



## **DIPLOMARBEIT**

zum Thema

# **Evaluation of Project Portfolio Management Software for ABB Engineering Centers**

ausgeführt zum Zwecke der Erlangung des Akademischen Grades eines Diplom-Ingenieurs  
unter der Leitung von

Ass. Prof. Dipl.-Ing. Dr. techn. Peter Kuhlang  
und Projektass. Dipl.-Ing. Thomas Edtmayr  
E330  
Institut für Managementwissenschaften

eingereicht an der Technischen Universität Wien  
**Fakultät für Maschinenwesen und Betriebswissenschaften**

von  
Milla Mouhu  
Matrikelnr.: 0426047  
Gumpendorfer Str. 140/2B  
1060 Wien

Wien, am 25. Mai 2011

Milla Mouhu

## ***Abstract***

The engineering company ABB has been facing an increasing number of late customer project deliveries in the past years. The competition in the industry puts more and more pressure on the company performance and the efficiency must be constantly improved. There are several factors contributing to the project success and, especially in an engineering-to-order company, the throughput or on time delivery cannot be increased simply by making more investments. The scarce resources, such as experienced senior engineers, are under a multi-project work load that they no longer can manage.

To plan the resources more efficiently, an overview of all the running projects in an engineering center must be obtained. There are several project portfolio management software solutions on the market, which support a central planning and management of the resources and claim to improve throughput up to 20%. The goal of my diploma thesis is to evaluate this software and identify one or two that would be most suitable for the ABB working processes.

As the most known software companies are mainly focused on IT project portfolios, the number of strong candidates was quickly reduced. The critical chain method, represented by the company Realization, has given good results in single project execution, but did not convince to be effective in multi-project resource planning outside manufacturing. Therefore, my conclusion was to prefer companies, such as Planisware, who use the traditional critical path method for project management.

## ***Kurzbeschreibung***

Das Technologieunternehmen ABB verzeichnete in den vergangenen Jahren eine steigende Anzahl der Verspätungen bei der Lieferung von Kundenprojekten. Der Wettbewerb in dieser Branche erhöht zunehmend den Druck auf die Unternehmensleistung, wodurch die Leistungsfähigkeit nachhaltig verbessert werden muss. Mehrere Faktoren tragen zum Projekterfolg bei. Insbesondere bei „Engineering-To-Order“ Unternehmen, kann der Durchsatz oder die Liefertreue nicht nur durch größere Investitionen sichergestellt werden. Knappe Ressourcen, wie die Engineering Spezialisten müssen ein hohes Arbeitspensum erfüllen, welches sich über mehrere Projekte erstreckt. Mit diesem zeitlichen Druck kommen die Mitarbeiter nicht mehr zurecht, wodurch sich die Projekte verspäten.

Um die Ressourcenplanung effizienter zu gestalten, muss man sich einen Überblick über alle laufenden Projekte in einer Ingenieurabteilung verschaffen. Auf dem Markt gibt es mehrere Projektportfoliomanagement Softwarelösungen, die die zentrale Planung und das Ressourcenmanagement unterstützen und behaupten somit den Durchsatz bis zu 20 % zu erhöhen. Das Ziel meiner Diplomarbeit bestand darin, diese Software zu evaluieren und eine geeignete Lösung für die Arbeitsprozesse bei ABB zu bestimmen.

Da die meisten bekannten Softwareunternehmen ihren Schwerpunkt vorwiegend auf IT Projektportfolios legen, verringerte sich die Anzahl der aussichtsreichen Kandidaten schnell. Die „Critical Chain“ Projektmanagementmethode von der Firma Realization erzielte gute Ergebnisse in der Einzelprojektabwicklung. Nicht effektiv erwies sich jedoch die Methode bei der Multiprojekt-Ressourcenplanung in anderen Arbeitsgebieten außerhalb der Produktion. Folge dessen ist meine Empfehlung eine PPM Software, die im Gegensatz zu „Critical Chain“, die traditionelle kritische Weg -Methode verwendet, auszuwählen. Beispiele hierfür sind Planisware 5 und Primavera P6.

## ***Table of Contents***

1. Introduction .....	1
2. Multi-Project Management .....	4
2.1. General problem definition .....	4
2.2. Critical Path .....	7
2.3. Critical Chain and Theory of Constraints .....	9
3. ABB Group .....	12
3.1. Organization .....	16
3.2. HVDC Ludvika, Sweden .....	20
3.3. Power Cables Karlskrona, Sweden .....	28
4. Software Vendors .....	29
4.1. Planisware .....	35
4.1.1. Multi-Project Planning .....	36
4.1.2. Interfaces .....	42
4.1.3. Controlling .....	43
4.1.4. Settings .....	44
4.1.5. Miscellaneous .....	46
4.1.6. Customer Reference: Schaeffler Technologies / INA .....	47
4.2. Oracle/Primavera .....	51
4.2.1. Multi-Project Planning .....	52
4.2.2. Interfaces .....	54
4.2.3. Controlling .....	55
4.2.4. Settings .....	57
4.2.5. Miscellaneous .....	59
4.2.6. Customer Reference: Alstom Group / Power .....	59
4.3. JDA Software .....	61
4.3.1. Multi-Project Management .....	62
4.3.2. Interfaces .....	64
4.3.3. Controlling .....	64
4.3.4. Settings .....	66

4.3.5. Miscellaneous .....	68
4.3.6. Customer Reference: Krones.....	68
4.4. HP .....	72
4.4.1. Multi-Project Planning.....	73
4.4.2. Interfaces.....	74
4.4.3. Controlling .....	75
4.4.4. Settings .....	77
4.4.5. Miscellaneous.....	79
4.4.6. Customer Reference: Exactitude Consulting for BHP Billiton .....	80
4.5. Realization/Concerto .....	82
4.6. Results.....	84
5. Implementation .....	86
6. Conclusion .....	88
Appendix: HVDC Engineering process work flow .....	93

## ***List of Figures***

Figure 1.	Planisware critical path display .....	7
Figure 2.	HP EVM illustration .....	8
Figure 3.	Five focusing steps of TOC.....	10
Figure 4.	Differences of buffers between critical chain and critical path method .....	11
Figure 5.	Timeline of the history of ABB Group.....	14
Figure 6.	Current ABB product offering .....	15
Figure 7.	Transformer production in Vadodara, India.....	17
Figure 8.	A robot assembles robots .....	18
Figure 9.	Division PS organigram .....	20
Figure 10.	HVDC organization.....	22
Figure 11.	ABB Market share in high voltage products in 2005 .....	23
Figure 12.	TOPS Management System in Ludvika .....	23
Figure 13.	Forrester Research comparison of business oriented PPM vendors .....	30
Figure 14.	Gartner Magic Quadrant .....	31
Figure 15.	Reporting wizard with time lines of all running projects .....	36
Figure 16.	Planisware multi-project list view .....	37
Figure 17.	Program level resource estimation divided into all running projects.....	37
Figure 18.	Planisware Gantt .....	38
Figure 19.	Planisware project simulations .....	39
Figure 20.	Planisware resource constraints .....	40
Figure 21.	Planisware resource distribution.....	40
Figure 22.	Planisware budget figures, KPI's and Stage Gate display.....	41
Figure 23.	Planisware resource leveling.....	41
Figure 24.	An example of the information exchange to SAP .....	42
Figure 25.	Planisware EVM, KPI's and Stage-Gate display .....	43
Figure 26.	Planisware overspending/delay display .....	44
Figure 27.	Planisware dashboard .....	45
Figure 28.	Planisware reporting wizard.....	45
Figure 29.	Project documentation.....	47
Figure 30.	Industry customers of Planisware outside IT .....	49
Figure 31.	Primavera project portfolio level Gantt .....	52

Figure 32.	Primavera capacity planning .....	53
Figure 33.	Primavera resource distribution between projects and planned offers.....	54
Figure 34.	Primavera/SAP information flow.....	55
Figure 35.	Primavera schedule checking .....	56
Figure 36.	Primavera labor costs by location .....	57
Figure 37.	Primavera executive dashboard .....	58
Figure 38.	Primavera reports by schedule time .....	58
Figure 39.	JDA EPP: Program Schedule Overview in master plan .....	62
Figure 40.	JDA resource allocation plan .....	63
Figure 41.	JDA resource pool capacity display .....	63
Figure 42.	JDA resources divided in hours per project.....	64
Figure 43.	JDA EPP: Single project KPI's with buffer consumption .....	65
Figure 44.	JDA critical path .....	65
Figure 45.	JDA program buffer consumption in master plan .....	66
Figure 46.	JDA utilization report to resource manager .....	67
Figure 47.	Experiences from the JDA implementation process .....	70
Figure 48.	HP resource allocation.....	73
Figure 49.	HP long term resource planning.....	74
Figure 50.	HP CCPM .....	75
Figure 51.	HP buffer calculation .....	76
Figure 52.	HP project buffer display .....	76
Figure 53.	HP dashboard .....	77
Figure 54.	HP overview report.....	78
Figure 55.	HP full portfolio timeline .....	79
Figure 56.	Category based value analysis.....	85

***Table of Tables***

Table 1. Planisware ratings ..... 50

Table 2. Primavera ratings ..... 60

Table 3. JDA ratings..... 71

Table 4. HP ratings ..... 81

Table 5. Value analysis ..... 84

Table 6. Category based scorings..... 85



## ***Abbreviations***

ABPP	Agile Business Process Platform
API	Application Programming Interface
BU	Business Unit
CCPM	Critical Chain Project Management
CPM	Critical Path Method
EPP	Enterprise Project Planner
EPPM	Enterprise Project Portfolio Management
ERP	Enterprise Resource Planning
ETO	Engineering To Order
EVM	Earned Value Management
HR	Human Resources
HVDC	High Voltage Direct Current
IT	Information Technology
KPI	Key Performance Indicator
MPCC	Multi-Project Critical Chain
MSP	Microsoft Project
NLS	National Language Support
NPV	Net Present Value
PMO	Project Management Organization
R & D	Research and Development
RoI	Return on Investment
SaaS	Software as a Service
SCM	Supply Chain Management
SOAP	Simple Object Access Protocol
TOC	Theory of Constraints
WBS	Work Breakdown Structure
XML	Extensible Markup Language

## **1. Introduction**

The word 'project' has nowadays a strong position in our work life vocabulary. As defined by Leach<sup>1</sup>, 'project' is "a temporary endeavor undertaken to create a unique product or service". He emphasizes the word "temporary" as defining the crucial difference to production. We often work on projects of different sizes, internal or external, dedicating our time and effort as an important resource to the given task. Additionally, someone needs to manage these resources as well as costs and time to ensure a successful project delivery in the end. This is called project management. Project management has continuously increased its importance and is believed to be one the most important deciding factors over a success of a project. Unfortunately, we often fail to deliver the project on time or on quality, due to various problems.

The nature of a project, creating something unique, already tells us that there are challenges to expect. We have tried to fight against project failure by planning projects better or more precisely. Depending on the project type and business, this can sometimes solve only part of the problem. No doubt, a well done plan is important, but no one should assume that the execution phase would run according to an exact, predefined plan. In a study of The Goldratt Institute, project management students named a few of the reasons hindering a project's success<sup>2</sup>:

- Unforeseeable bad weather
- Unforeseeable difficulties at vendors who supply equipment
- Longer-than-expected time in meeting government requirements
- Unrealistic schedule
- Unreliable (but cheaper) vendors or contractors
- Difficulties in matching operators available with project needs
- Unforeseen emergencies

---

<sup>1</sup> Leach, 2005, Glossary.

<sup>2</sup> Leach, 2005, page 10.

---

This all becomes even more challenging when we combine multiple projects within one unit and make them share the given resources. Scheduling the resources in an environment where little works out as planned, can easily lead to “firefighting”, where you are just trying to survive from one day to another.

In spring 2010 I received the opportunity to write my diploma thesis for the company called ABB in Switzerland. In their headquarters in Zürich-Oerlikon, the Department of Quality and Operational Excellence had started a project to find a solution to help their engineering centers around the world, in their struggle with delays caused by inefficient resource planning. I was able to participate in this project and I have summarized our work and the obtained conclusions, in this thesis.

ABB is a typical project management organization (PMO) with numerous customer projects as well as resource and development (R & D) projects, running simultaneously in a matrix organization. Managing a single project is already challenging as it is, but additionally, ABB has to manage the complete resource allocation between multiple projects. Therefore, the focus of this work was multi-project management. Knowing that the market offers software solutions that have helped companies facing similar problems, it was decided that my task would be to look into this software market more closely and evaluate the functionalities that they offer. If a suitable tool would be found, this could be recommended for engineering centers throughout the organization.

For single project management there are several different software solutions available and no one can imagine nowadays running a bigger project without the support of some software. The most common functionalities include

- budget planning and cost controlling
- resource planning with individual calendars
- work breakdown structure (WBS) and network plan
- time lines for baselines vs. actual progress i.e. Gantt chart
- document storage
- reporting assistance

---

There is no standard tool being used within ABB, some use MS Project, the majority Primavera and in Norway a tool called Safran. As useful and as advanced as these tools are, the traditional PM software is not capable in combining the information of two different project plans, in order to analyze, for example, the resource availability.

The multi-project software would have to offer the line managers the possibility to control their scarce resources, in an up-to-date plan that reflects the true status of all different projects running in their department. Currently there are several ways the individual engineering centers are running their resource management. One of the most common solutions is a self-constructed excel-sheet that, unfortunately, isn't able to meet all their needs. Already in the beginning, we defined some crucial functionality that the software must provide, such as what-if simulation on program level, or a closed-loop interface to SAP and to the project management tool being used. The first step was to find solutions that offer these functionalities, preferably from a vendor that has experience with business oriented projects instead of only IT projects. After selecting the most suitable vendors, we would then have to verify the claims by talking to the reference companies that have been using the tool to improve their performance.

As the ABB has been cooperating for years already with a company called "Realization", in improving their performance in single project management, it was important to investigate if their solution would be suitable for multi-project management as well. The crucial difference to other vendors is that Realization uses critical chain method for their project planning and execution. Hence, one of our goals was to find out if critical chain method can be used to solve the problem of resource allocation between multiple projects as efficiently as it seemed to work in single project management.

## **2. Multi-Project Management**

### **2.1. General problem definition**

First we need to make clear what we mean by multi-project management. How does it differ from portfolio management?

The company Actano defines the project portfolio as “the sum of all projects in a company. Projects are managed and assessed in terms of operative benefits and corporate strategic alignment by the means of project portfolio management.” and “Whereas project management focuses primarily on efficient project execution, project portfolio management targets greater effectiveness in project controlling. This includes assessing projects on the basis of their costs effectiveness and their benefits for achievement of the company’s strategic goals.”<sup>3</sup>

This means that the ABB engineering centers theoretically manage, therefore, a portfolio, as opposed to for example a program. Portfolio management has, however, the function of also selecting the most suitable portfolio mix that corresponds to the company strategy and makes the business most profitable. Within ABB this is not done, nor would it be possible, and as the focus is only on management and execution of multiple projects, we prefer to refer to multi-project management. The software on the market is, however, called project portfolio management as it is suited to the needs of the majority of the companies. I also often interchange the management and planning concepts. There is, however, the difference that management has a wider meaning including -not only planning, but also controlling.

The most difficult environment for multi-project planning is an engineering-to-order (ETO) company. These organizations have usually adopted a matrix organization structure. They have a high degree of variability in their products and high dependency between different projects. Long and intensive engineering process and several projects running parallel makes the resource planning more challenging. This is because the time for completing a task is

---

<sup>3</sup> Actano online glossary, [www.actano.com](http://www.actano.com)

---

impossible to estimate precisely in the beginning, and numerous changes in the resource planning arise during the execution phase.

In the paper “A hierarchical approach to multi-project planning under uncertainty”<sup>4</sup>, Hans, Herroelen, Leus and Wullink suggest solving this problem with a process management view, where resources are seen as work stations visited by work packages that are given forward after completion. The problem here is how to set the priorities between the work packages when choosing the next one. In their paper, the authors refer to using intermediate milestones for prioritization. In my opinion however, the problem is more complex and needs a more sophisticated system for deciding which project should be given the scarce resources. The time pressure is constant, and often no one has the control over the relative importance of different project milestones.

For the resource planning they suggest the following: “In the early stages of the project, when only rough information about the project content is available... the most important output are the internal and external due dates, milestones and required capacity levels.” “In later project stages more information gradually becomes available... These data are combined with information generated by process planning and design and passed on as an input for the operational planning phase.” I fully agree that this is in the right direction and certainly this is also recognized by the planning divisions in ABB.

Currently there is, however, no software supporting such gradual integrated planning in use within ABB. Some of the information is stored in SAP<sup>5</sup>; single project scheduling is done with a project management (PM) tool such as MS Project or Primavera; Excel sheets are produced to obtain an overview of total resource availability, but none of these tools are communicating automatically with each other. For efficient multi-project planning and management, there must be a tool that can up/download information on a regular basis from SAP and PM tool and combine this information in a useful way. One of the most needed functionalities is to see how changes in one project affect the complete resource planning and thereby other projects.

---

<sup>4</sup> Hans, Herroelen, Leus, Wullink, 2007

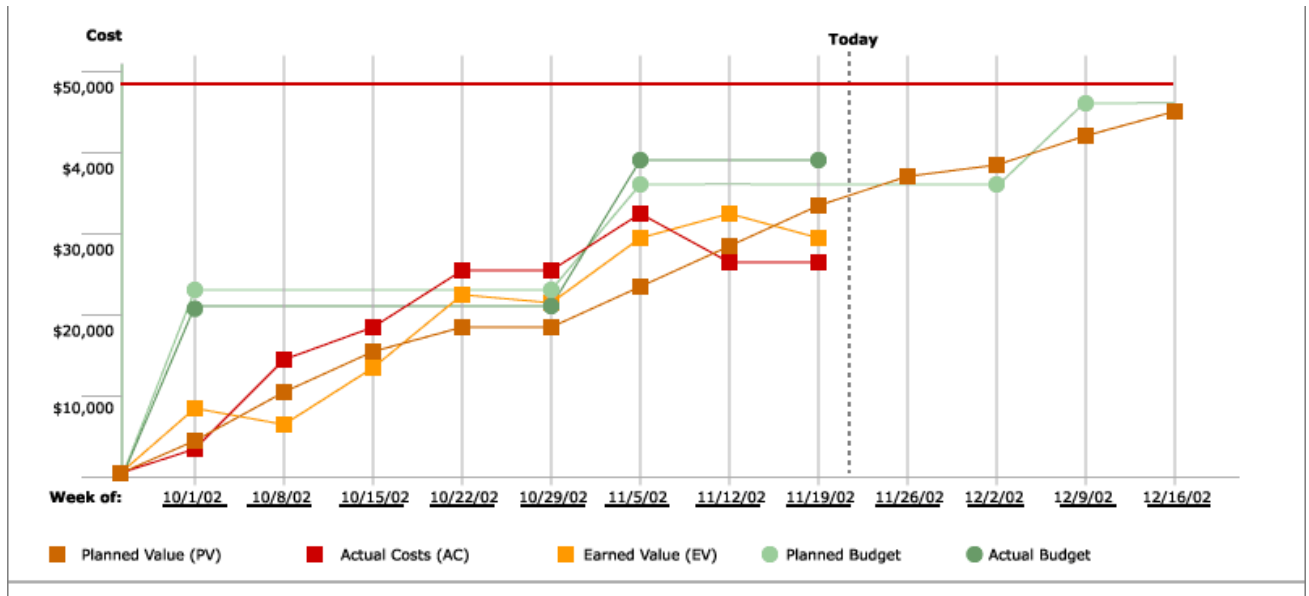
<sup>5</sup> ABB uses SAP as their ERP system, including HR functions.

There are various solutions to this problem in the market but before we get into the detailed presentations, I would like to give an overview of the two main approaches in a single project planning. Critical chain, including the theory of constraints, or the wider-spread critical path method, build the basic principles on which we can differentiate the project planning software later.





cost savings might delay the project even more, leading to penalties or, as another example, the curve doesn't reward early delivery as it is considered to be a deviation -such as a delay.<sup>6</sup>



**Figure 2. HP EVM illustration<sup>7</sup>**

The display of critical path and EVM are well known and easy to use. If they are the ideal illustrations to help a project manager in his decisions, remains to be discussed.

<sup>6</sup> Discussions with the Realization representatives in August 2010

<sup>7</sup> HP answers to the questionnaire

---

### **2.3. *Critical Chain and Theory of Constraints***

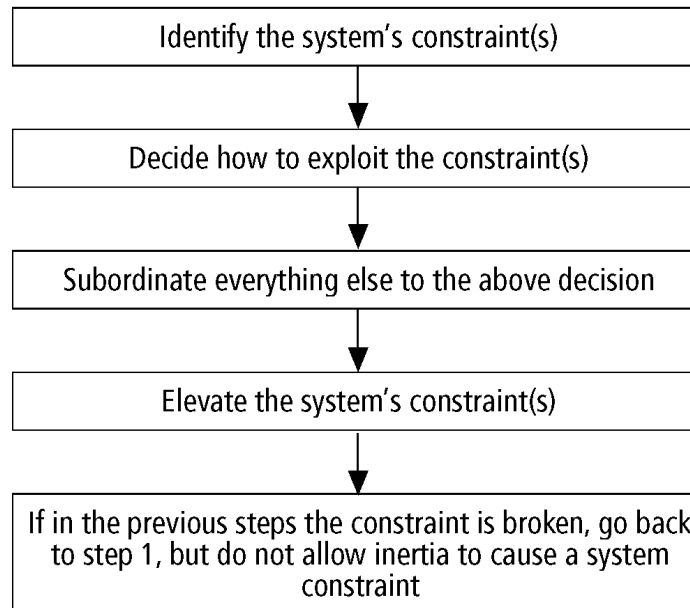
Critical Chain Project Management (CCPM) concentrates on resources instead of tasks, believing that resources need to be more flexible in changing between tasks, and that way, resource load can be kept steady. The inventor of the method is a famous Israeli physicist Eliyahu M. Goldratt, who introduced Theory of Constraints (TOC) in his book *The Goal* (1988). He noticed how the projects were constantly failing due to various changes, and he therefore focused on managing uncertainty better.

Theory of constraints says that all systems have a constraint that limits the output, the bottleneck, so to say. This means that the throughput is defined by this constraint, and it is important to identify this constraint and plan the production around it. As described by Leach, “Systems are analogous to chains. Each system has a weakest link (constraint) that ultimately limits the success of the entire system.”<sup>8</sup>. The theory sounds logical and is certainly true for a simple production line; in an engineering environment however, this becomes more complicated.

The TOC follows a five step process as a key to ongoing improvement; these are shown in Figure 3.

