specifications were reviewed for special characteristics relating to physical properties, performance, environmental, handling, and storage requirements.
- The team defined new equipment, tooling and facilities requirements: that must ensure that the new equipment and tooling is capable and delivered on time the production.
- Team Feasibility Commitment and Management Support , it satisfied that the proposed design can be manufactured, assembled, tested, packaged, and delivered in sufficient quantity, at an acceptable cost to the customer on schedule.

After this analysis, in 2018 the launch phase is expected to produce the Process Design and Development phase with related activities (not addressed in this chapter).

7.2 Steps of analysis

Starting from the real case and from the present documentation the following activities have been carried out:

1) Examination of the documents present in the case in question

The team had some meeting to review the documentation relating to the activities described above; these activities were presented in the APQP formats and respected the previous ISO-IATF versions.

In parallel to this analysis the gap analysis carried out in the preceding chapters was considered.

A review was carried out and the key points that emerged in the gap analysis were confirmed.

2) After the review of the documentation, a first questionnaire (interview to the various functions) was given on the degree of satisfaction of the team on the APQP, from which these first results were extrapolated.

Funzione : data:

Segnare con una "X" la valutazione dell' item

Scheda valutazione APQP	Valutazione				
Item	1	2	3	4	5
1)Soddisfazione documentazione in supporto della vostra attività					
2)Completezza info necessarie per la vostra attività					
3) Aggiornamento dei templates, check list					
4) Area condivisa documentazione					
....					

Suggerimenti:

Leggenda:
1 non soddisfatto
2 poco soddisfatto
3 soddisfatto
4 molto soddisfatto
5 abbastanza soddisfatto

Figure 7.1 Example of questionnaire

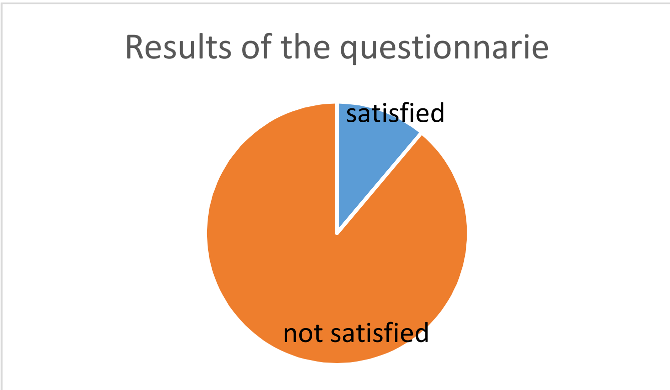


Figure 7.2 Results of the questionnaire

About 18% of people prefer to continue using APQP because it is a system known and used for project management for years.

In particular, we refer to people who have worked for a long time in the company and are anchored to the "traditional" project management.

The remaining part (82%) does not consider itself satisfied for the problems / gaps that the system generates.

Even for the lack of communication between the functions, each one up to now managed its function with a different tool.

The idea of having a tool that puts everything together in a large matrix is very stimulating.

3) Subsequently, training sessions have started from the various functions on the Pro launch and on the ISO-IATF standards.

At the beginning, a workshop was held with the functional leaders to show:

- what has been done;
- because it was done;
- how it was done;
- what were the expected objectives;
- when the new tool would be implemented;

After that, more training sessions for the engineering team were needed and for direct comparison with three different functions.

In fact, in addition to the engineering team were involved Sales, Product Strategy, Purchasing and plant managers to guide them to a uniform project management.

4) Other specific sessions were conducted with the engineering team to change / pass the documentation on the Pro launch Activity Matrix.

In this phase all the activities with related documentation were analyzed and the transition from APQP to the new Pro launch forms was verified, allowing the alignment of the documentation with the ISO-IATF and the construction of the Activity Matrix.

It was complicated to find the correspondences and to make sure that the whole team would meet frequently and get involved.

In fact, several reviews have been made.

5) Several cross-tests have been carried out to verify that the new documentation incorporates everything not only at a theoretical but also practical level and favors compression and use for everyone.

6) Once the documentation is ready, a shared network area has been created and uploaded to everyone.

7) The previous questionnaire was repeated and the result was very satisfactory:

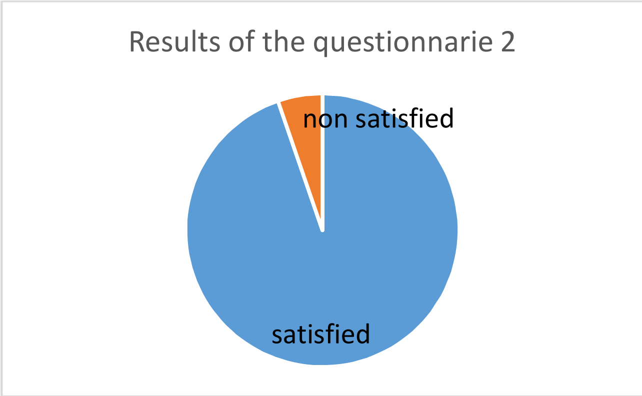


Figure 7.3 Results of the questionnaire 2

8) A presentation of the project to the plant managers was carried out so that they could also implement their activities on the Pro launch for a perfect and coherent sharing of information, facilitating the exchange of communications even between distant locations (Turin, Poland, Germany ect).

The team will proceed with the following activities using the Pro launch, then the proposed tool will also be used by the plants

7.3 How to implement the evaluation process?

Starting from the study of the team's comments / attitudes towards the new tool and the results of the test, an evaluation was conducted in the new process.

The evaluation process implies a certain balance between time and resources, research and analysis work, management of the work team and building relationships with the interested actors. In order for this process to be carried out efficiently, it was necessary to:

A. define the context of the project (previous paragraph);
B. carry out an evaluation (implementation of the method and the work program, cultivate relations with the actors involved, manage the work team, resolve unforeseen issues): the evaluation with the questionnaires before;
C. define a program for presenting the results (plan the frequency of meetings and the most opportune moments);

D. define the nature and style of evaluation reports.

The point C e D have been done thanks to the help of functional leaders, the team estimated the indicators of the process.

7.3.1 Definition of indicators

The indicators are measurement tools that provide useful data for the management of the project as well as for monitoring and evaluating the efficiency of the activities carried out. In this way they can improve the decision-making process, promote greater efficiency and produce more relevant results.

An indicator is a synthetic measure, usually expressed in quantitative form, coinciding with a variable, or composed of several variables, able to summarize the trend of the phenomenon to which it refers.

The trend of the phenomenon or, in other words, the change in the status of fact, are therefore summarized by the indicator, which can not measure all the correlated variables, but the one considered most relevant. Obviously, if possible and not disproportionately burdensome, it would be advisable to use not single indicators, but indicators systems, which can more fully define the observed phenomenon.

By simplifying to the maximum, it can categorize the indicators through the dimension that they measure:

a) Efficiency, ie the relationship between resources used (input) and products (output), they therefore support the analysis of the technical process and the management of production factors;

b) Internal effectiveness

• They are the product indicators, ie cd. "Project implementation of the operational objective" (refer to the ways of transforming input into output);

c) External efficacy

• Result indicators (outcame, eg modification of the behavior of target recipients);

• Impact indicators (impact, measure how much the activities performed have influenced the change in the unwanted situation).

7.3.2 KPI definition and identification

Key Performance Indicators (KPI), are a series of qualitative / quantitative indicators that measure the company results achieved, with reference to fundamental aspects such as the achievement of a certain market share, the achievement of a certain quality standard, efficiency performance, the level of service, the degree of loyalty of customers in the repurchase.

In a competitive environment like the current one, the performance measurement system must include a very wide range of business process performance: this is why KPIs are mainly focused on processes.

From the KPI point of view, the management process is a set of activities that, using a whole series of resources, produces an output in response to service requests. The objective is to measure the full range of performance of a process, which together must quantify the value of the process output for the customer.

The better the KPI is chosen and measured, the better the control of improvements and the adjustment of objectives can be.

KPIs are a set of indicators that measure: Efficiency performance. The indicators measure the productivity and unit costs with which the outputs for the customers of the process are obtained. Efficiency measurement is the primary objective of traditional management control systems, which calculate margin and total costs of activities and products.