---

<sup>8</sup> Leach, 2005, p.45

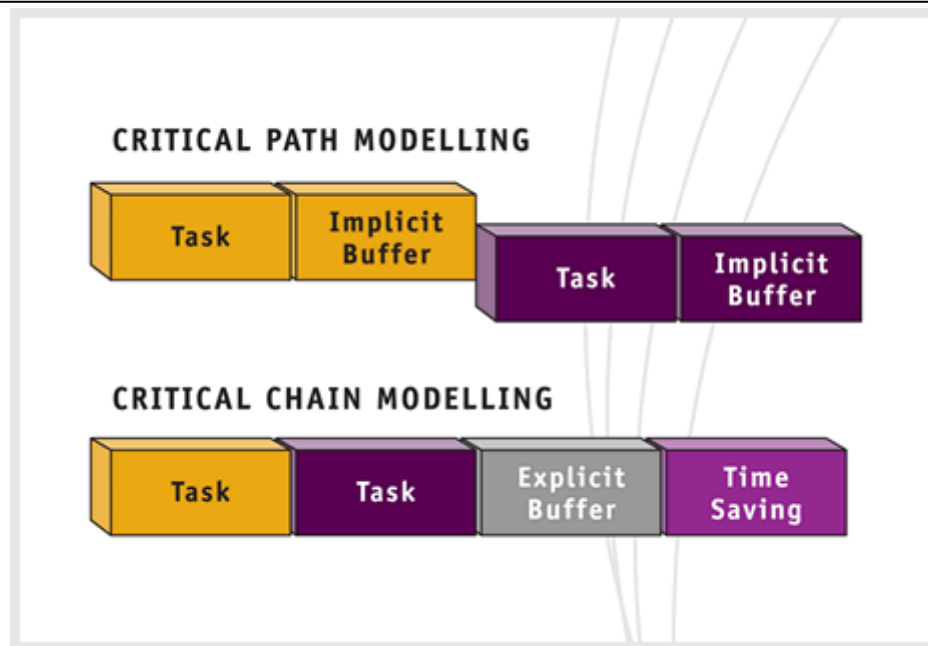


**Figure 3. Five focusing steps of TOC<sup>9</sup>**

A big difference between CPM and critical chain is the buffer management. One of the cornerstones of critical chain method is identifying the implicit, or unknown, buffers and controlling the buffer consumption as a feedback of project status. The assumption is that the work could always be done faster than notified in the planning, because people tend to add implicit buffers to their delivery times. Critical chain method aims to eliminate the implicit buffers by reducing the task time by, for example, 50% and replacing these buffers with a joint explicit buffer at the end of all tasks. This explicit buffer, or feeding buffer, has in the example case the length of 50% of the total duration of the tasks in the feeding chain. This way, the consumption of feeding buffer can be observed and, even when the feeding buffer is completely used, there would still be a remarkable time saving. Unfortunately, this fights against human nature and in reality the implicit buffers are very hard to eliminate.

---

<sup>9</sup> [www.emeraldinsight.com](http://www.emeraldinsight.com)



**Figure 4. Differences of buffers between critical chain and critical path method<sup>10</sup>**

The multi-project critical chain (MPCC) approach aims to reduce inefficient multi-tasking by aligning the projects to be completed one after each other, instead of working on several projects simultaneously. This is nothing new for ABB, as each project has their own project team, and so each individual should be, theoretically, working on only one project at a time.

One of the main vendors offering critical chain solutions is Realization Inc. (See chapter 4.5.) Also the vendor Jda offers the possibility to follow the buffer consumption to detect delays. The method has proven to give very good results on single project execution. Companies report up to 20-40% increased throughput and shorter cycle times. This does not apply only in manufacturing businesses, but in some ABB units as well. Theoretically, the same approach should work in multi-project environment; there are, however, no functioning examples where critical chain would be used to manage multiple projects sharing their resources.

<sup>10</sup> Source: [www.caravelgroup.com](http://www.caravelgroup.com)

### **3. ABB Group**

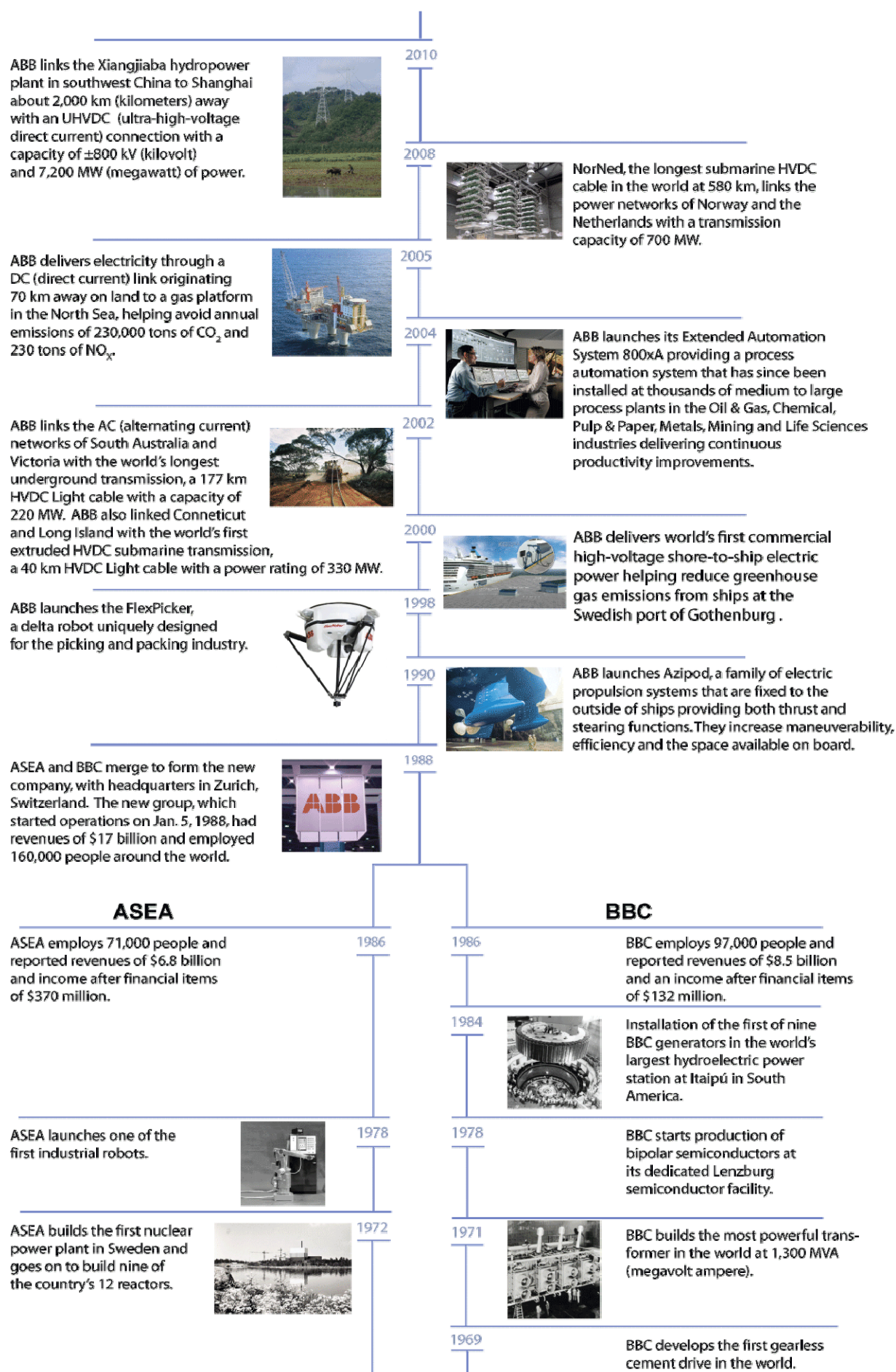
“Power and productivity for a better world” (ABB slogan)

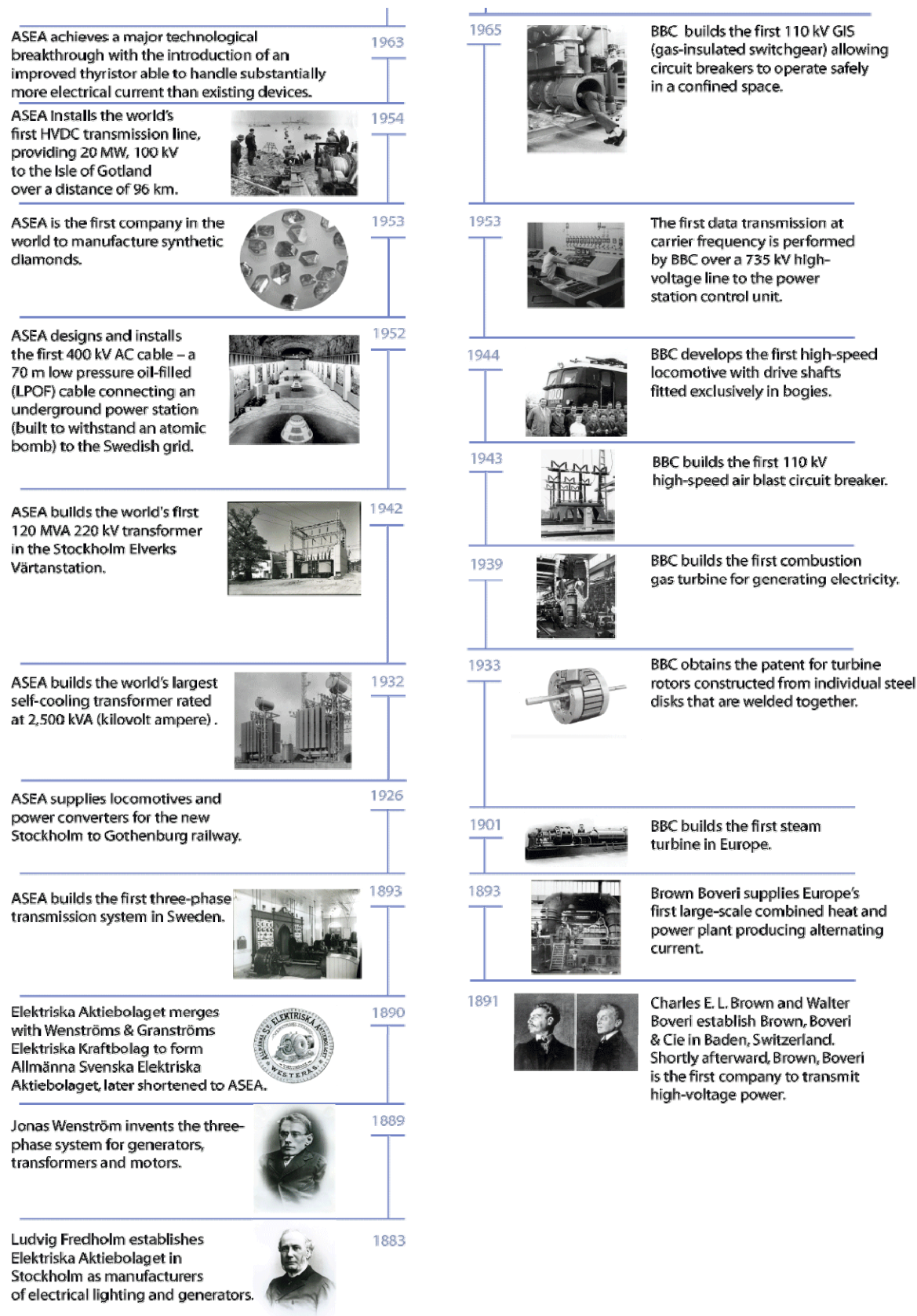
ABB Group is one of the world leaders in power and automation technology. They are specialized in improving power efficiency of industry customers and lowering environmental impact of their solutions. With a total of 120 000 employees in over 100 countries, it is also one of the largest engineering companies in the world, and has its headquarters located in Zürich, Switzerland. The revenue of 2009 was 31.8 billion USD<sup>11</sup>, whereas the biggest competitor is Siemens AG.

ABB was founded in 1988 as the two companies, Swedish ASEA (Allmänna Svenska Elektriska Aktiebolaget) and Swiss BBC (Brown, Boveri & Cie), merged as a result of toughened market competition. ASEA had been manufacturing electrical light and generators since it was established in 1883 and had factories in several Swedish cities, whereas BBC, also a electrical engineering company, was founded 1891 in Baden, Switzerland and later took over the Maschinenfabrik Oerlikon in the surroundings of city Zürich. The Figure 5 shows the history timeline of ABB, and in Figure 6 you may see the current offering selection.

---

<sup>11</sup> ABB Homepage [www.abb.com](http://www.abb.com)



Figure 5. Timeline of the history of ABB Group<sup>12</sup><sup>12</sup> Source: www.abb.com



## The world of ABB in power

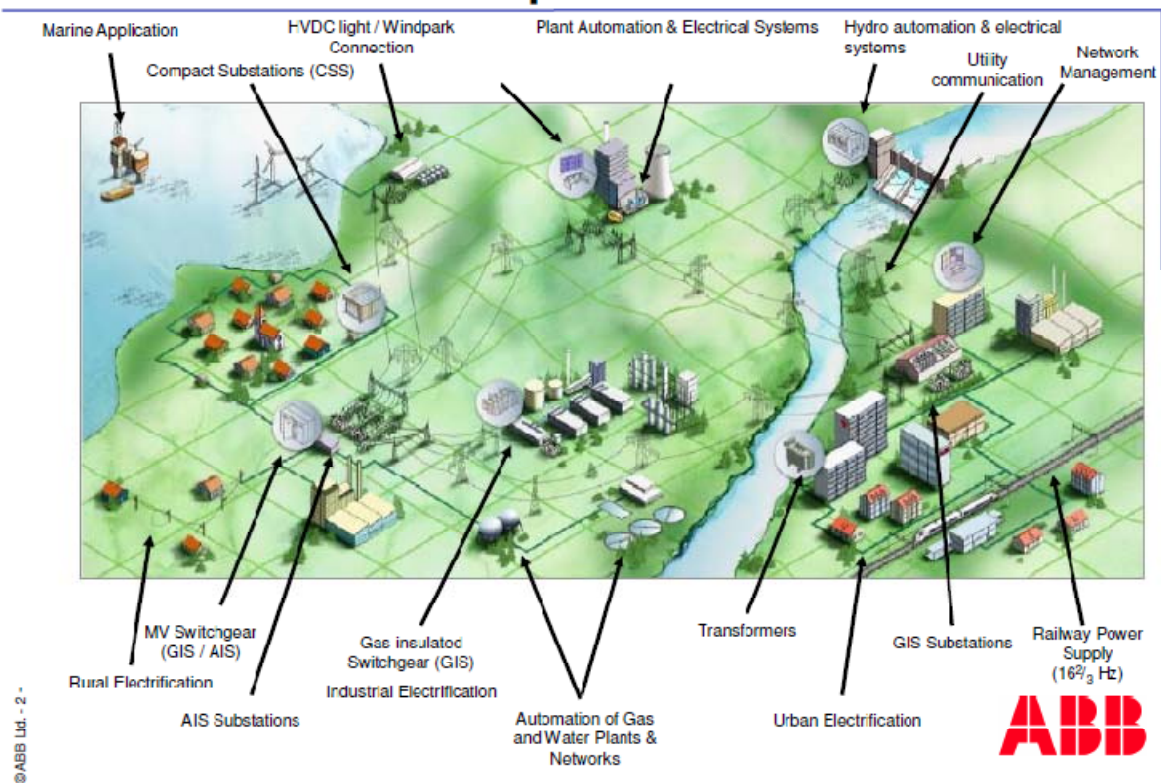


Figure 6. Current ABB product offering<sup>13</sup>

In the following chapters, I would like to give a better understanding of the working environment within the ABB and the problems that they face in their daily life. This analysis was also an important part of our discussions with the vendors later on, as they needed to understand the problems we face, and the requirements we have for the software.

<sup>13</sup> Source: ABB/PP



---

### **3.1. Organization**

ABB is a global company of rather large dimensions so the organizational structure is accordingly quite complicated. Due to the historical development and working culture, the individual business units have maintained their independency in many aspects.

Group functions are mainly located in the headquarters in Switzerland. It includes departments such as Human Resources (HR), Marketing, Legal Affairs, Global Footprint, Finance and many smaller units like Internal Audits, Supply Chain Management (SCM) and Quality and Operational Excellence, where I was based. Additionally to the divisions, there are also global market departments, where each country or area has their own management.

The five main divisions are divided into several smaller business units (BUs), where one BU can have an estimated 1000 engineers working in 3-7 of their engineering centers globally. Here are the five divisions and their working areas presented<sup>14</sup>:

---

<sup>14</sup> ABB Homepage [www.abb.com](http://www.abb.com)

---

## 1. Power Products



**Figure 7. Transformer production in Vadodara, India**

Power Products are the key components to transmit and distribute electricity. The division incorporates ABB's manufacturing network for transformers, switchgear, circuit breakers, cables and associated equipment. It also offers all the services needed to ensure products' performance and extend their lifespan. The division is subdivided into three business units.

## 2. Power Systems

Power Systems offers turnkey systems and services for power transmission and distribution grids, and for power plants. Substations and substation automation systems are key areas. Additional highlights include flexible alternating current transmission systems (FACTS), high-voltage direct current (HVDC) systems and network management systems. In power generation, Power Systems offers the instrumentation, control and electrification of power plants. The division is subdivided into four business units.

---

### 3. Discrete Automation and Motion



**Figure 8. A robot assembles robots**

This division provides products, solutions and related services that increase industrial productivity and energy efficiency. Its motors, generators, drives, programmable logic controllers (PLCs), power electronics and robotics provide power, motion and control for a wide range of automation applications. The leading position in wind generators and a growing offering in solar systems complement the industrial focus, leveraging joint technology, channels and operations platforms.

### 4. Low Voltage Products

The Low Voltage Products division manufactures low-voltage circuit breakers, switches, control products, wiring accessories, enclosures and cable systems to protect people, installations and electronic equipment from electrical overload. The division further makes KNX systems that integrate and automate a building's electrical installations, ventilation systems, and security and data communication networks.

---

5. Process Automation

The main focus of this ABB business is to provide customers with products and solutions for instrumentation, automation and optimization of industrial processes. The industries served include oil and gas, power, chemicals and pharmaceuticals, pulp and paper, metals and minerals, marine and turbo charging. Key customer benefits include improved asset productivity and energy savings.

The large organization creates already some problems, for example in communication, and it might be unjustified to compare different business units directly. It can be said however that on a global basis the average on time delivery is only ca. 60%, which leaves a lot of room for improvements. Some BU's are doing better than others and have completely different problems. Our wish is to have the multi-project planning software implemented only in those BU's who could benefit from such a tool in the first place. This could apply to ca. 20 engineering units out of the total of ca. 50 BUs.

### 3.2. HVDC Ludvika, Sweden

High Voltage Direct Current (HVDC) engineering lead center in Ludvika near Stockholm is part of the PS/Grid systems division as shown in the

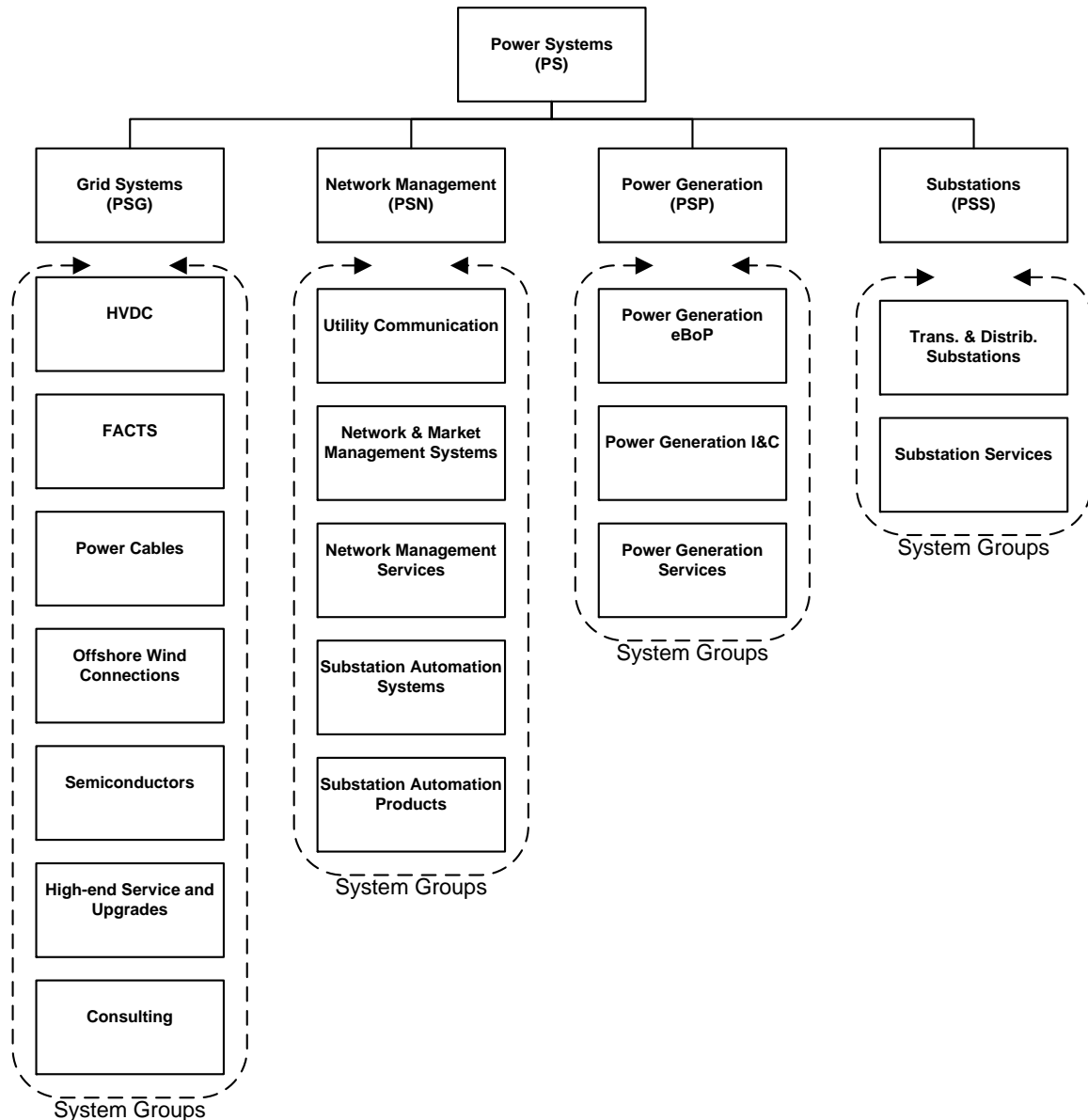
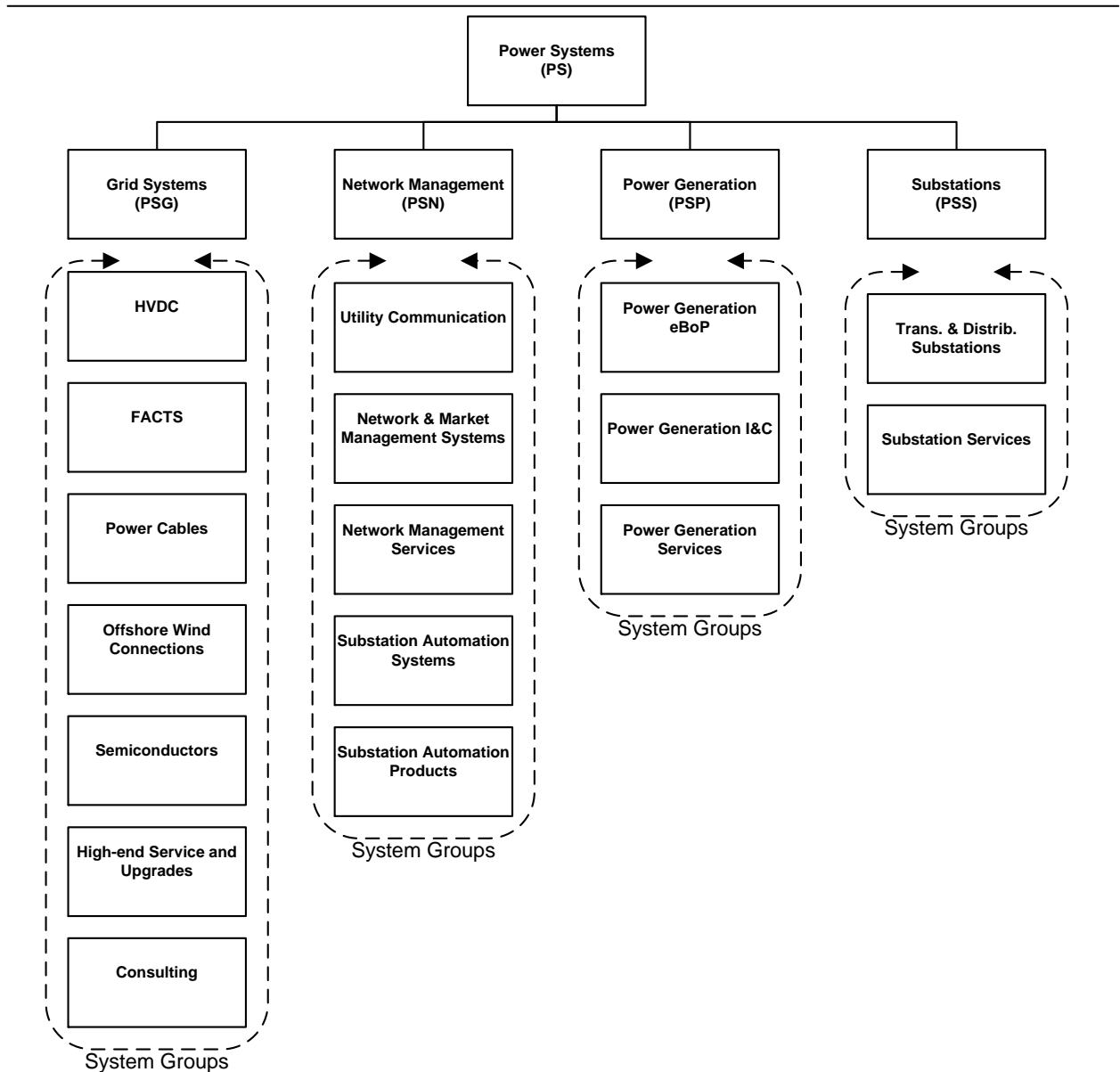


Figure 9. I received the opportunity to make a visit to this center and observe the Realization team conducting their feasibility analysis there. In two days, we interviewed employees as well as management from different working groups, in order to understand the problems that they face in project planning and execution. As this is a quite typical engineering center in the ABB organization, it can be assumed that many other engineering centers around the world face some of the same challenges.



**Figure 9. Division PS organigram**

In HVDC they produce two product lines, both ca. 50%:

- Classic: 300-6400MW, long distance overhead transmission lines or submarine cables
- Light: 50-1200MW, underground and submarine cable power transmission

For the project execution, there are no big differences. Usually two converter stations are built i.e. two plant sites, except when a back-to-back solution with only one plant site. As DC lines take less space than the AC lines, Europe is changing into using more and more DC. In the city areas, especially in the US, underground lines are preferred.

The engineering center HVDC consists of a total of over 700 employees, of which ca. 100 are based in Chennai, India and ca. 480 in Ludvika. The Chennai unit is used as a resource center

---

for completing tasks that are not connected to the work in Ludvika. In China they have another independent unit, and additionally there are units in the countries where construction is in progress. 100 new employees are trained in Ludvika and 30 in India this year.

At the moment they are running 18 customer projects, 3 Research and Development (R&D) projects and 2 upgrades. 24 tenders had been left by August 2010. Until now, they have not paid any penalties, although the projects almost always finish late. This is because the customer is partly to blame, for example, for not delivering the necessary information on time. Other parties, like suppliers, are often also late, giving ABB more time to finish their job. The delay from the ABB side is then no longer considered as serious, as the work “would be late anyway”. As the workload is increasing and some projects are facing heavy problems, it is to assume that penalties will be paid in the coming projects.

A work flow of a typical project is illustrated in Appendix: HVDC Engineering process work flow. It shows the responsibilities of each department and how they are interconnected. In each of the divisions (TS/TV/TK/PD), there is a separate project unit that contains the persons who have the main responsibility for each project (TSP/TVP/TKP/PDP). This person attends to all project meetings, and communicates information concerning new developments or any crucial changes to his own department. Project teams consist of a PM, lead engineer (TL), assigned individuals from each group, controllers etc. The organigram is shown in

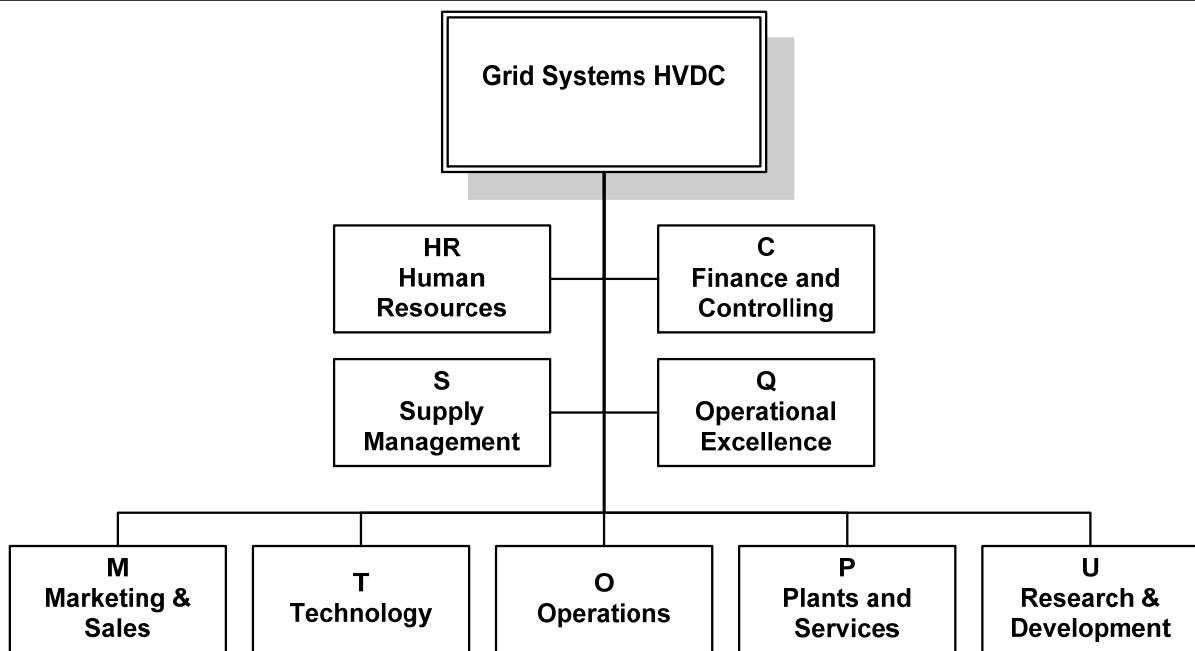


Figure 10.

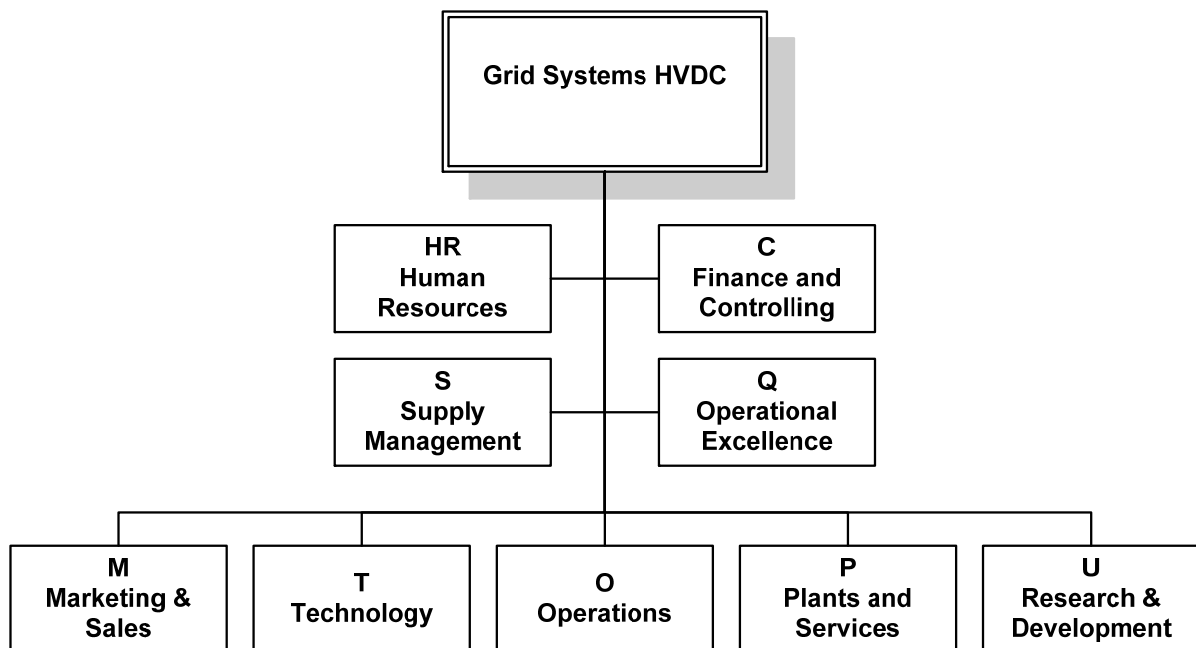
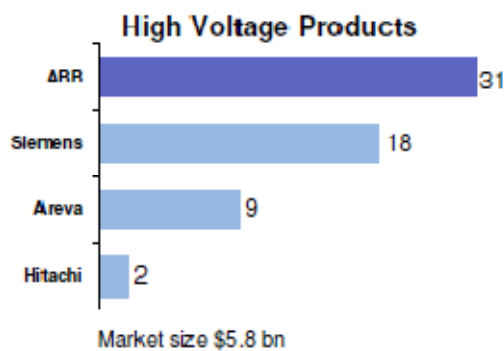


Figure 10. HVDC organization

Since 2006, the market for HVDC lines is growing in the whole world. If they wish to maintain their market share of current 50%, it means they need to double the capacity within 2 years. In 2009 the total market was worth 4 000-5 000 Million USD.



The biggest competitors are Siemens and Areva, as illustrated in Figure 11. ABB is seen as rather expensive, but very committed to its projects and finishes the job well, even when late. The winner of the tendering often has a new technology solution which enables them to deliver cheaper or faster. There are no other big differences as the margins are about the same, 8-15%, throughout the industry. Offshore projects will be increasing but the cable manufacturing capacity is limited, which prevents the market from growing faster.



**Figure 11. ABB Market share in high voltage products in 2005**<sup>15</sup>

For a better overview of their processes and to help incoming employees, HVDC has been using a management system called TOPS to illustrate their processes. The landscape is shown in Figure 12. In their intranet each word leads to a more specific description and the employees can, in this way, get more information about their processes. The employees have found this very useful and are actively using it.

---

<sup>15</sup> Source: ABB/PP

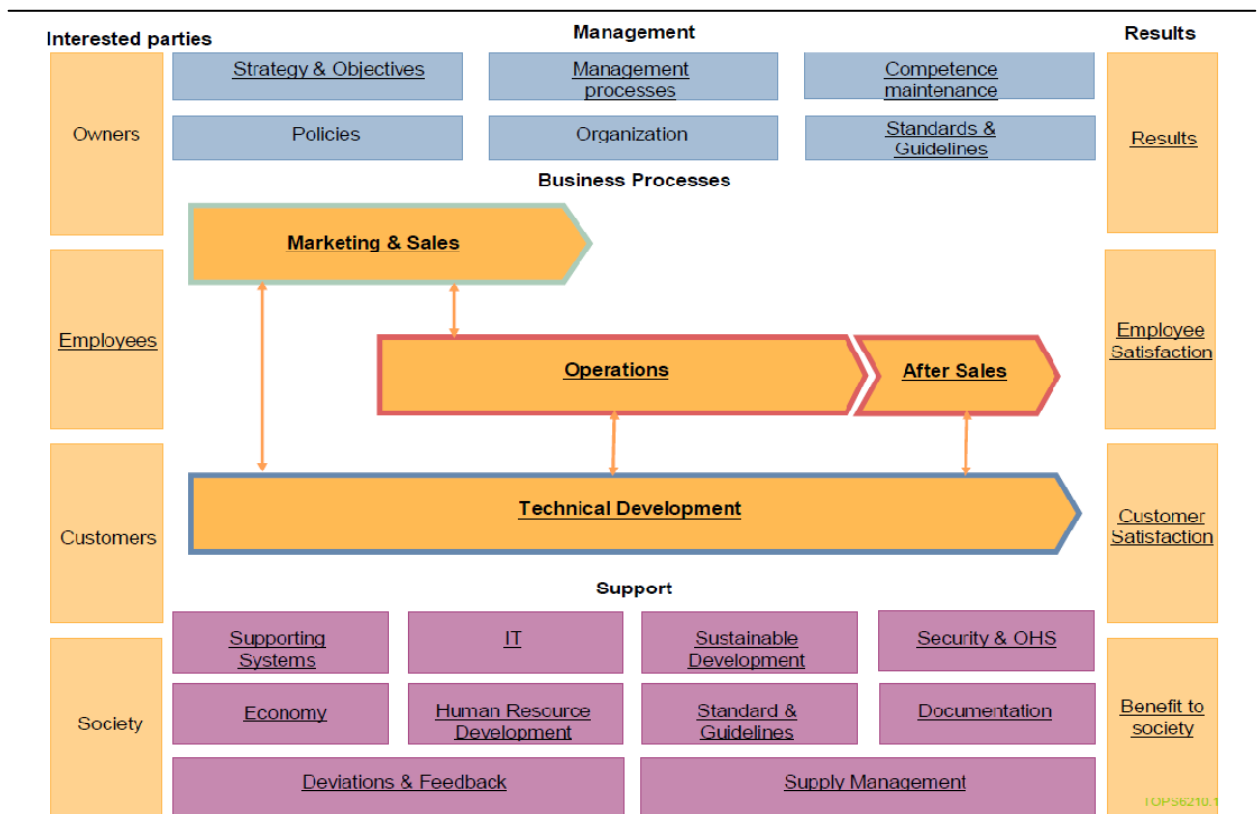


Figure 12. TOPS Management System in Ludvika<sup>16</sup>

There are various problems in the process execution that cause delays. I have here listed some of the points that were mentioned during our interviews.

From the customer side:

- Obtaining network data from the customers is a huge problem. According to the contract, they should deliver them within the first 2 weeks, but in reality this extends to months, or even more than a year. Ideal time for the project execution would be to have the data within the first month.
- Customer specifications are often received late and also at a phase of the development when much of the work must be redone, due to these changes.
- Customer reviews don't come back fast enough. Work is still continued with a high risk of having to change everything again.

Process:

<sup>16</sup> Source: ABB/HVDC Ludvika

- 
- The work on new projects is started almost immediately, even when the required information from the customer has not been received. Plenty of work is done based on assumptions, which sometimes turn out to be wrong and rework must be done. This often influences several units, which need to redo the design etc.
  - Long delivery times of crucial parts, like transformer (12 Months) or bushings (12 Months), hence the orders are done in the very beginning, even with lack of information. Note: Most suppliers are within ABB organization.
  - Senior engineers (TK, TS, PD) cannot commit to their project, because they are needed for many other tasks, such as tendering, to be present at the site, old work from previous projects, meetings, administration etc.
  - The material planning at the site is disorganized and required items, especially small parts, cannot be found, causing a lot of delay. Storage places of the parts are not planned, and the right items might be in the wrong place when needed. Drawings do not comply with the delivered material.
  - Due to the lack of information from the other departments, and originally from the customer, the local construction company is chosen at a very late phase.

#### Others:

- Damage to the parts during transportation
- Weather conditions on the site: monsoon rains, heavy waves on the open sea during the winter
- Work permits, visas. HR is not taking care of it, but the units have to do the administration themselves, causing a lot of time lost for other duties

#### The current software in use are:

- PM tools: mainly Primavera, also some MS Project
- SAP ERP Version 6.0
- Excel based SVP for planning of sales and future resource capacities:
  - gives information how many people from which department are needed, and the line managers then assign the resources to each project
  - Plans 8-10 weeks ahead

- 
- Updated in a meeting between the project managers, planning department and line managers once a week, visible for everyone through a central document library

#### Current development projects or plans

- They have now started to take notes on the time spent for rework and are marking this in deviation orders
- Valve assembly will become more planned
- SVP will be developed more
- Extending the use of Primavera P6
- Training of 150 new engineers in 2011, general increase of capacity
- Looking for other suppliers outside ABB, because of on time delivery problems.

To summarize the situation, in some departments, adding more volume helps to do the work faster. However, the bottlenecks are in departments where senior engineers need extensive experience, and require 5-10 years to be able to take on the responsibility alone. These individuals are needed in so many phases of the execution, like tendering, supervising at the site and work on already delivered projects, that they cannot commit their time to the actual project that they are assigned to.

Due to very uncertain planning, problems arise in the execution phase. A “hockey stick”<sup>17</sup> form of the resource consumption is witnessed in almost every project, and the employees have to work long hours, under heavy stress, during the last phase before each milestone. Most delays are a consequence of the insufficient data from the customer as the work is started based on assumptions. An enormous amount of rework is done to correct this later on. Also, customer specifications are received at very late stages, causing big changes. In the end phase of the project i.e. at site, several site managers and senior engineers are required to guarantee the successful delivery date and hence, are pulled away from their new projects, causing them to delay.

---

<sup>17</sup> A shape of a curve that is relatively flat and then rises rapidly representing, for example, the amount of effort one puts out as deadline approaches.

Tendering is also disturbing the normal work enormously, as some tenders must be returned within the shortest time. In China they might give a working time of only 2 weeks instead of the reasonable 1-2 months. To make a presentable tender, requires in that case, the most experienced people and again, they cannot work for their current project. In the TSD for example, ca. 40% of their time is spent in tendering. All these distractions result in less work done for R&D projects, which are the most important part for guaranteeing competitive solutions.

Possible solutions that could ease the situation:

- Longer time between signing a contract and beginning of work, not starting until network data has been received.
- If the customer requires changes at a late phase, this should be an extra charge from the customer.
- Portfolio management: Not to tender for all projects, but to start selecting more carefully, which to do and if capacity is available. Prioritizing the projects based on portfolio selection.
- Better communication systems; failsafe document sharing to ensure only the up-to-date drawings are worked on, computer based schedule visible for everyone, notification of changes
- Long term career planning for employees, to train them in the shortest time to become “seniors”, delegating as much work as possible for the juniors
- Customers should be present during the testing phase, to learn how to do it. This way they can solve their problems later on themselves. This has already proved to be efficient.
- In the commissioning phase, two teams are needed at site to work in two shifts. Now only one shift is working, because of lack of supervisors. 10 persons from TK and 6 from TS are needed.
- Software for better overview of the resource planning, replacing the Excel-based SVP.



---

### **3.3. *Power Cables Karlskrona, Sweden***

Another possible location for a pilot project would be the high voltage cable factory in Karlskrona in south Sweden. This engineering center is also part of the division PS/Grid Systems as shown in Figure 9. They employ ca. 450 people in Karlskrona and additional 120 in their factory in the US. As one project last 1-4 years, they have the capacity for running ca. 5 big and 5 small projects simultaneously. As they require mostly raw material like copper and other metals, most of the suppliers are outside ABB.

The market demand has been increasing tremendously during the last few years and due to the lack of capacity, ABB has most likely even lost some of its market share. Main reasons for the quick market growth are:

- EU is changing from national power grids to a Europe-wide grid
- Oil and gas companies need electricity from the main land to be transferred offshore
- New (offshore) wind power
- Increasing amount of underground cables, as overhead line permits are no longer granted
- Earlier, ABB was able to sell cables together with the HVDC stations, but now the trend is to buy cables separately.

There are some clear business challenges being faced at the moment:

- Vessels are hard to get. Cables are huge and require special vessels which are often not available.
- Cable must be individually designed, no two are the same
- Sufficient buffers must be planned to guarantee flexibility, resulting in other lost business opportunities
- Due to recent investments, the introduction of new machinery has required extra time. In general, they have doubled their capacity during the last 3 years.
- The winning chances of the bids are very uncertain, and therefore, the resource estimations are very difficult to do without a tool capable of doing what-if simulations.

## ***4. Software Vendors***

There are hundreds of project management tools on the market, all claiming to be the right solution for your company. For single project management, there are two clear market leaders for engineering companies: Microsoft Project and Primavera from Oracle. Primavera has a long experience with the engineering business, and is preferred also in several ABB units, as the tool itself is very powerful and is well suited for the type of projects that we have.

When it comes to project portfolio management (PPM) tools, the typical leaders fail to show sufficient functionalities, or they focus only in the IT branch. The PPM market is constantly growing, and even the smallest companies try to create their own versions. Providing some basic functionality appears to be no challenge for the programmers, but for the use of a company such as ABB, there needs to be a lot more. The tool needs to be comprehensive enough so that its use can be expanded later if wanted and the company behind it must be able to give the needed support and development.

Currently all tools are web-based and practically all companies offer additionally the possibility to do the implementation as SaaS (software as a service) where the tool is hosted from outside the company. Hence this variation requires less resources from the client company, and the implementation runs more smoothly. According to several researchers this gives also a better Return on Investment (RoI), already after five years<sup>18</sup>. Personally, I believe this is also the future trend that will be adopted throughout the business, after some time.