• The level of service. The indicators measure the response times to customer requests and the flexibility of the supplier. For example, the time to market, the lead time, the percentage of accepted changes, the global level of service perceived by the customer.

• The quality of business processes. The indicators measure the conformity of the outputs to the customer's expectations. Typical indicators are the percentages of rejects and returns or the level of image.

In the KPI perspective, the management process is a set of activities that produces an output in response to service requests, using a series of resources.

The KPI indicators are aimed at measuring the full range of performance of a process, which together must quantify the value of the process output for the customer.

With the KPI method, a global set of information is selected that must be able to evaluate the competitive performance of the process in all respects, while remaining small in number. A simple approach to identify the KPIs of a process is represented by the following scheme, figure 7.4:

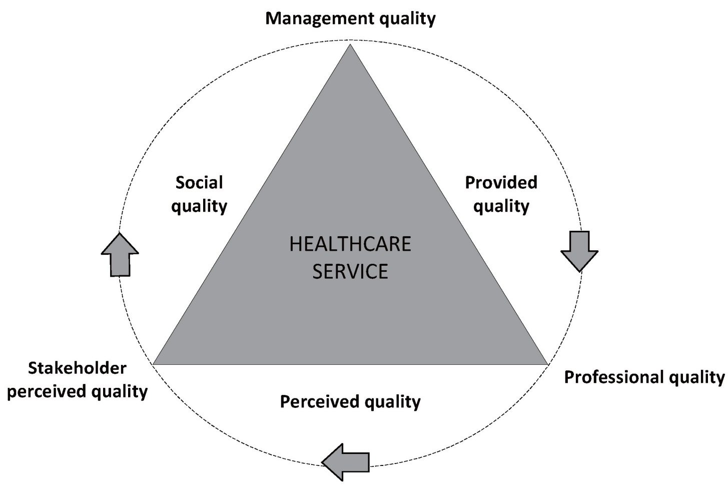


Figure 7.4 Identification KPI of process

At the center of the triangle are the main resources involved in the process and the input and output volumes and then, for each of the vertices, the indexes relating to inputs, resources and outputs are noted.

7.3.3 KPI estimate for the Product Engineering

After defining the indicators at the theoretical level, interactions were made to the functional leaders on how they intend to evaluate the effectiveness and efficiency of the Pro launch and what emerged and presented in Table 7.1.

The indicators built to evaluate the benefits were reported, with the continuous interaction with the team it was possible to estimate and identify the values.

These indicators chouse to quantify the new product development process.

Everything was based on continuous interviews with the team and functional leaders, which is why the KPIs were grouped into macro areas (column 1).

Obviously these indicators concern only Product Engineering and Quality, which is why there are no economic indicators (there are no Sales, Purchases, Product Strategy).

It has been estimated that if all the areas implemented the Pro launch for project management, there would be an increase in profitability of + 0.1% and a reduction in the 5% time required for communication with the client and between the various areas.

The values shown in the table 7.1 are not real but close to reality, for reasons of corporate privacy no real data will be reported.

Area of interest	KPI	Unit of measure	Notes on transformation e aggregation	Value with use of the APQP	Expected value with use of the Pro launch
Design area	Management of orders for month	number	n° job orders processed simultaneously with the month	8	10
	Number of changes to schedules for incorrect scheduling of activities	number	n ° monthly changes to planning planning (due to incorrect management)	4	2
	Satisfaction changes requested by the customer every year	%	n°requests for modification of the project by the customer satisfied / total of the modification requests received	0,20	0,30
Management area	Team satisfaction with use of Pro launch	%	employee satisfaction	60%	70%
	Reduction of complaints and non-compliance	number	n°non-compliance and customer complaints assigned to each employee	2	1
	Objectives achieved at the end of the year	number	n ° objectives achieved by individuals	9	10
	Project implementation time optimization	%	Activity execution time / Estimated time for the realization of this	0,60	0,70
	Non-compliance assigned during the annual audit phase	number	non-compliance assigned	3	2
	Implementation of multiple self audits	%	n° internal inspections carried out / no. planned internal inspections	0,70	0,80
	Number of improvement activities per year	number	number of actions deriving from audits	7	9
	Suggestions for improvement implemented	%	% of recommendations made during the audits that have been implemented	0,90	0,90
	Time reduction for monthly corrections	hours	Dedicated time for power failure operating instructions or for incorrect instructions	16	8
Managerial area	Overview of the timing and activities carried out monthly	number (max 10)	Complete view of project progress	5	8
	Monthly open point reduction	%	n ° open point / total number of points of the project	0,20	0,15

Table 7.1 KPI estimate for P.E.