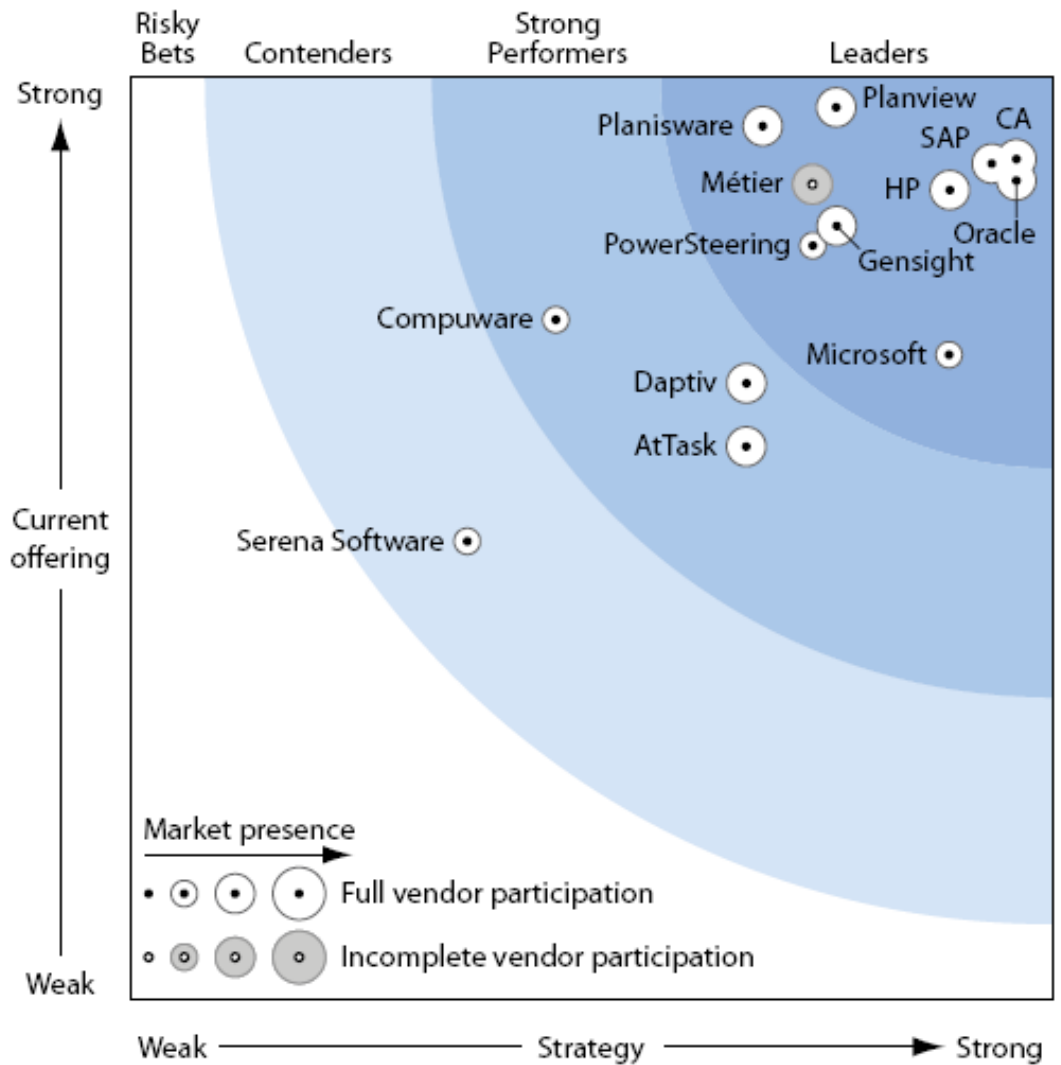
Forrester Research Ltd. is one company that does intensive research in the PPM market and we were able to obtain their 4<sup>th</sup> quarter 2009 publication. As most of the vendors offer a solution clearly for IT projects only, they have divided the vendors into business oriented and IT oriented sectors.

---

<sup>18</sup> Powersteering Webcast 2010; DeGennaro, Visitacion, 2009; Symons, 2009



Figure 13 shows their comparison between business oriented vendors of Q4 2009. We excluded some of the vendors Forrester claimed to be leaders, based on previous bad experience (SAP) or because they are too focused on the IT market (Planview).



**Figure 13. Forrester Research comparison of business oriented PPM vendors<sup>19</sup>**

<sup>19</sup> Source: Forrester Research

Also, the company Gartner provides comparisons done between PPM vendors. However, they concentrate clearly on IT vendors and for this reason their material was used only to see what other vendors there are to consider in the first place. Figure 14 Shows their comparison from June 2010.

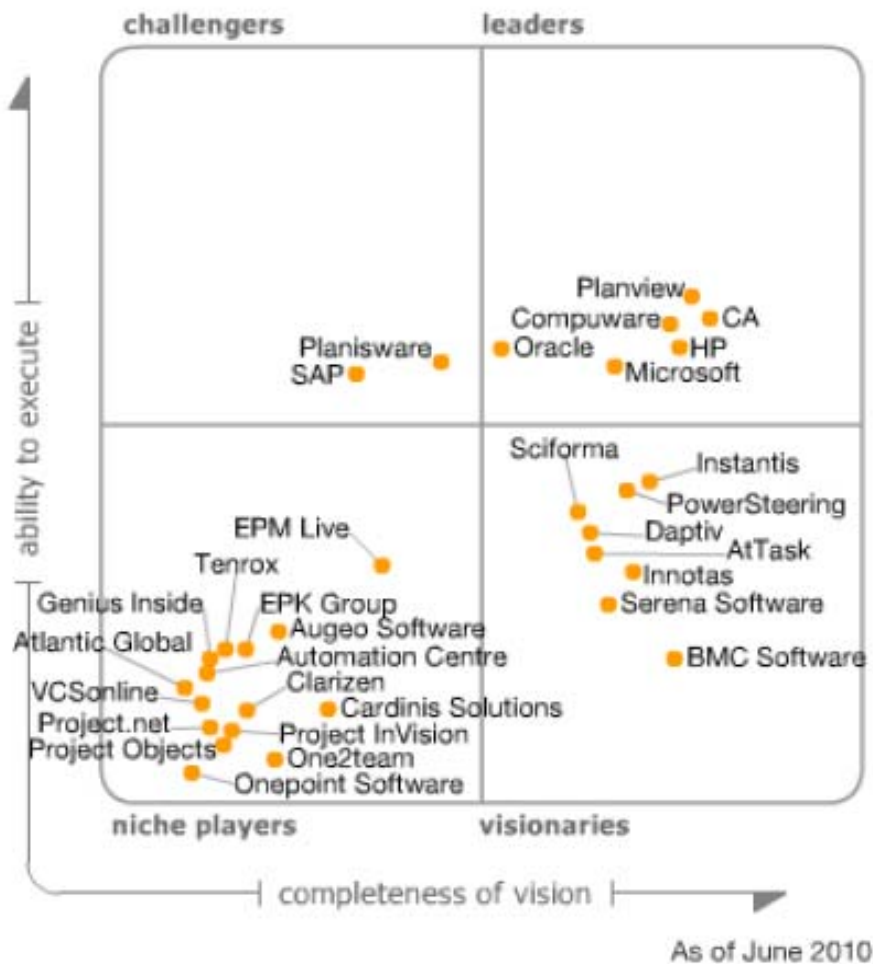


Figure 14. Gartner Magic Quadrant<sup>20</sup>

<sup>20</sup> Source: Gartner Inc.

In the following chapters, I will present the vendors that came into consideration. I am not claiming them to be the Top 5 on the market, rather a mixture of interesting companies that we wanted to explore more closely, such as promising Planisware and Jda. Also vendors that would be obvious solutions, as they are already used within ABB, such as Realization, HP and Primavera were considered. Additionally, I did some research on the following other vendors, but they couldn't convince me that they could provide ABB a proper solution:

- Actano
- CA
- Enrich Consulting
- GenSight
- IBM
- Instantis
- Métier
- Microsoft
- Planview
- PowerSteering
- ProChain
- Safran
- SAP
- Scheuring
- SemanticSpace
- Sopheon
- Txe Solution

We started by collecting different qualities and functionalities that we considered important for us. However, in the course of the evaluations, I noticed, that the differences are not to be found in single functionalities by asking “can you provide this?”, but more in the complete solution as a whole. For example, one may display the same function as all the others, but when you compare the graphs, there are great differences in the readability, accuracy, and all-in-all quality of the displayed information.

In my hope of finding a numerical way of comparing these solutions, I listed the most relevant functionalities and rated them on a scale from 1 (satisfactory) to 3 (ideal). I asked the vendors to answer some questions concerning different functionalities, and used the received answers, information on their homepage, other comparisons and the interviews conducted with the reference companies to make this rating. The screenshots also give a good impression of how the tool works, and verify most of the information. The results are presented in chapter Results.

---

The questionnaire included various questions, some of which I have listed here to give a better idea of the nature of the questionnaire:

- **Dashboard** - Clear, structured overview showing the information that is important for the specific user
- **Highlighting of constraints** - Are the constraints pointed out automatically? How much effort is needed to find them?
- **Resource capacity analysis** - Display of resource capacities and current load factors
- **Resource load differentiation** - Is it possible to differentiate which part of the planned resource load consists of an unconfirmed project i.e. offer?
- **Forecasting of medium-term work load** - To what extent can the resource load be estimated? How early is it possible to reveal bottlenecks?
- **Report customizing** - Is it possible to adjust the report manually?
- **Problem task identification** - Is it possible to identify the tasks which repeatedly violate constraints or cause extra buffer consumption?
- **Material constraints** - Reporting of current and forecasted material constraints
- **Interfaces: MS Project and Primavera** - A dynamic interface to Microsoft Project is a must. Interface to Primavera is also necessary and any additional integration possibilities to, for example Safran, are considered as an advantage.
- **SAP ERP** - The software must be dynamically linked with SAP ERP system that we are using.
- **SAP ERP Human Capital Management** - Can human resources and their skill categories be taken from SAP?
- **Suppliers** - Is it possible to connect workflows with suppliers? Is it possible to see at a glance to which different projects the same supplier is delivering?
- **Early warning system** - How is the user notified when a task is threatening to cause problems? Is there a visual alert on the dashboard or any other notification possibilities?
- **Adjustable criteria for the alerts** - Can the user manually set criteria which defines the moment when a task is considered escalated and requires interference?
- **Earned Value Management** - Is EVM reporting supported by the software?
- **Buffer status or EVM analysis display** - How is the extent of the problem illustrated?

- 
- **Optimizer** - Does the program include an optimizer which automatically suggests corrective measures? How does it prioritize the projects or tasks? Can these assumptions be manually changed?
  - **What-if simulation** - Is it possible to try different scenarios and compare these with the original version? Are the relevant parameters easily comparable?
  - **Differentiating project status** - Can a project be given different statuses such as offer or scheduled? How are these displayed in master plan?
  - **Project definition ASAP/ALAP** - Can a project be defined to start as soon as possible and others as late as possible?
  - **Project parameters** - Are project parameters manually adjustable?
  - **Planning templates** - Can different project planning templates be saved?
  - **Language selection** - Can the program be run in different languages? If yes, which ones? Is National Language Support included?
  - **General flexibility** - To what extent can the layout or start page values be defined for each user or user group? How flexible are the program settings?
  - **Web-based**
  - **Accessibility 24/7/365** - How reliable is the solution? Back-up of necessary data?
  - **Scalability** - To which extent can the performance be guaranteed?
  - **Implementation as a managed service** - Is there an implementation option where the software is managed remotely?
  - **Support and training** - How is the user support and initial training provided?
  - **User groups** - Which different users or access levels exist? Is the information limited only to those who it primarily concerns, or is it visible for other users as well?
  - **History logging** - Is there a possibility to track done changes, and to see who did this and when?

### 4.1. *Planisware*

Planisware 5 (formerly known as OPX2) is an enterprise project portfolio management (EPPM) software solution created for large and mid-size companies. The company Planisware



was incorporated in the USA 1999 with headquarters in San Francisco, California and they have additional offices around the US and in Europe. With a steady annual growth of 30-50%, they have managed to win some big clients, especially in the business oriented sector. In 2009 they had revenue of 24.2 MEUR<sup>21</sup>.

Central characteristics:

- Stage-Gate Ready and SAP certification
- High flexibility and scalability
- Advanced program level what-if simulations
- User friendly with clear visual tools
- One-click up or down load to/from project management or MS office tools
- Easy to use reporting wizard



Quotes from Forrester Research and BARC<sup>22</sup>:

- **Planisware brings a global approach to project portfolio management.** Like many of the leaders, Planisware is a good example of the balanced approach that vendors must take to differentiate themselves in both the business and the IT markets by offering support of global projects and distributed teams. Planisware leverages effective planning capabilities at every level — from strategy and portfolio planning to program and project planning. Planisware's ability to leverage long experience with product development makes it a particularly strong choice with business and product-driven portfolios; however, its ability to build and modify robust methodologies makes it a choice for large IT organizations as well.

---

<sup>21</sup> Planisware Homepage [www.planisware.com](http://www.planisware.com)

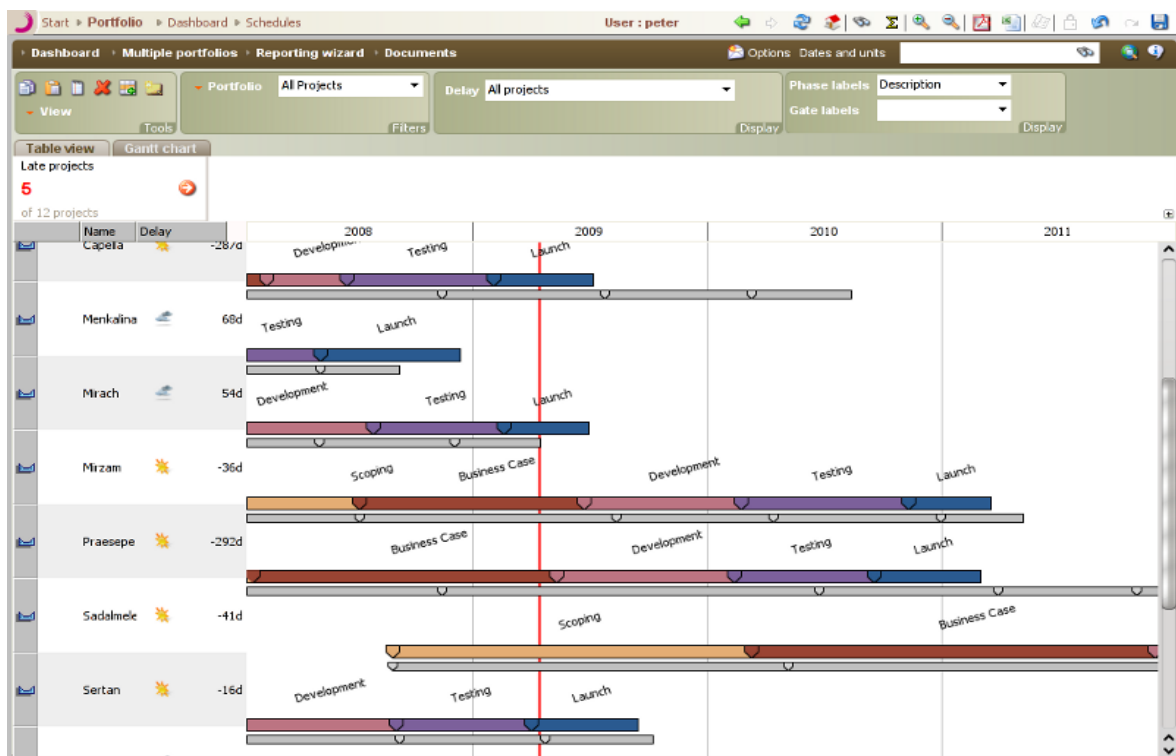
<sup>22</sup> DeGennaro, Visitacion, 2009 and [www.planisware.com](http://www.planisware.com)

**BARC (Business Application Research Center), 2008**

*“ One of Planisware 5’s remarkable strengths is its high configurability. [...] Planisware 5 is a highly flexible and powerful application that is well suited for the management of large sets of projects or programs. It offers a wide spectrum of functionality that can be configured to meet almost any organization’s requirements.”*

**4.1.1. Multi-Project Planning**

One of Planisware’s advantages is that it is developed especially for multi-project needs. Its capabilities exceed those of the competitors, especially in portfolio level. The visual tool and graphics are also clear and easy to interpret as shown in the following figures<sup>23</sup>.



**Figure 15. Reporting wizard with time lines of all running projects**

<sup>23</sup> All figures are either from the questionnaire answer sheet and/or available on [www.planisware.com](http://www.planisware.com)

## 4. Software Vendors

My projects	My opportunities	By status	By Therapeutic Area	By Compound	Templates	Versions	Simulations	Permanent projects	Project Priority List		
Open	▼Name	Description	Stage & gate	Therapeutic Area	Compound	Responsibility	Estimate at completion (EAC)	Planned start	Planned finish	Owner	
Cardiovascular & Metabolic											
	Adhara Macro	Adhara Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Protopium	Neuroscience		52,247 K\$	01/04/10	02/15/19	antoine	
	Alamak Macro	Alamak Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Phenylcoldoxamine	Oncology		50,015 K\$	10/01/12	12/30/22	antoine	
	Alpha Macro	Alpha Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Lithipride	Primary Care		50,015 K\$	09/16/10	07/07/20	antoine	
	Biosynthesis Macro	Biosynthesis Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Phenylcoldoxamine	Oncology		74,858 K\$	10/11/06	12/31/25	antoine	
	Castor Macro	Castor Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Butirone	Primary Care		51,095 K\$	10/01/05	08/14/15	antoine	
	Chi Macro	Chi Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Phenylcoldoxamine	Neuroscience		96,615 K\$	10/11/06	12/18/18	antoine	
	Gianfar Macro	Gianfar Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Skinoxacilin	Primary Care		26,710 K\$	08/01/08	05/29/18	antoine	
	Heka Macro	Heka Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr NA	Neuroscience		26,931 K\$	01/31/08	11/21/17	antoine	
	Maia Macro	Maia Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Caspanib	Oncology		5,778 K\$	12/01/08	08/31/40	antoine	
	Mizar Macro	Mizar Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Glupazone	Oncology		1,333 K\$	01/07/12	12/31/14	antoine	
	Mulphein Macro	Mulphein Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr becodal	Primary Care		50,947 K\$	11/11/08	07/16/41	antoine	
	Themisto Macro	Themisto Macro	◆◆◆◆◆◆◆◆◆◆	Cardiovascular & Mr Antilukast	Primary Care		12,227 K\$	06/02/03	12/31/12	antoine	
Immunology											
	Test Gald Macro	Test Gald	◆◆◆◆◆◆◆◆◆◆	Immunology	Cytorexate	Neuroscience	6,714 K\$	01/01/10	07/22/17	antoine	

Figure 16. Planisware multi-project list view

In Figure 17, the company level resource availability is divided into different project workloads. The resource managers can see the availability and the consumption of their resources by sub-departments or by projects. Resource load can be also differentiated by status of the projects, like offer, unconfirmed etc. For the pending tenders, “dummy projects” can be created, where the probability of winning the project can be estimated and different scenarios compared. When problems arise, the project manager can compare the changes to the approved baselines and can see the impact on other linked projects, as in Figure 18.

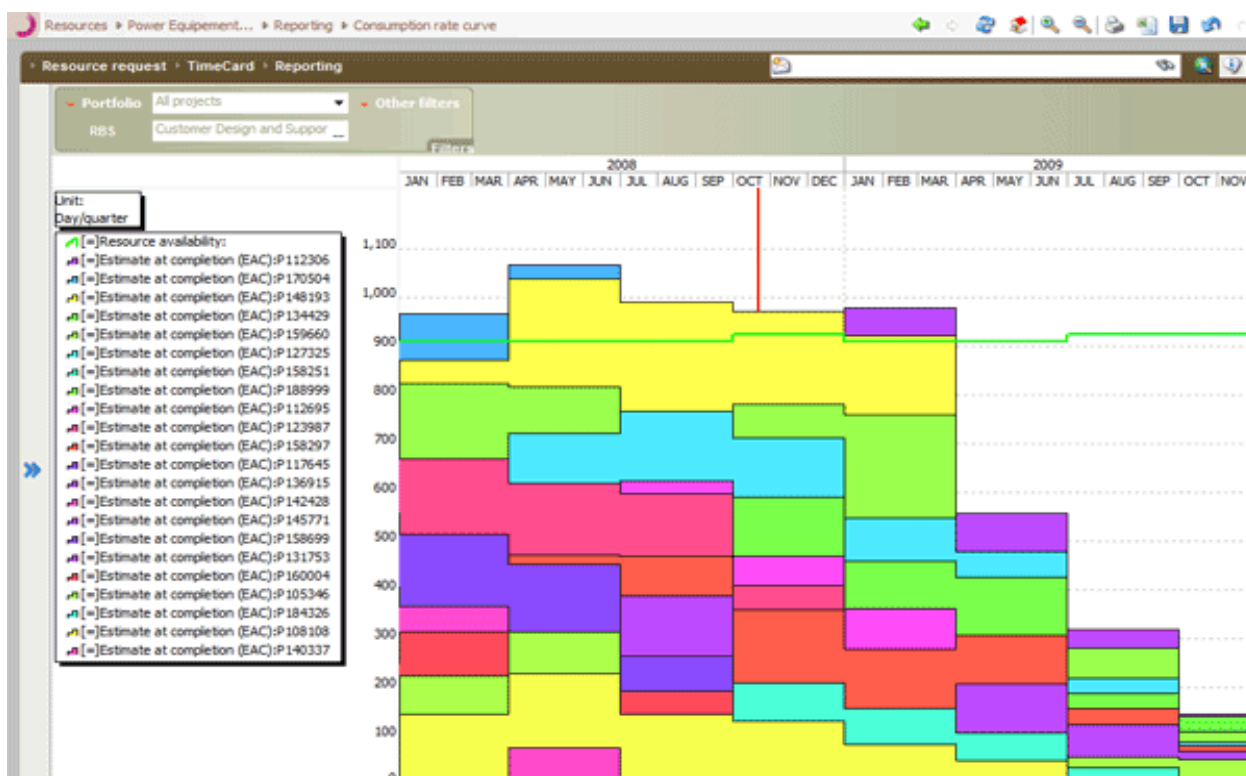
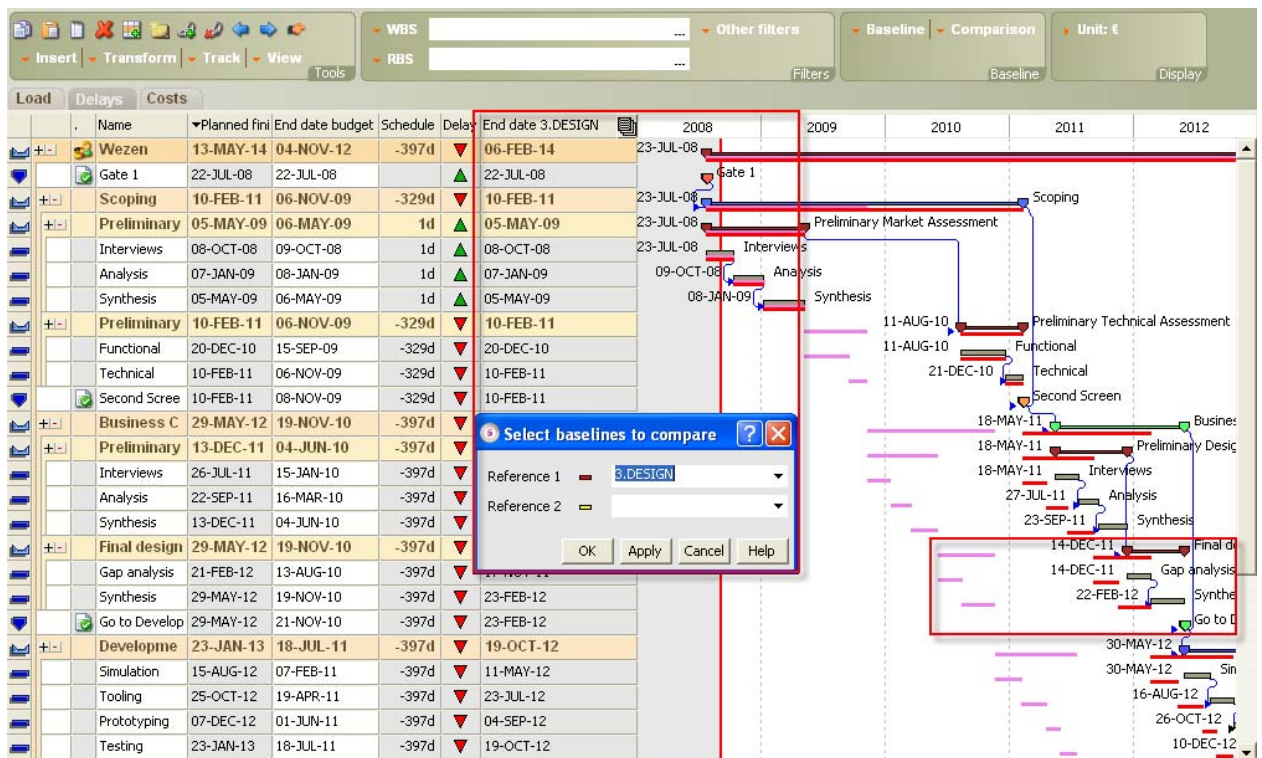


Figure 17. Program level resource estimation divided into all running projects





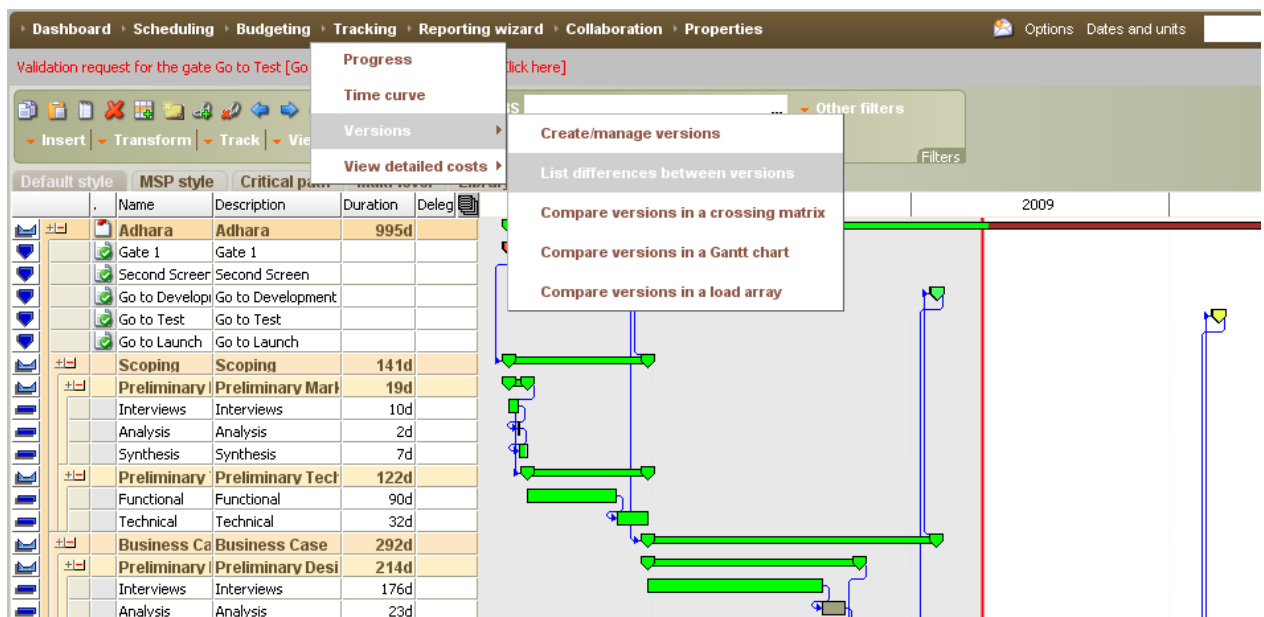
**Figure 18. Planisware Gantt**

Resources are allocated based on a supply and demand model, where the project manager sends a request for specific resources and the resource manager appoints the available persons. Changes done by the resource manager to the allocation doesn't automatically make changes to the project plan, but allows the "supply and demand" to be compared and discrepancies solved.