Chapter 8

Conclusion

The present theis was developed over a period of nine months, from 06/03/2017 until 26/11/2017, starting from an obsolete situation and with little use of the Project Management tools.

Clear objectives have been identified: reorganization of the project management system and alignment of the structure with the ISO-IATF regulations.

Very important was the initial phase, knowledge of the tools (APQP, ISO-IATF..) and analysis of them, after this it was possible to identify and build a tool able to meet the expectations.

In this thesis, the management tool (Pro launch) was presented and described, for undestand the help of the Pro Launch in the management of new product development projects and to ensure alignment with the expected quality standards.

This work was carried out mainly with the Product Engineering (R & D) team, in some cases the other functions (Sales, Purchesing..) were involved.

8.1 Benefits with the use of Pro launch

Starting from the objectives set, the results achieved are very satisfactory.

Thanks to the implementation of the Pro launch, it will have a coherent and efficient execution, the activity matrix allows to manage all activities without confusion; there will be greater visibility to advance problems.

A better focus of the project team, given that responsibilities are assigned in each activity, it is possible to know what and who should do. This will allow a complete integration among different functionalities, it is possible to visualize the responsibilities of the various areas that interact with the Engineering and their responsibilities for each specific activity.

One of the objectives was to standardize the management of processes, in particular in the cases where the RFQ concerned the development of a valve very similar or even equal to one of the past.

Improved decision-making, better organization of ideas and choices was one of the goals of this implementation.

Higher quality results, thanks to the launch of Pro, are archivied:

- Product performance in compliance with customer requirements;

- Team efficiency in carrying out activities;

- Security, nalysis for the product;

- Reliability of the product.

One of the company's benefits will be the standardization of product development phases and an excellent preparation for the IATF certification audit.

Starting in fact from the KPIs described in chapter 7, this will allow the company to reduce the times in the phase of preliminary feasibility, to have a better time management of the resources used.

In addition, a very important aspect is the clear identification and assignment of repositories for each activity, in fact both the functions responsible and the functions supporting each activity have been defined (for example, DFMEA is an activity for which the project engineer is responsible but the quality engineer is a function to support this).

Another great result for the company was the creation of an effective communion between the various functions and activities.

Thanks to the project management mix and quality tools, the objectives set at the beginning of the project have been fully achieved.

The Pro launch proves to be an instrument ready to manage future projects and to be aligned with ISO-IATF standards.

At the end of the work the training was carried out and with the help of interviews and questionnaires it was possible to verify the degree of satisfaction of the team, estimating the KPI to evaluate the process.

Collaboration between the team was a key element of the elaborate.

8.2 Limits of the thesis

At the beginning of the obsolete phase of departure and lack of information, creating a new tool seemed very complicated.

The first periods were intense because it was necessary to analyze what was already there and what it had to build.

An initial limestone of the thesis was represented by the set of documents and manuals on which the analysis was based.

Understanding the starting point required a period of two months.

Starting with unclear and non-standardized documentation, and then starting to understand the new standards has complicated and slowed down time.

Finding the correspondences between what was there and what had to be there was the most complicated part of the thesis.

Because of the limited time it was not possible to study / deepen in the factories where the situation was the same as that of the R & D area, the complexity here was also represented by the resources that would have been involved in the activity.

In particular, going to dig into the historical documentation within a plant would have required a long analysis and comparison with functional leaders but also with operators.

It would have been very interesting and would have given the maximum standardization to align Design and Production in a single management tool.

Another limiting aspect was to have few data to evaluate for a quantitative analysis, to put down the KPIs was only possible thanks to the intervention and collaboration between the functional leaders.

Furthermore, a budget analysis was not addressed because Sales and Purchases were only involved as support and their activities were not analyzed and revolutionized.

Remember that this work has been developed in the Product Eng., Laboratory and Testing area.

8.3 Next steps after this thesis in the company

Starting from these advantages, already foreseen and discussed in the previous chapters, it can be said that the following elaboration has led to very satisfactory results.

But starting from the established guidelines and guidelines, the company will improve this in a single project management system.

This will allow a perfect communication between the various functions and a continuous internal and external improvement for the company, a real step towards standardization.

The approach used in the following elaboration will be the starting point for continuous continuous improvement.

This will bring great benefits for both project management and time optimization of resources used in activities.

One of the next steps will be to continue this activity in the plants first in Turin and then abroad, thanks to the approach founded and described here we think the implementation times will be reduced.

The result of this work will be a guideline for the company for subsequent updates and internal improvements.

Chapter 9

9.1 Bibliography

For books Alessandro Grandi, (2017), Gestione dei progetti di innovazione, McGraw-Hill Education, Italy.

For books Marco Cantamessa, Esther Cobos , Carlo Rafele, (2017), l project management. Un approccio sistemico alla gestione dei progetti, Isedi, Italy.

For books Harold Kerzner, (2005), Project management. Pianificazione, scheduling e controllo dei progetti, Hoepli.

For journal M. Bobrek [a] , M. Sokovic [b],(2005), Implementation of APQP-concept in design of QMS, M. Bobrek [a] , M. Sokovic [b] (*).

(*)M. Bobrek [a] , M. Sokovic [b]

a Faculty of Mechanical Engineering, University of Banjaluka, Bosnia and Herzegovina

b Faculty of Mechanical Engineering, University of Ljubljana, Aškerceva 6, SI-1000 Ljubljana, Slovenia.

For journal Yemisi, (2014), New Product Development In New Ventures: the quest for resource, Yemis A.Bolumale, Roger J.Calantone, C.Anthony di Benedetto & Steven A.Melnyk, USA.

9.2 Websites

- http://www.provincia.bz.it/cultura/download/Manuale_Project_Management(1).pdf
- *http://www.humanwareonline.com/project-management/center/cose-il-project-management/*
- *http://www.pmi.it/tag/project-management*
- *https://www.francoangeli.it/Ricerca/Scheda_libro.aspx?ID=276*
- *http://www.sdabocconi.it/it/formazione-executive/trasversale/project-management*
- *https://www.pmi.org/learning/library/project-management-new-product-development-2391*
- *https://marketing-insider.eu/new-product-development-process/*
- *http://www.npd-solutions.com/processtools.html*
- *http://www.eaton.com/us/en-us.html*
- *https://it.wikipedia.org/wiki/Valvola*
- *http://www.motogarden.net/motori-motori-le-valvole*
- *http://quality-one.com/apqp/*
- *http://searchcio.techtarget.com/definition/product-development-or-new-product-development NPD*
- *https://www.tequa.hu/sites/default/files/transitioning-to-iatf-16949-whitepaper_aiag-3.pdf*
- *https://it.wikipedia.org/wiki/Work_breakdown_structure*
- *https://www.leanmanufacturing.it/six-sigma.html*
- *http://www.newcomweb.it/blog/pillole-di-marketing/article/kpi-cosa-sono-e-perche-sono-cosi*
- *https://it.wikipedia.org/wiki/Indicatore_chiave_di_prestazione*
- *http://www00.unibg.it/dati/corsi/6623/25468Il%20sistem%20di%20misurazione%20delle%20prestazioni%20aziendali.pdf*
- *https://www.performancemonitor.eu/voce.php?ID=100100*
- http://www.promisalute.it/upload/mattone/gestionedocumentale/4.7%20monitoraggio%20e%20valutazione_784_2708.pdf
- http://www.qualitapa.gov.it/fileadmin/mirror/t-gestperf/Slides_MV_ud4.pdf

Every statement with no indicated source is related to internal sources of the company where the project has been carried out, such as documentations, reports, meeting presentations, knowledge acquired by the Student by interviewing experts or through trainings.