Resource bottlenecks can be identified as soon as they are entered into the system. Once a department is experiencing resource problems (red highlighting in Figure 20), it is possible to drill down to the specific timeframe and resource department in order to see which projects contribute to the resource overrun, sorted by priority. Projects can be prioritized by giving them accumulated scores, and then resources can be automatically reorganized with a "schedule resources" tool. Resource leveling is possible with priorities set on tasks and resources, but generally not recommended as it leads to pushback of the milestones. Further, the Monte-Carlo estimation module guides portfolio decision processes by taking probabilities (NPV, risks, potential delays, etc.) into account. Whenever constraints, such as budget, time, resource, are violated, this is notified with visual alarms.

What-if simulations in portfolio view are very important for ABB, and Planisware was one of the few tools that I saw accomplishing this in a smart and useful way. Projects can be linked to each other and simulations compared. A copy of the portfolio simulation can be created to be sent to others etc. Stable milestones can be appointed to fix them during simulations.

1. Undo/redo/tree-do features are available for simple what-if scenarios almost anywhere in the application (project/cost/resource/portfolio management).
2. Different project versions are available for simulating alternative strategies at the project single level (outsourcing, accelerating a phase by increasing the resource level) with comparison features. The selected scenario can then be restored as the current project.
3. Portfolio level: A copy of a portfolio and the contributing resource departments can be created in a separate portfolio simulation, used as a sandbox. Projects can be delayed, killed, outsourced etc. or the resource availability can be simulated without impacting on the real data.



**Figure 19. Planisware project simulations**

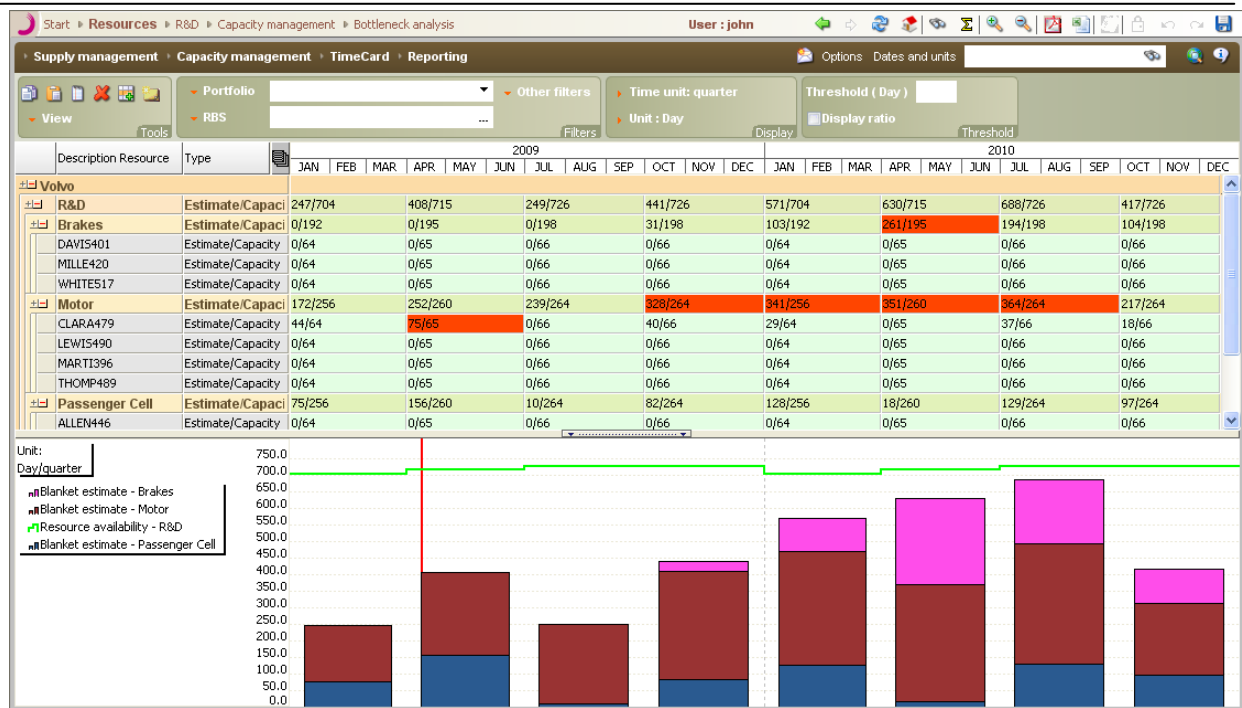


Figure 20. Planisware resource constraints

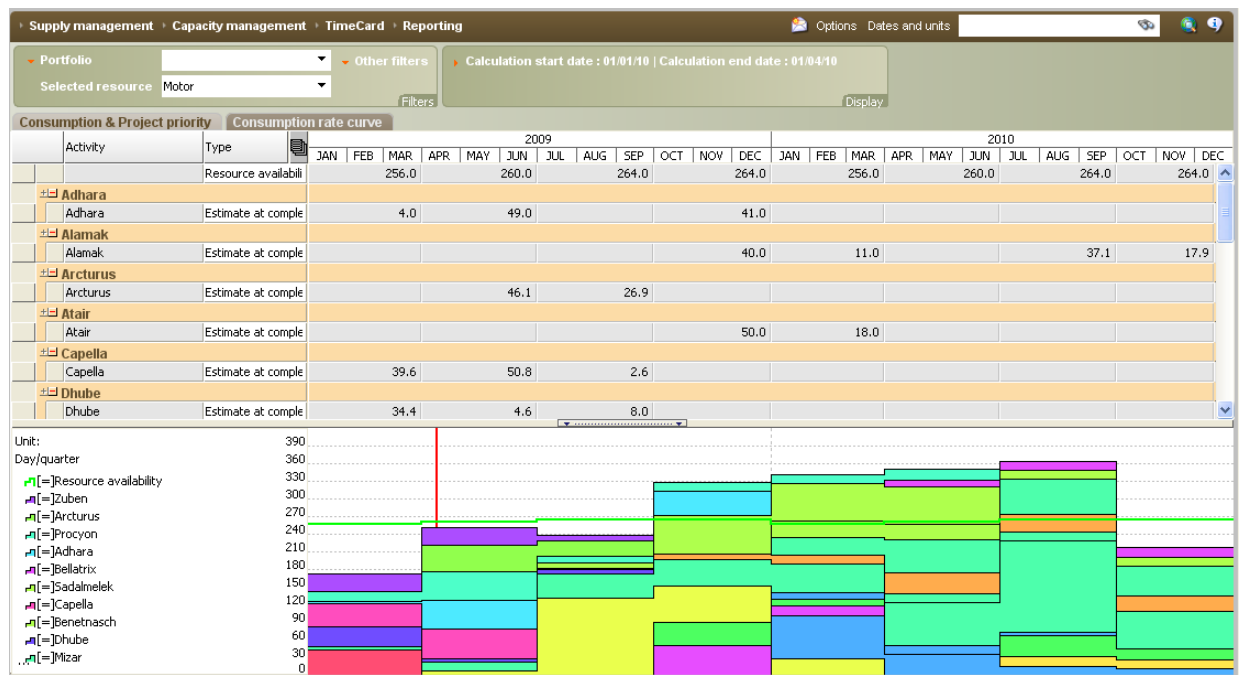


Figure 21. Planisware resource distribution

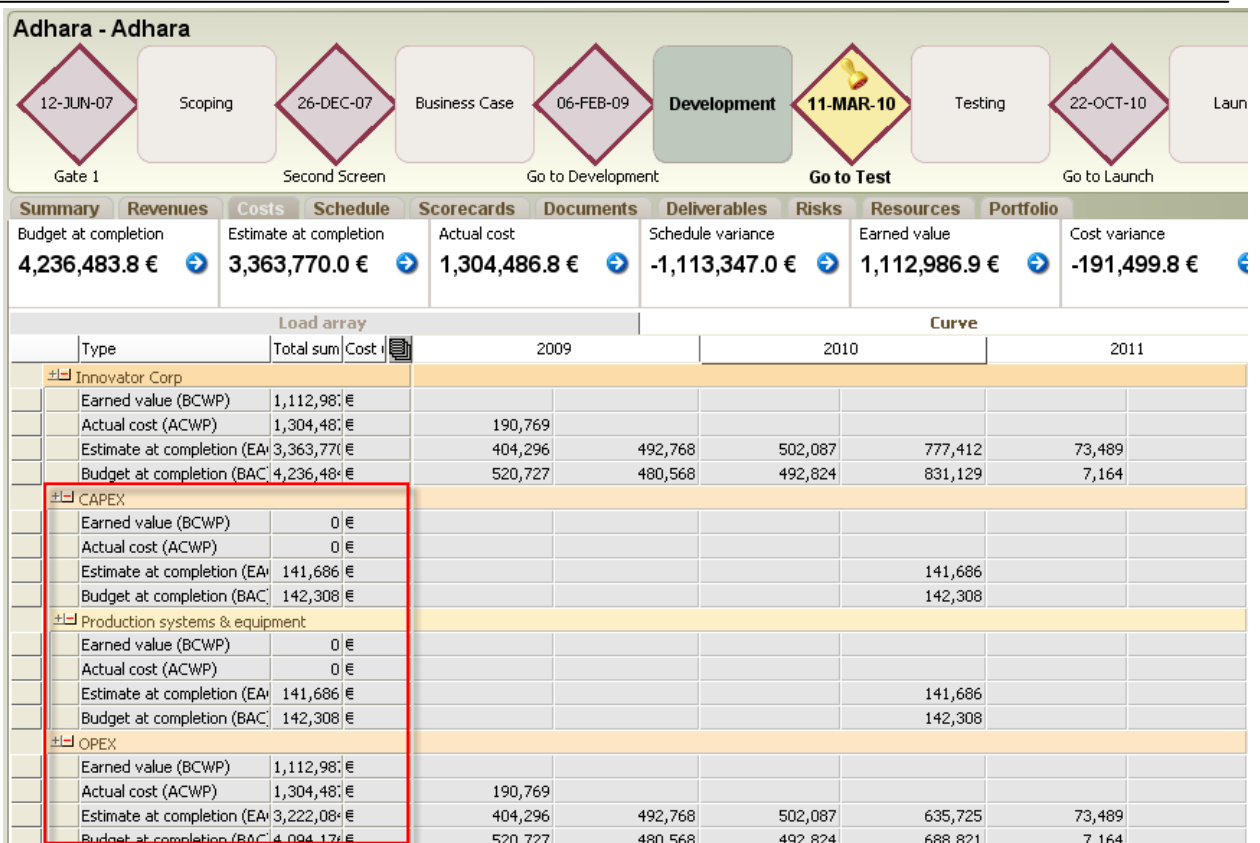


Figure 22. Planisware budget figures, KPI's and Stage Gate display

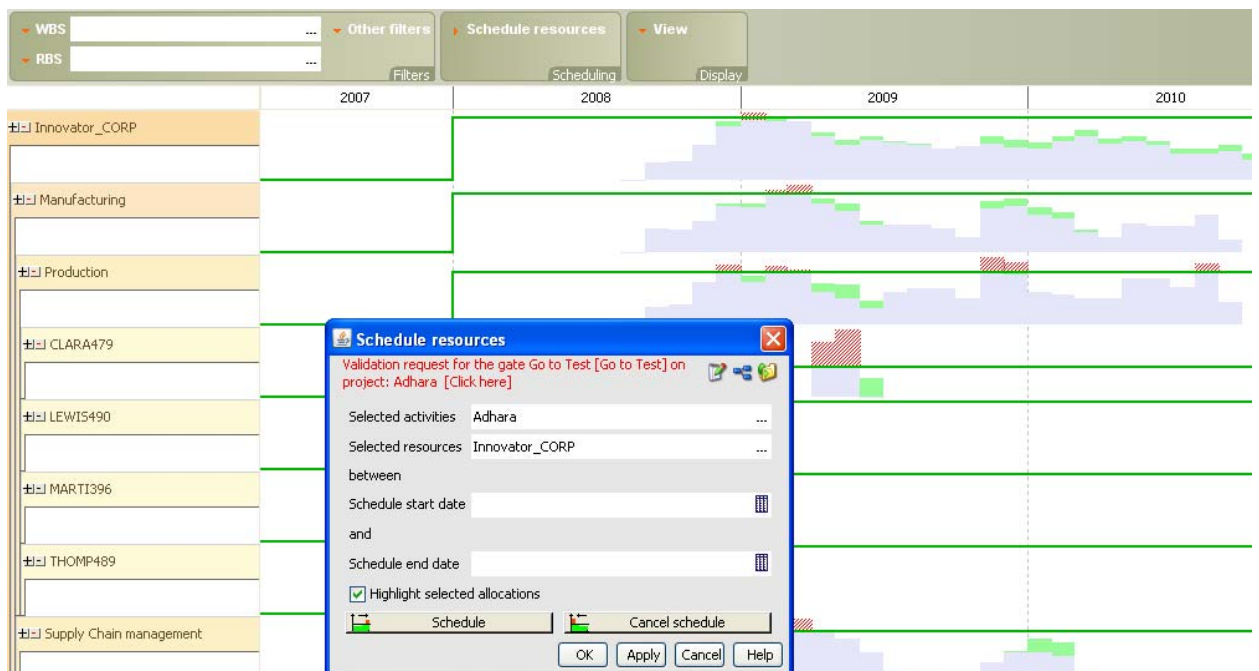


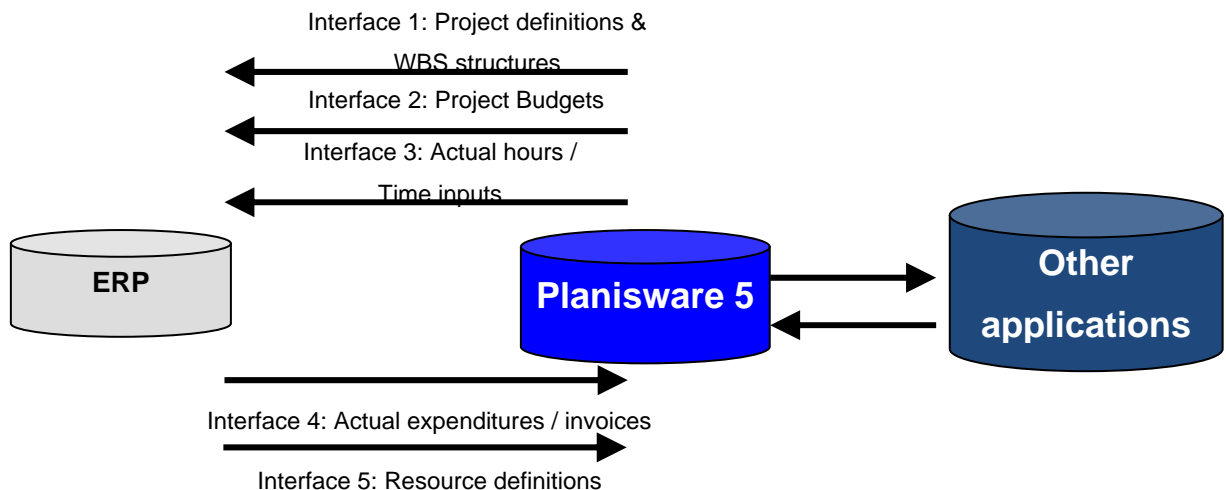
Figure 23. Planisware resource leveling

### 4.1.2. Interfaces

Planisware provides interfaces with Microsoft Project and Primavera P6 through XML format. With a single click, it is possible to up/download the newest plan to MS Project. The same possibility can be configured for Primavera as well.

Planisware is also SAP-certified, and can provide interfaces to any SAP module. “Generally speaking, Planisware is an open product with flexible interfacing capabilities, whether real time interfaces (SOAP/Web services) or flat file by batch.”<sup>24</sup>

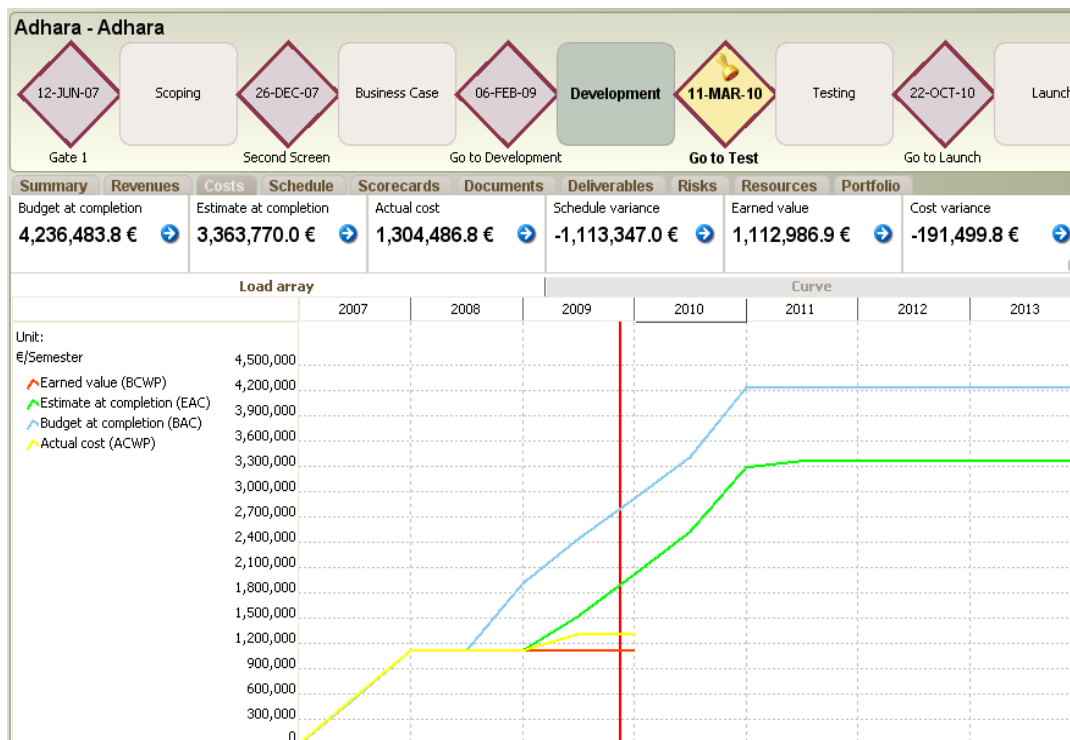
**SAP® Certified**  
Integration with SAP Applications



**Figure 24.** An example of the information exchange to SAP

<sup>24</sup> Planisware questionnaire answers

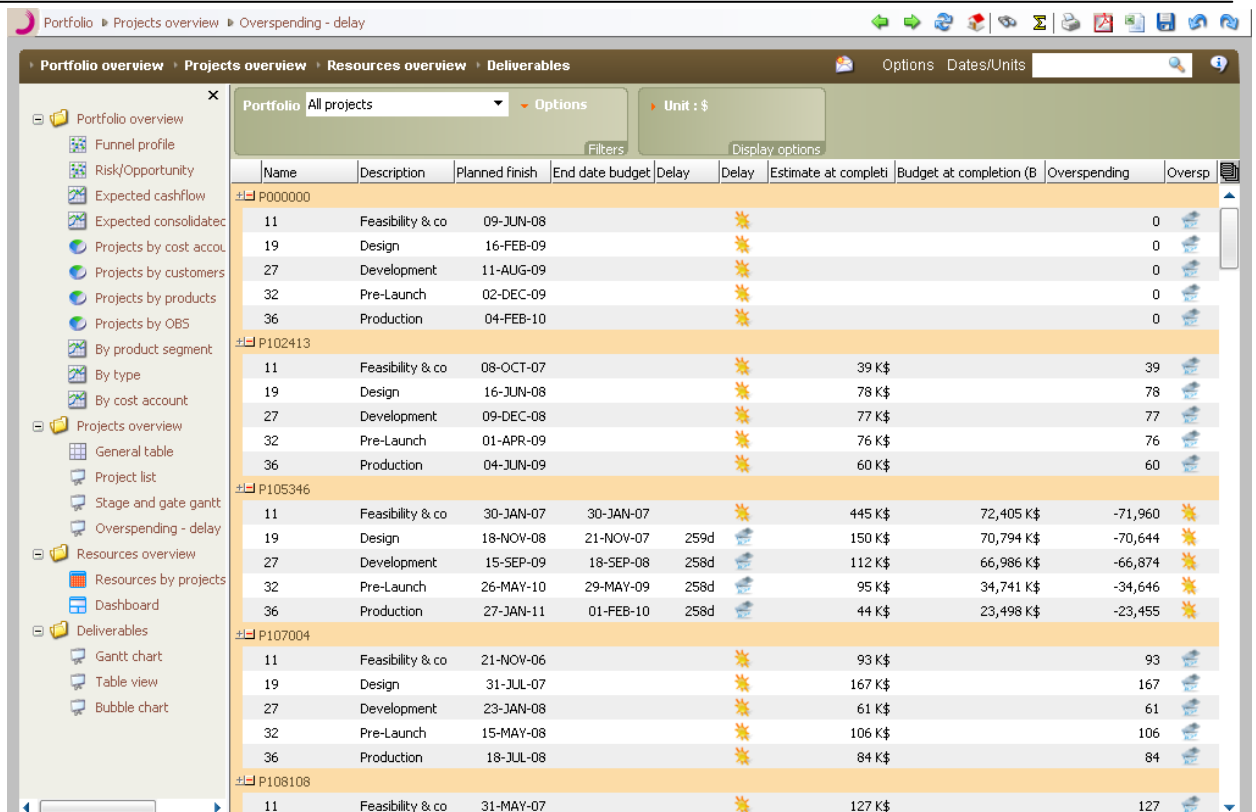
### 4.1.3. Controlling



**Figure 25. Planisware EVM, KPI's and Stage-Gate display**

Planisware does not support critical chain or buffer consumption. According to their representative, they did an implementation with multi-project critical chain for a company requesting it, but in use, it was too unclear and they do not believe that critical chain can work efficiently in a multi-project environment. Instead they use EVM and S-curves for controlling.

Figure 26 shows how the project managers and team members are warned with smileys, indicators, highlights, warnings, to directly focus on the cause of slippage or overspending of a task or a project.



**Figure 26. Planisware overspending/delay display**

#### 4.1.4. Settings

Dashboard can be adjusted to show exactly the information the user prefers. It usually contains Stage-Gate status and some KPI's. In general, it is user friendly, easy to configure, and very flexible.

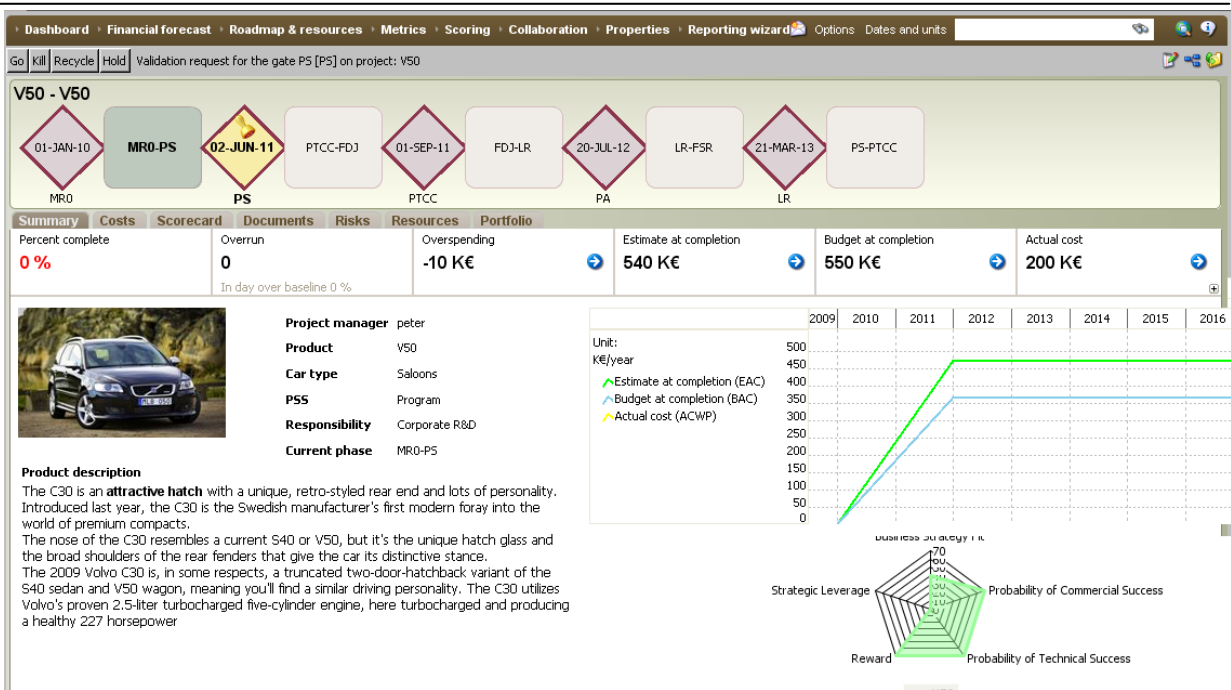


Figure 27. Planisware dashboard

Reporting is available through a reporting wizard. This Business Intelligence tool, integrated into Planisware, makes it easy for the user to manually build any type of reporting as described below, including drill down capabilities and the ability to save the report that is generated.



Figure 28. Planisware reporting wizard

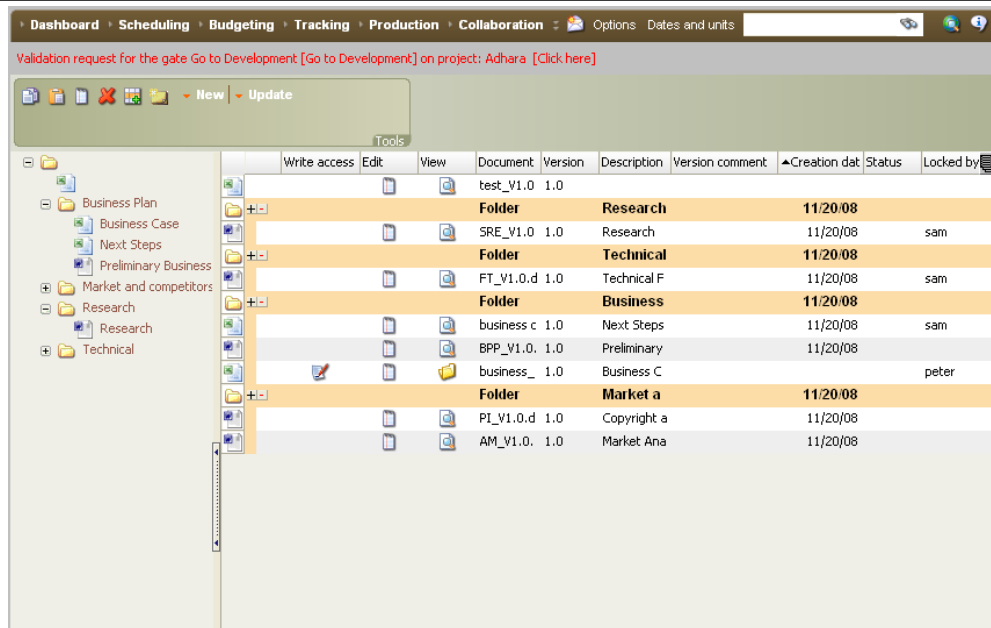


---

**4.1.5. Miscellaneous**

Information provided by the vendor:

- Language selection: English, French, German, Italian, Dutch, Spanish, Korean, Japanese. National Language Support is not included.
- General flexibility: The tool is very flexible and configurable. Report layout, colors, data model, additional fields, formulas, workflows, graphics (Gantt/pie, radar, bar, matrix charts...) as well as default values/program settings that can be changed individually.
- Accessibility: The application server need to restart every night in order to let the batches (time tracking integration if relevant for instance) to be run.
- Scalability: Planisware have customers running the system with more than 1 million activities. Some customers have more than 10 000 people connecting to the system. There is no software limitation in the number of clusters to be extended except the hardware limitation of the server. For big systems (more than 3000 users), JMeter testing is recommended to validate the specific configuration in terms of performance.
  - Planisware has had over 250 installations totaling 200,000+ users
  - Planisware technology is designed to serve a population of users of 100 to 10,000+ users
- User groups: Built-in. Specific rights can be tuned at the portfolio/project/activity/risk/document/object level. Standard read-write/read-only/no read access is provided.



**Figure 29. Project documentation**

#### **4.1.6. Customer Reference: Schaeffler Technologies / INA**

“The Schaeffler Group's INA brand stands for the development and manufacture of rolling bearings, plain bearings and linear systems as well as precision components for the automotive industry for engines, transmissions and powertrains worldwide. For 60 years, INA brand products have stood for creative application solutions as well as top engineering and production expertise to the company's customers.”<sup>25</sup> We had a discussion with the INA chief of central project management Mr. Meyer.

- 66 000 employees, 180 sites globally
- 2007 turnover: 8,9 billion €
- 3.500 employees in R&D in 30 labs
- Located in Herzogenaurach in Germany

Schaeffler Group/INA started with the implementation of Planisware 5 in May 2008 as they needed a tool for a better resource management for their multi-project environment. The decision to go for Planisware was clear as it was the strongest candidate, especially in resource planning. The pilot project went live in January 2009.

<sup>25</sup> Schaeffler Group Homepage [www.ina.com](http://www.ina.com)

Before, the implementation project managers were using mainly MS project or Excel sheets, and, as the Planisware includes the same capabilities, the goal is to have all project planning done only in Planisware. This means that all new project data had to be gradually inserted into Planisware, which proved to be quite an organizational challenge. They have an average project duration of 1,5 years. The change has also caused a lot of problems in the project management part, as the users needed to adjust to the new working culture. People seemed to have very different opinions on how they should work in the environment, and this needed to be clarified and standardized.

As they try to eliminate other project management tools, they have no need for the import/export function between Planisware and MS Project/Primavera. To SAP, they have an interface which delivers the budgeted and actual costs. The data is transferred always once at the end of the month. Most of the planning is done in Planisware, and only the essential parts somewhere else.

At the moment, ca. 80% of the business units and their department managers in Germany are using Planisware; the aim being to have it first completely implemented throughout Germany, and later to other global business units as well. The number of users is currently 1500-2000, of which 30-50% are project managers. The financial benefits of the tool cannot be calculated at this point, as it will take some more time before the tool is working in all business units and can be efficiently used for planning also in that level.

Implementation was aiming at

- optimizing quality of operational project management processes
- creating an accurate and integrated dataset for portfolio management
- achieving a significant simplification of management processes
- defining reports to optimize portfolio management and resource allocation
- ameliorating the quality of data to control portfolio and capacity
- guaranteeing auditing acceptability
- integrating the solution into SAP

Current construction sites:

- activation of development expenses / IFRS standard
- SAP interface enlargements
- annual budgeting process to be implemented as a workflow
- system's enlargements for additional project types: IT and organizational

Planisware was able to name also several other customers using their software for business oriented projects as shown in Figure 30.

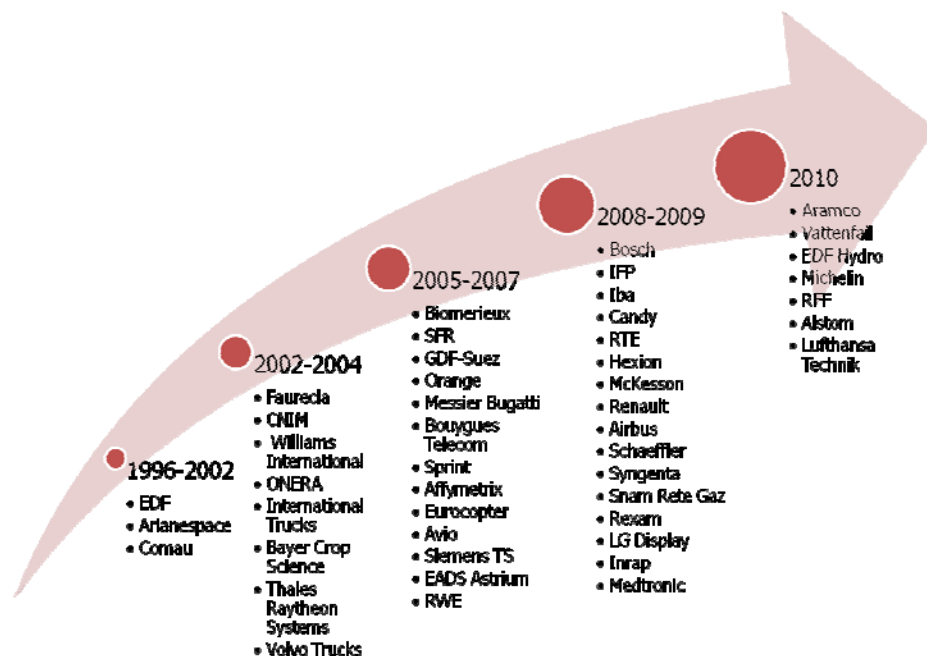


Figure 30. Industry customers of Planisware outside IT<sup>26</sup>

<sup>26</sup> Power Point presentation by Mennesson

Based on the presented information, different categories were rated. The scores are shown in Table 1.

<b>Planisware</b>	<b>Score</b>
<b>Multi-Project Planning</b>	
What-if multi simulation	3
Optimizer	1
Resource allocation	3
<b>Interfaces</b>	
MS Project + Primavera	3
SAP closed-loop	3
<b>Controlling</b>	
EVM or buffer status	2
Adjustable alerts	2
Constraint identification	2
<b>Settings</b>	
Individual dashboard, flexibility	3
Report wizard/templates	3
Single Project settings	2
Communication between users	3
<b>Miscellaneous</b>	
Language selection	2
Accessibility	1
Scalability	3

**Table 1. Planisware ratings**

#### 4.2. Oracle/Primavera



Oracle is a software giant best known for their database management systems. It was founded in 1977 and has, with over 100 000 employees, its headquarters in Redwood Shores, California. “The company is the world’s leading supplier of information management software and the world’s second largest independent software company”<sup>27</sup>. In October 2008 they acquired the application Primavera Software Inc. which was the leading provider of project portfolio management solutions for project-intensive industries.

Primavera is well known also within ABB and is one of the best project management tools used, since it is clearly designed for comprehensive and complex projects that are typical for ABB. In November 2010 they released a new version, Primavera P6 v. 8 Enterprise Project Portfolio Management (EPPM) that shows a lot of improvements. The changes seem to be exactly what we were hoping for, but as there are no user experiences or live demos available, most of the information, partially also the rating, is based on the older versions.

Central characteristics:

- Comprehensive tool from a company with a long experience in project management
- Provides all standard functionalities, but not much more
- Program level views and multiple possibilities in reporting
- Fails in providing a true dynamic interface to SAP
- Robust, always available and highly scalable

---

<sup>27</sup> Oracle Homepage [www.oracle.com](http://www.oracle.com)

Forrester Research<sup>28</sup>:

- **Oracle's full menu of solutions appeals to mature organizations that want one-stop shopping.** With the acquisition of Primavera in 2008, Oracle strengthened its ability to meet the needs of mature, project-focused organizations. Now that Primavera is part of the Oracle stack, organizations that need end-to-end life-cycle planning will find much to fit their needs. While the vendor has made real efforts in making the tool easier and more accessible, Oracle still is best suited to business-driven projects with extensive planning requirements.

#### 4.2.1. Multi-Project Planning

What-if simulations on single project level are naturally available, and an automated "reflection" capability allows the changes to be integrated to the master schedule. Critical activities are displayed on a project defined dashboard. Additionally, a user can insert a flag on a problematic activity that may become critical. It is also possible to leverage the Primavera Risk Management capability to perform an automated Monte Carlo analysis, which shows all activities that may have an unexpected impact on the project. An activity may have primary or secondary constraints of any type, and these can be individually applied to a project.

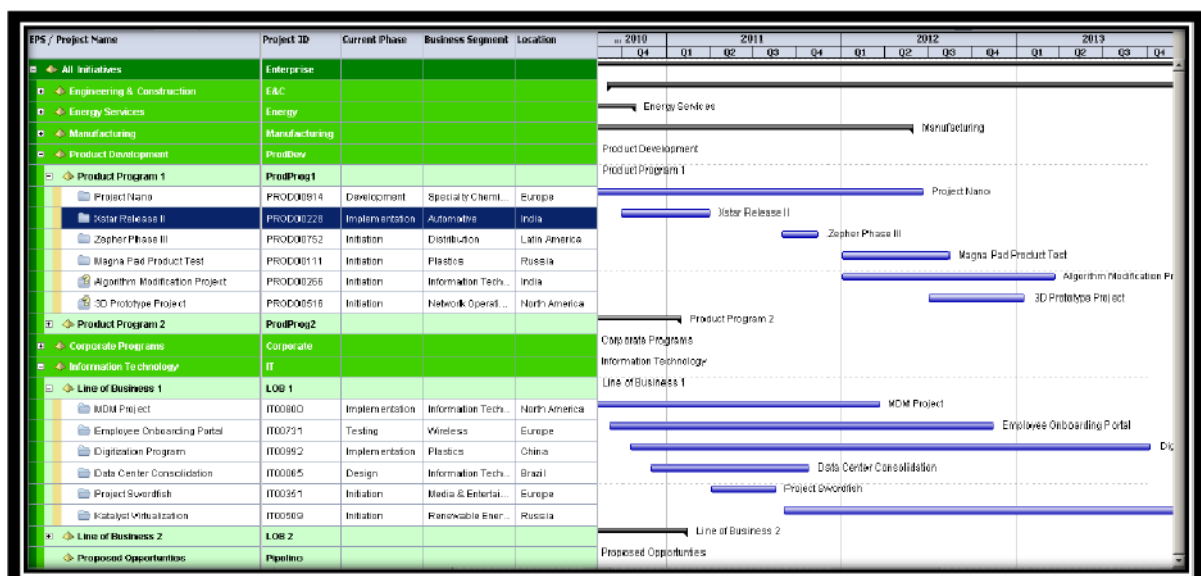
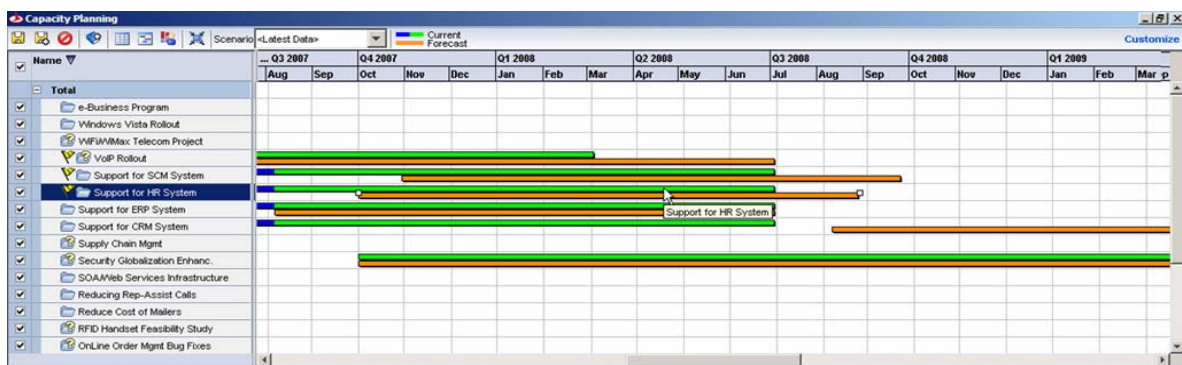


Figure 31. Primavera project portfolio level Gantt<sup>29</sup>

<sup>28</sup> DeGennaro, Visitacion, 2009

<sup>29</sup> All figures of Chapter 4.2. are from the questionnaire answer sheet provided by Oracle

Resources can be scheduled top-down and what-if simulations can be done in the master plan. Scenario comparison can be created in Gantt layout, as in Figure 31. “Use the Analysis tab to evaluate resource usage and costs in customizable histogram, stacked histogram, area chart, and pie chart formats. You can examine total units or costs for an individual resource, or summary values for all resources belonging to a resource team or code. The data displayed in this tab is also available as a portlet you can display in a dashboard.”<sup>30</sup>

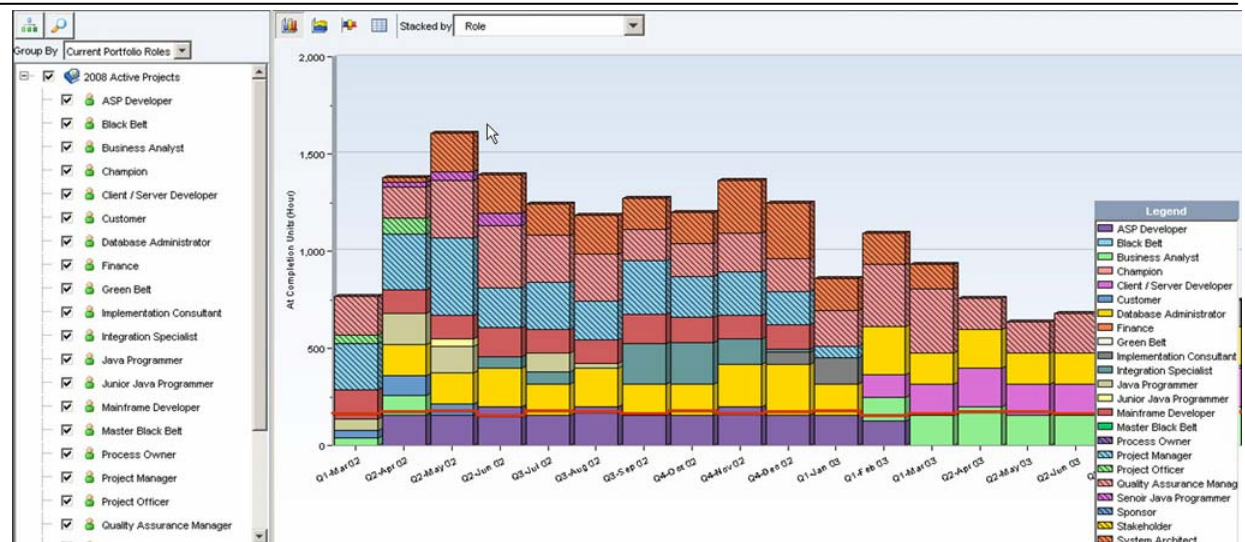


**Figure 32.** Primavera capacity planning

Resources are grouped into roles and organized in a hierarchy, for easier management. The set of roles for an activity defines the tasks skill requirements. Roles are project personnel job titles or skills, such as mechanical engineer, inspector, or carpenter. They represent a type of resource with a certain level of proficiency, rather than a specific individual. “You can temporarily assign roles during the offer stages of the project to see how certain resources affect the schedule. Once you confirm your plans, you can replace the roles with resources that fulfill the role skill levels.” (15)

<sup>30</sup> Primavera questionnaire answers





**Figure 33.** Primavera resource distribution between projects and planned offers

#### 4.2.2. Interfaces

A Primavera plug-in product called ProjectLink enables the project manager to work in MS Project while being connected to P6. They may open or save files to/from P6 and also manage their allocated resources in MS Project. P6 users have only limited editing possibilities in MS Project, but they can export new projects for the project manager to edit.

SAP is Oracle's biggest competitor as an ERP provider. Knowing that many of the potential customers are using SAP ERP, they have tried to develop a working interface between P6 and SAP with a product called "Inspire for SAP". This allows all necessary information, including HR, to be imported to P6.

## Typical integration flows with Finance Systems

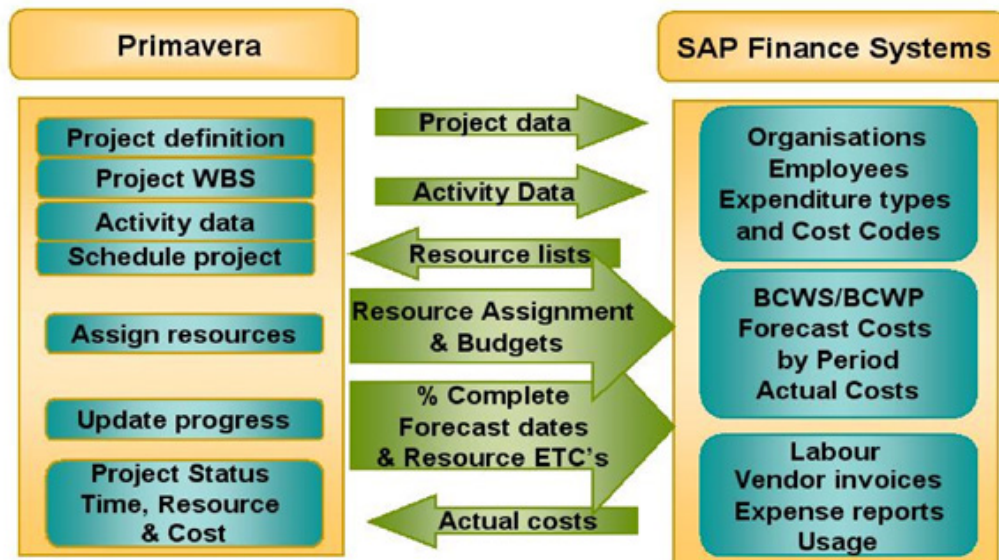


Figure 34. Primavera/SAP information flow

### 4.2.3. Controlling

EVM curves and metrics are displayed on the dashboard (provided out of the box). The metrics can also be rolled up to the project level and drilled down on to discover the root cause. Schedule overrun is illustrated with traffic light warning signals (Figure 35: green, amber, red).

Schedule check project information					
Project ID	Project Description	Data Date	Total Activities	Complete Activities	Total Links
E000630	Saratoga Senior Community	01-Jun-11 12:00 AM	132	0	216
Linked Closed Projects					
Schedule Check Summary					
Check	Description	Target	Actual	Found	Total
Logic	Activities missing predecessors or successors	< 5%	4%	5	131
Negative Lags	Relationships with a lag duration of less than 0	< 1%	11%	24	216
Positive Lags	Relationships with a positive lag duration	< 5%	10%	20	216
Long Lags	Relationships with a lag duration greater than 352 hours	< 5%	0%	1	216
Relationship Types	The majority of relationships should be Finish to Start	> 90%	84%	182	216
Hard Constraints	Constraints that prevent activities being moved	< 1%	0%	0	131
Soft Constraints	Constraints that do not prevent activities being moved	< 5%	5%	6	131
Large Float	Activities with total float greater than 352 hours	< 1%	74%	97	131
Negative Float	Activities with a total float less than 0	< 1%	0%	0	131
Large Durations	Activities that have a remaining duration greater than 352 hours	< 5%	47%	55	117
Invalid Progress Dates (before the data date)	Activities with forecast dates before the data date	< 1%	0%	0	131
Invalid Progress Dates (after the data date)	Activities with actual dates after the data date	< 1%	0%	0	131
Resource / Cost	Activities that do not have an expense or a resource assigned	< 1%	0%	0	117
Late Activities	Activities scheduled to finish later than the project baseline	< 5%	07%	113	117
BEI	Baseline Execution Index	> 0.95	1	-	-

**Figure 35. Primavera schedule checking**

P6 enables you to distinguish resources between labor, material, and non-labor resources. Labor and non-labor resources are always time-based, and material resources, such as consumable items, use a unit of measure you can specify. Figure 36 illustrates the labor costs.

Resource	Role	Project ID	Activity Name	At Completion Cost	At Completion Units	Q2 2011	Q3 2011	Q4 2011	Q1 2012	Q2 2012	Q3
<b>Australia</b>				\$651,007.50	6,972				\$117,405.00	\$308,046.00	\$215,006.07
<b>Brazil</b>				\$960,002.00	9,600					\$146,333.33	\$164,446.09
<b>China</b>				\$376,426.88	4,226	\$145,571.37	\$107,590.00				
<b>Europe</b>				\$1120,596.72	12,451	\$195,419.26	\$166,451.95	\$145,783.63	\$143,482.90	\$38,131.71	
<b>Engineer</b>				\$144,537.25	1,606	\$7.07	\$45,170.01	\$47,520.21	\$43,494.08		
<b>Lead Engineer</b>				\$48,227.67	402	\$76.03	\$35,423.74				
Alice Wynn	Lead Engineer	PROD00914	Analyze New Product	\$8,803.93	82	\$76.03					
Alice Wynn	Lead Engineer	PROD00914	Design New Product	\$38,423.74	320	\$35,423.74					
<b>Lean Six Sigma Specialist</b>				\$66,239.03	882	\$319.94	\$5,871.31	\$0.00	\$1,506.15	\$8,506.63	
<b>Market Manager</b>				\$177,834.86	1,976	\$104.46	\$8,357.21	\$14,179.50	\$43,230.00	\$30,630.71	
<b>Product Analyst</b>				\$161,828.25	2,022	\$26.33	\$32,562.52	\$31,690.14	\$28,996.05	\$4,070.71	\$18,151.63
<b>Product Designer</b>				\$37,528.74	900		\$31,667.45	\$2,071.01			
<b>Product Manager</b>				\$171,489.16	1,885	\$79.93	\$23,518.26	\$27,436.95	\$15,310.18	\$23,442.66	
<b>Product Project Manager</b>				\$27,632.12	272	\$14.13	\$18,498.98	\$11.00	\$1,859.99	\$21,420.14	\$10,216.94
<b>Product Tester</b>				\$79,487.24	984			\$29,714.72	\$38,661.40	\$2,036.86	\$9,076.76
<b>Sales</b>				\$146,886.35	1,536	\$95.52	\$564.04	\$0.00	\$3,489.64	\$45,926.84	\$21,554.94
Peg Ithan	Sales	PROD00914	Commercialize New Product	\$43,891.52	465				\$3,489.64	\$40,491.88	
Peg Ithan	Sales	PROD00914	Define Business Case	\$36,932.56	378	\$95.52	\$264.00				
Peg Ithan	Sales	PROD00914	Evaluate New Product	\$26,888.91	278					\$4,633.97	\$21,554.94
Peg Ithan	Sales	PROD00914	Scope New Product Idea	\$39,583.37	411						
<b>India</b>				\$1073,611.42	11,022	\$2.07	\$0.00	\$0.00	\$0.00	\$15,216.36	\$171,298.73
<b>Latin America</b>				\$129,595.36	1,456			\$65,341.01	\$73,214.34		

Figure 36. Primavera labor costs by location

#### 4.2.4. Settings

The dashboard provides the standard information as illustrated in Figure 37. The information is controlled by module access and security settings, administrator configuration and user interface view settings, your assignments to activities, filtering criteria, and the customized content and the selected layout. This dashboard can be configured either centrally, or by the individual user if they have the correct security permissions

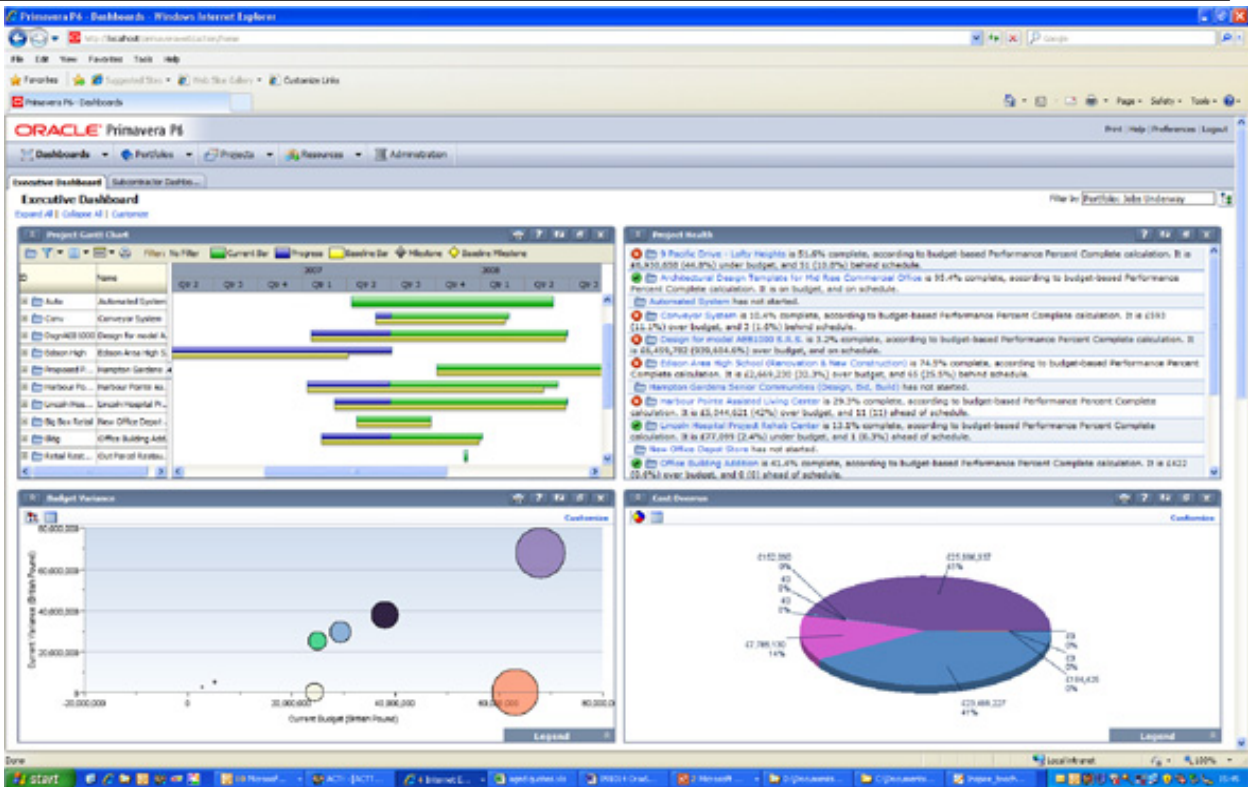


Figure 37. Primavera executive dashboard

In general, stored data can always be reported with a report wizard or a report editor that allow customized reporting. The new version 8 provides Business Intelligent Publisher for authoring, managing and delivering all reports. “The Capacity Planning page of Portfolios enables you to analyze role allocation and cost over time for a project group. Multiple chart formats display role allocation for the projects and roles you select, enabling you to quickly identify areas of under- or over-allocation.”<sup>31</sup>

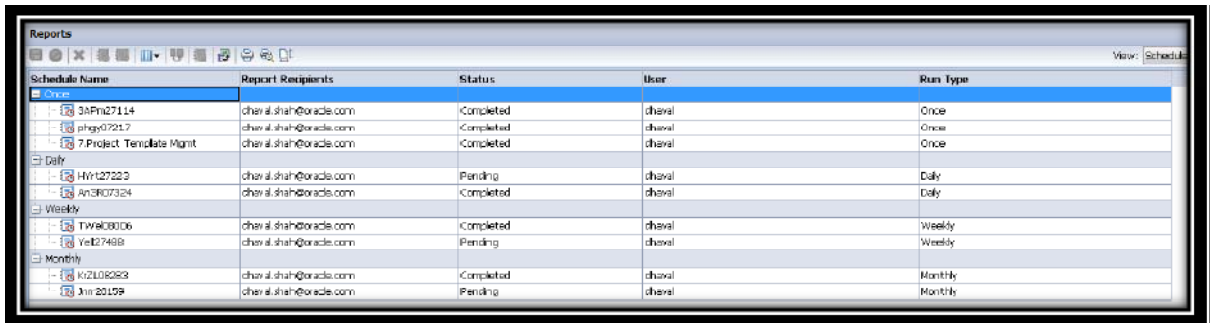


Figure 38. Primavera reports by schedule time

<sup>31</sup> Primavera questionnaire answers

---

#### **4.2.5. Miscellaneous**

- Language selection: Out-of-Box Languages supported for the User Interface are: English, French, German, Spanish, Russian, Chinese (Simplified and Traditional) and Japanese. The P6 Applications allows you to choose locale specific formatting, such as Date, Currency and Number.
- Accessibility: Primavera P6 Web Access is designed as a robust always available application. Where required, Application Server clustering can be employed for fail-over and load balancing purposes. Application data is stored within the P6 database.

#### **4.2.6. Customer Reference: Alstom Group / Power**

Ahlstom Group is a world leader in transportation infrastructure, power generation and transmission. The power generation sector has its headquarters located in Baden, Switzerland and they run projects that, from scope and complexity, are very similar to ABB projects. “Alstom is a global leader in power generation with a portfolio of products covering all fuel types. Close to 25% of the world's power production capacity depends on Alstom technology and services.”<sup>32</sup>

The director of project management systems and information systems, Mr. Harry Moosmann, shared with us his experiences with Primavera P6 that they have been using for several years already. Alstom power has 6 business fields, where ca. 50 big projects are running. The users include a total of 500-600 project managers and 1000 team members. An update between the systems is normally done once a week, but in critical project phases this can be done even daily. When we know what information we want to up/down load to SAP, this interface can be easily installed. In general, Primavera is faster and better in processing the information than SAP, so they try to avoid using SAP too much.

There is a possibility for document storing in P6, but it is possible to integrate the product to MS SharePoint or Documentum. An SaaS implementation is possible and they are now

---

<sup>32</sup> Ahlstrom Homepage [www.ahlstrom.com](http://www.ahlstrom.com)

testing it in Ireland and USA. The multi-project resource management, as such has not been done with the old version, but they are now purchasing the v8 which should enable also the multi-project resource planning. The other sectors are using MS Project and Primavera for their project management, but they are not doing a program level management with these tools.

As Mr. Moosmann has been in the position for only few years now, he was not able to give any specific information if the usage of P6 in program level has increased throughput, or on time delivery.

The scorings of Primavera was decided according to Table 2.

<b>Primavera</b>	<b>Score</b>
<b>Multi-Project Planning</b>	
What-if multi simulation	2
Optimizer	1
Resource allocation	2
<b>Interfaces</b>	
MS Project + Primavera	3
SAP closed-loop	2
<b>Controlling</b>	
EVM or buffer status	2
Adjustable alerts	2
Constraint identification	2
<b>Settings</b>	
Individual dashboard, flexibility	2
Report wizard/templates	3
Single project settings	3
Communication between users	2
<b>Miscellaneous</b>	
Language selection	2
Accessibility	3
Scalability	3

**Table 2. Primavera ratings**

---

### 4.3. JDA Software

Jda is a supply chain software company that you do not find in any of the PPM comparisons. It was founded in Alberta, Canada in 1978. They later acquired brands like Manugistics (2006) and i2 Technologies (2010), making it a leading supply chain company<sup>33</sup>.



Jda solution Enterprise Project Planner (EPP) differs greatly from the other more traditional project management tools. The former i2 created a multi-project planning and scheduling tool especially for ETO companies. It suggests a plan automatically, using a patented optimizer that works based on soft and hard constraints and CCPM. The manual work of planning and decision making is then done by master planners, who need to be additionally trained for this new job title. The tool relies on buffer elimination, so it exploits the critical chain method principles. It also depends heavily on SAP, and the information exchange between the two is an important part of the tool.

Central characteristics:

- Optimizer with soft and hard violations, hard violations are never violated
- Buffer status calculation, based on multi-project critical chain. Shows also EVM.
- Master planners have the control and the decision making power
- Closed-loop integration with SAP
- The plan is always feasible
- Homogeneous resource pools where individuals cannot be selected

---

<sup>33</sup> JDA Homepage [www.jda.com](http://www.jda.com)



### 4.3.1. Multi-Project Management

The master planners have the control over the resource planning. They are able to do what if simulations and compare them against the baseline in Gantt chart or resource load. Each independent department can have their own planner, if they share only project and no resources.

Optimization engine works based on a set of hard and soft constraints network, that each adds a penalty when violated. It uses a comprehensive algorithm to find the best schedule for all projects and all tasks, to have the lowest penalty. It never violates hard constraints.

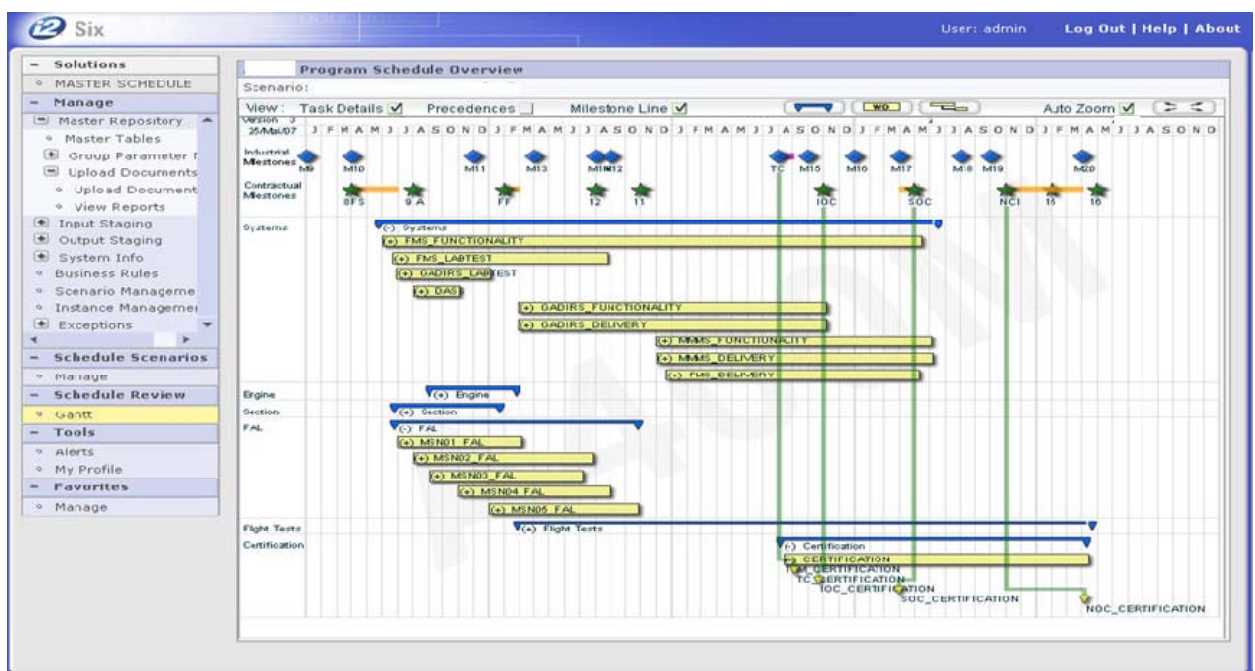


Figure 39. JDA EPP: Program Schedule Overview in master plan<sup>34</sup>

The resources are automatically allocated, which means that one has to manually gain flexibility into the system. For this reason, JDA recommends scheduling only 80-90% of the capacity in the beginning before the stable status is reached.

<sup>34</sup> All figures in chapter 4.3 are from the jda questionnaire answers or from EPP white paper

Master planners make the high level planning, after which the resource managers assign work to individuals and generate work lists for them. Master planners can analyze the load profile by resource or resource pool.

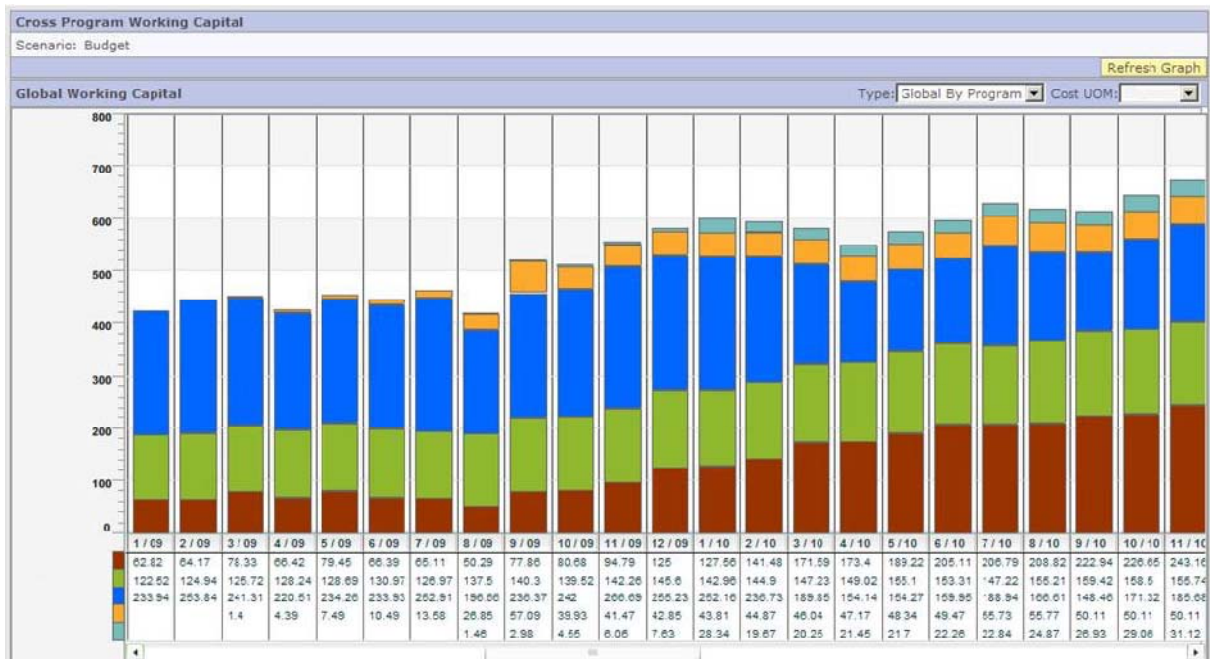


Figure 40. JDA resource allocation plan

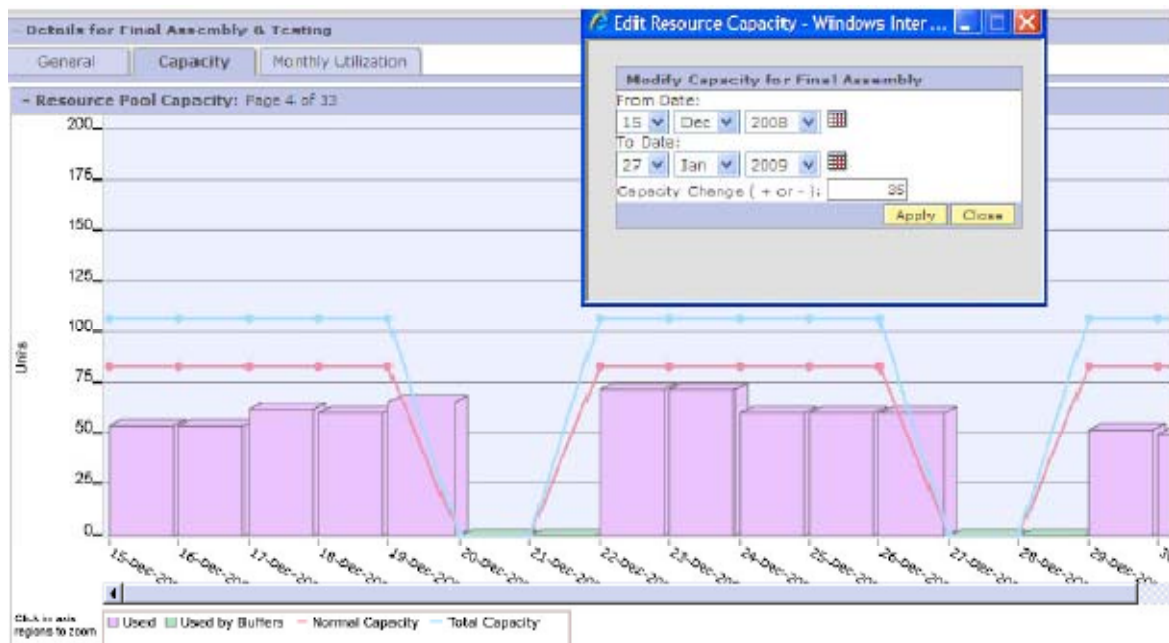
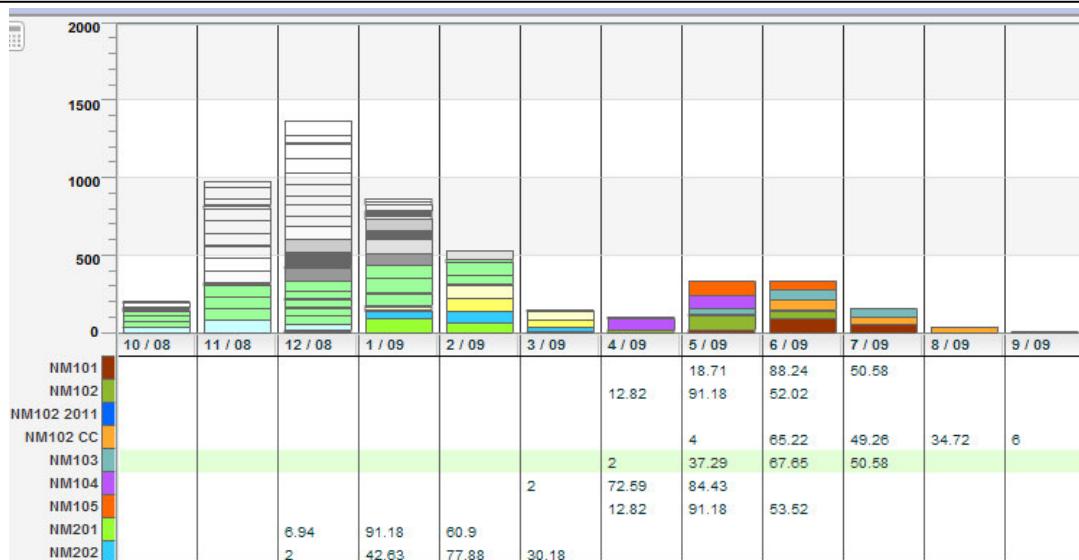


Figure 41. JDA resource pool capacity display



**Figure 42. JDA resources divided in hours per project**

#### 4.3.2. Interfaces

MS Project and Primavera interfaces are working via XML, and a standard MS Project import function is also available. The synchronization points can be defined as wished.

The software is closely connected to SAP, and changes a lot of information in a closed-loop to keep both systems up-to-date. The i2 ABPP<sup>35</sup> has the “Powered by SAP NetWeaver” status.

#### 4.3.3. Controlling

In general, the project well-being is shown in EVM graph and as a buffer consumption status. The KPI’s are also presented on the dashboards. The master planners can observe the buffer consumption of all running projects with traffic light alarms, as illustrated in Figure 45.

<sup>35</sup> Agile Business Process Platform

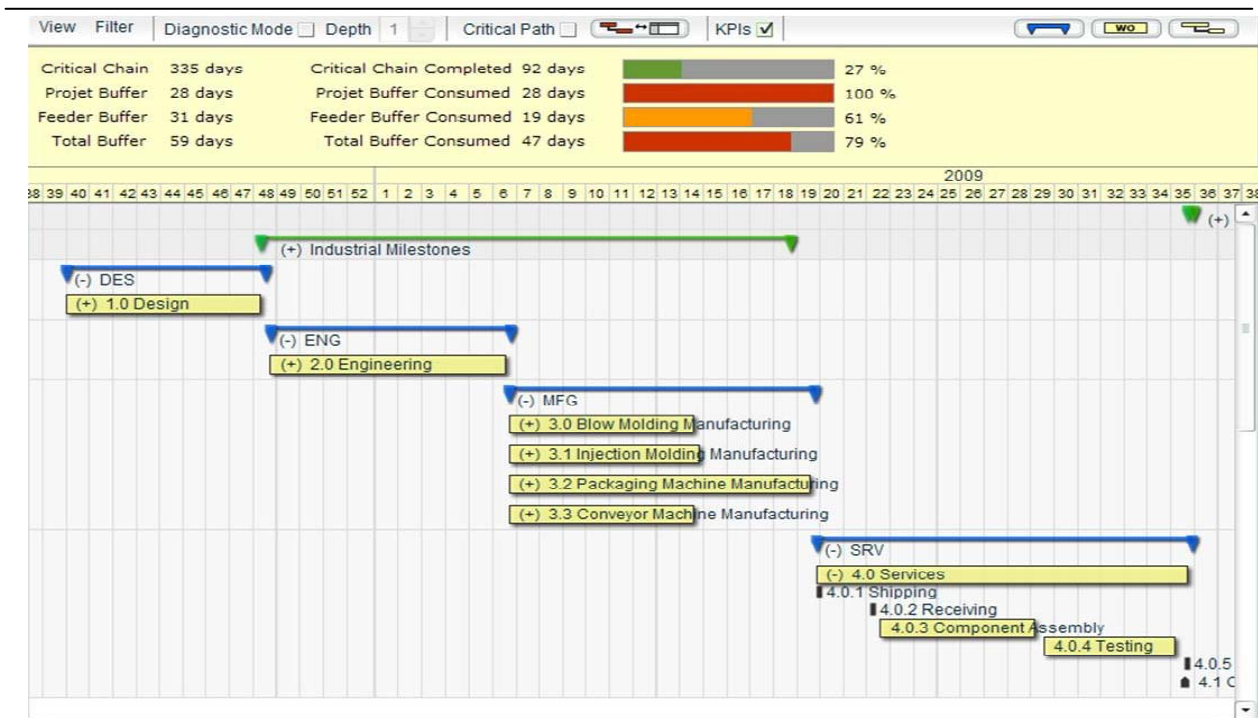


Figure 43. JDA EPP: Single project KPI's with buffer consumption

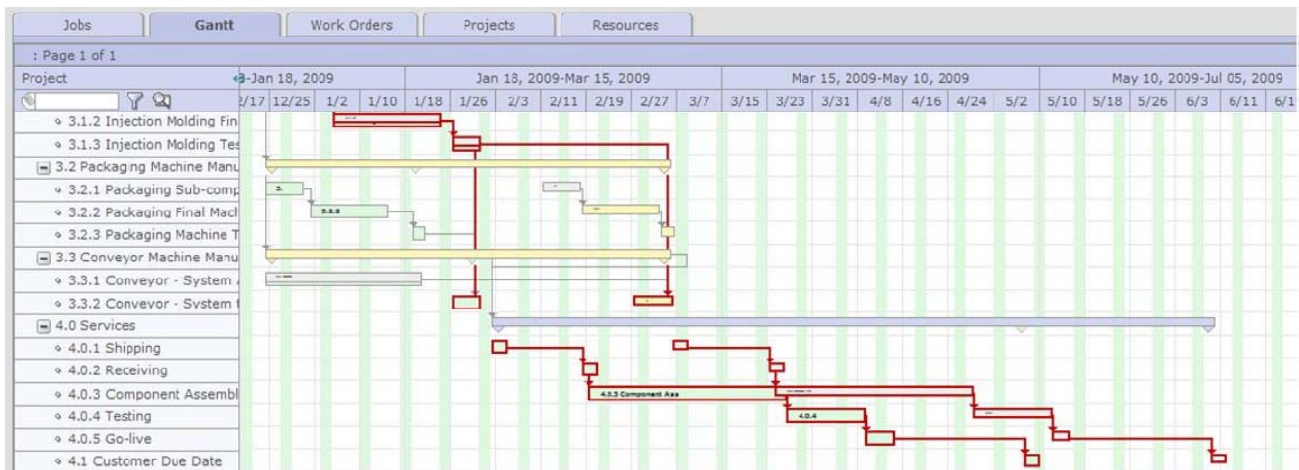


Figure 44. JDA critical path

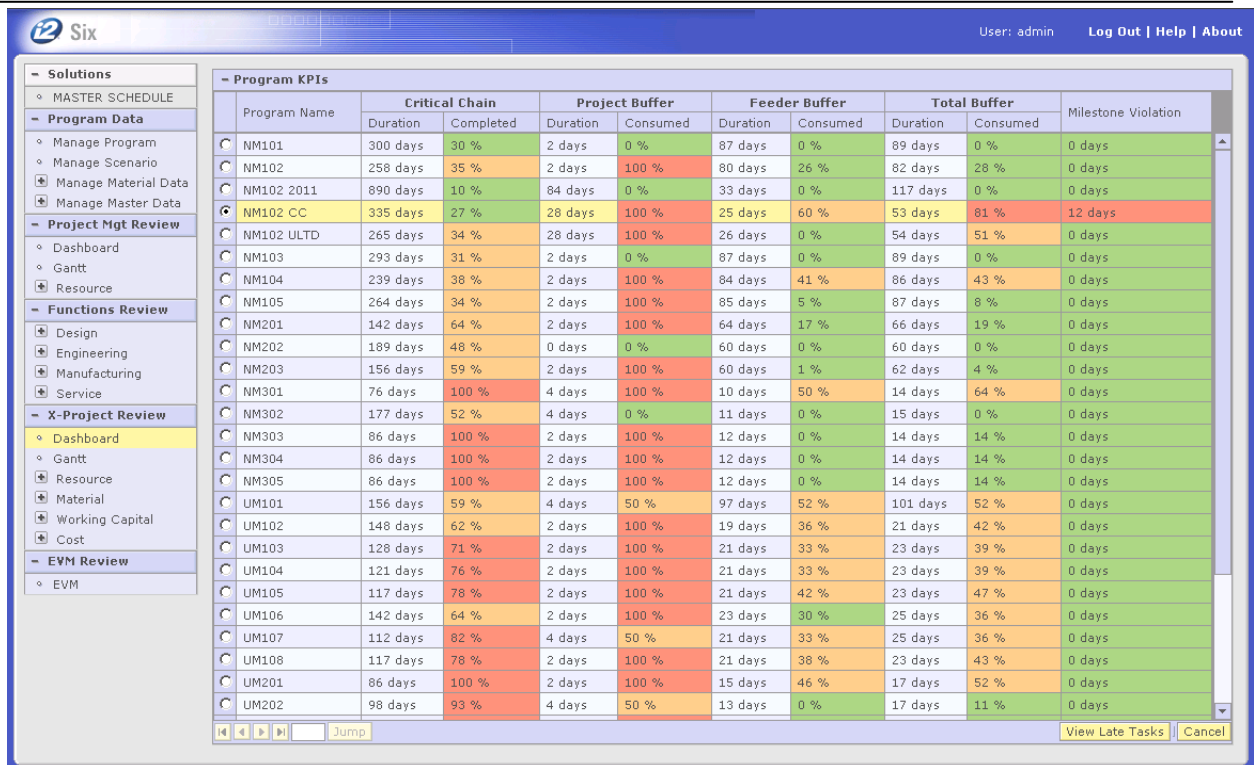


Figure 45. JDA program buffer consumption in master plan

#### 4.3.4. Settings

There are several predefined user groups with specific rights and limited information.

- Resource manager

Resource managers manage the calendars and the capacity of the resource pools. The feedback is given as a resource utilization report in Figure 46.

- Project manager

Project managers see only their own projects. Feedback from the planners is given in form of metric reports that include all problems, such as constraint violations or unplanned tasks.

- Material manager

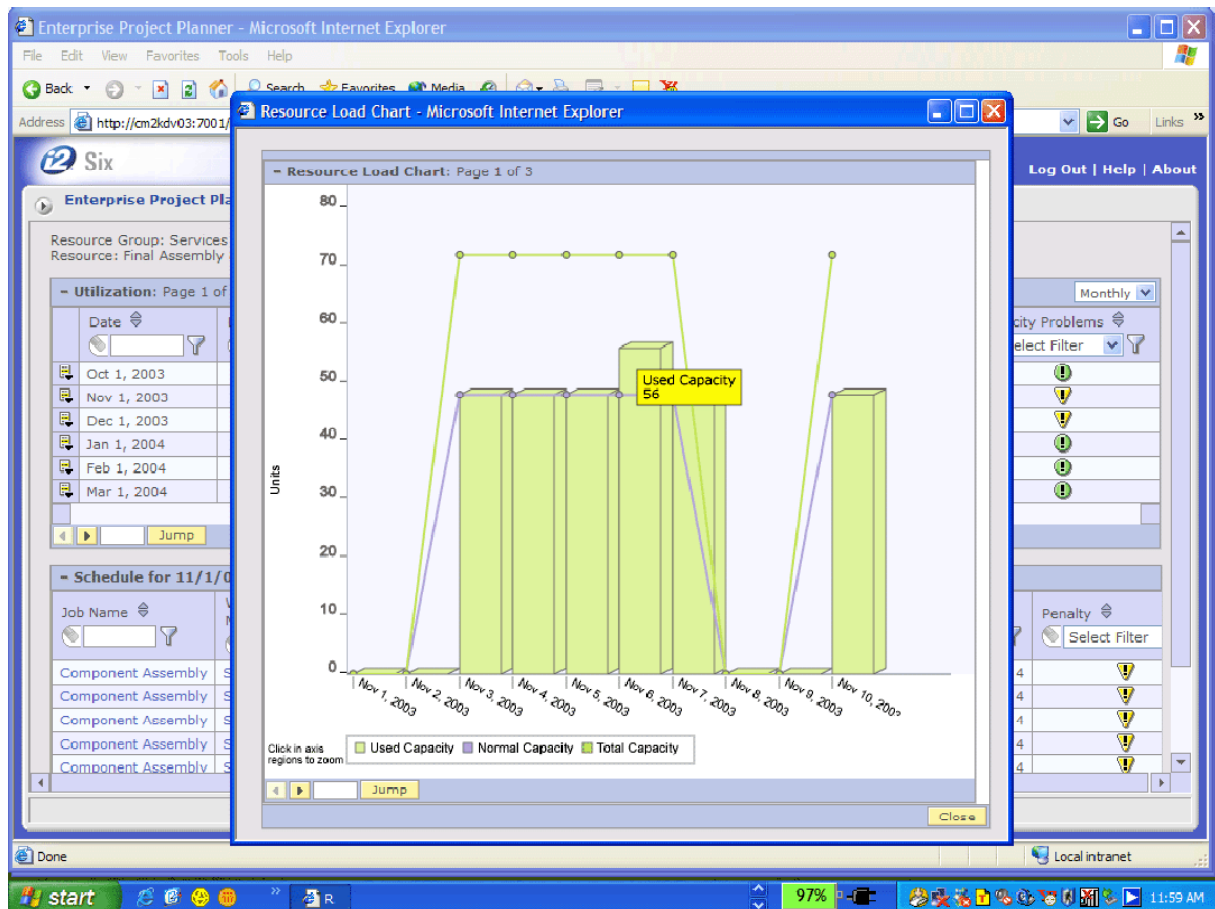
Material managers must manage the inventory of needed materials. Their feedback comes as a material utilization report via EPP.

- Individuals

The individual resources get their work lists from EPP. Their duty is to submit the actual end dates into the system.

- Master planner

Master planners are responsible for the manual work that needs to be done after the planning engine has done the scheduling. He is allowed to overrule the optimizer and violate even the hard constraints.



**Figure 46. JDA utilization report to resource manager**

A role specific dashboard typically contains

- Exception report with critical tasks of the week
- KPI's
- Colored Gantt: single project view for project manager and multiple Gantt chart with limited tasks for the resource manager
- EVM reports

It can be customized only in company level.



E-mail notifications can be installed to inform the project and resource managers about the changes done by the master planners. Reporting is done via standard exports to Excel.

### **4.3.5. Miscellaneous**

- The tool is available in English and in German
- Scalability: see the reference in chapter 4.3.6.

### **4.3.6. Customer Reference: Krones**

The Krones Group, headquartered in Neutraubling, Germany, plans, develops, and manufactures machines and complete lines, for the fields of process technology, bottling, canning and packaging and intralogistics. It was founded in 1951 and has five production plants in Germany. Worldwide, they have 10 300 employees worldwide, ca. 8000 of them in Germany and the consolidated sales were in 2009 1 865 million €<sup>36</sup>.

The company produces all the machinery needed in the bottling process, e.g. labeling and filling machines, PET-bottle shaping, for customers such as Coca Cola. The machines are designed and manufactured within the production plants and then installed at the customer site. Delivery time is 3-5 months plus installation 3-6 months. All customer orders, regardless of size, are recorded as projects and around 4000 such projects are running in the system. Approximately 10 big and 13 small new projects are started daily. They are currently in the process of adding the internal projects into the planning tool.

Krones implemented the JDA solution (at the time i2) factory planner and enterprise project planner (EPP) back in 2004. They use it more or less as an add-on to the SAP system, so that both systems are always up-to-date and share a lot of information. Each work order in SAP has its own network plan and the configuration is done in SAP. Bids are not fed into the

---

<sup>36</sup> Kaltenbrunner, 2009

---

system until the order is accepted, because they want to maintain the flexibility concerning due dates and capacity.

The employees are divided into homogenous resource pools, e.g. 6-8 persons, who have the exact same qualification and are therefore interchangeable. This way the project manager cannot decide which individual he gets to work in his project. Only 85-95% of the resources are entered to the system to maintain flexibility in case of sickness, administrative work etc. EPP allows utilization up to 300% (red, hard constraint), whereas exceeding 100% is marked yellow (soft constraint). The focus is on the horizon of 1-2 months, as in an emergency they can employ new people within this timeframe.

4 user roles that are in use: project and resource managers, master planners and individuals.

- They currently require 15 master planners: 1 for each machine group
- Ca. 400 resource managers
- Ca. 200 project managers
- 2000-3000 staff licenses: The individual sees a 3 week “frozen work horizon” and the EPP doesn’t make any changes to this period. The employees insert the job start and finish date or the estimated end date in case of delays. Due dates must be met, but otherwise they are allowed to work quite independently (Management by exceptions)

Master planning is done for four German factories, centrally from the headquarters. All 120 000 job plans are rescheduled every night and the updates appear to the users on the next morning. No what-if simulations are used, because each of the 15 planners has his own machine group; with only one planning engine, this would be possible. Priorities are given only based on the milestones, with no active prioritization. The business area managers and master planners meet once a week. The planners have the duty to point out the bottlenecks, and the department must solve these problems independently. The users receive a training of only one hour for using the tool, whereas the master planners who work daily with the tool, need several months to learn it completely.



It was not possible to measure the results of the implementation numerically, as no figures were collected prior to the improvement project 2002-2004. In general, the throughput has increased at least 20%, without adding resources. However, the work stress has remained the same, and they have to work often on Saturdays to guarantee on time deliveries. The project managers seemed to be less pleased with the tool, partially because their working environment has changed a lot and they don't always agree with the master planners' decisions. In cooperation with i2/JDA, they have improved the tool during the last few years and continue working on their planning processes.

**KRONES – Supply Chain Management**

**Challenges in performing a company wide master planning**

**expected challenges:**

- “change management” is very important but difficult
- not too many people are interested in getting the whole picture of the supply chain
- no understanding that local optima are not always good
- nobody likes to get due dates

**unexpected challenges:**

- fear of transparency
- resource-planning is much more difficult than expected:
  - only charts which show an overload are accepted
  - no will to draw the obvious solutions
- everybody prefers his own EXCEL-schedule (even if it is much more work)
- the competence of the master planning team is always questioned

14

**Figure 47. Experiences from the JDA implementation process<sup>37</sup>**

<sup>37</sup> Power Point presentation by Kaltenbrunner

The JDA scorings are presented in Table 3.

<b>JDA</b>	<b>Score</b>
<b>Multi-Project Planning</b>	
What-if multi simulation	2
Optimizer	3
Resource allocation	2
<b>Interfaces</b>	
MS Project + Primavera	2
SAP closed-loop	3
<b>Controlling</b>	
EVM or buffer status	3
Adjustable alerts	2
Constraint identification	3
<b>Settings</b>	
Individual dashboard, flexibility	1
Report wizard/templates	1
Single Project settings	2
Communication between users	1
<b>Miscellaneous</b>	
Language selection	1
Accessibility	1
Scalability	2

**Table 3. JDA ratings**

#### 4.4. HP



Hewlett-Packard is the world's largest IT company with a revenue of 126 billion USD (2010). It was founded in 1939 and has now approximately 304 000 employees worldwide and the headquarter is in Palo Alto, California<sup>38</sup>. They offer a wide selection of products and services in almost all areas of technology. ABB has been cooperating with the company for years, and recently HP was chosen to also do the project management in ABB's IT branch. Their product Project and Portfolio Management (PPM) appears to be designed only for IT oriented projects, with a strong emphasis in portfolio management. According to their representatives, IT projects don't differ that much from customer engineering projects, and there I disagree. Probably due to the lack of experience with such customers, the tool has not been further developed for multi-project execution and, despite of the good first impression, it does not compare to the other presented products.

Central characteristics:

- Uses Critical Path Method but allows also buffer management
- The tool provides most standard functionalities, but cannot do program level simulations or plan optimization
- Interface to Primavera must be through MS Project
- Uses resource pools, resource demand in project staffing profiles
- Comparison of the simulated portfolio key figures, but no linking of different projects possible
- No SAP certification
- Many of our wishes require additional configuration

Quote from Forrester Research<sup>39</sup>:

---

<sup>38</sup> HP Homepage [www.hp.com](http://www.hp.com)

<sup>39</sup> DeGennaro, Visitacion, 2009

- HP's solution is well suited to organizations with complex IT management needs. HP continues to build out its vision for managing IT like a business with greater emphasis on executive visibility into the impact and cost of IT investments. HP PPM provides depth in managing various types of IT projects and continues to add integrations and features, such as financial management, that support IT management decisions. HP provides additional depth by opening the door for integrations with other HP applications and third-party apps.

#### 4.4.1. Multi-Project Planning

PPM lets you create different portfolios and compare them based on NPV, ROI, costs etc. It supports decision making in portfolio management with various graphs and warnings.

This is for ABB however, not useful, as we don't do portfolio selection. Baseline comparisons are possible only in single project level.

PPM uses resource pools to manage resource capacity. Each user has its own calendar to track absences, and belongs to one or many resource pools. Pool net capacity is then calculated for the project staffing profiles. Loan factors can be calculated for an entire resource group, as well as for sub-groups or each named resource. Medium term workload forecast can be calculated to see where the bottlenecks are. Accumulated resource capacity for different portfolio combinations can be compared as in Figure 49.

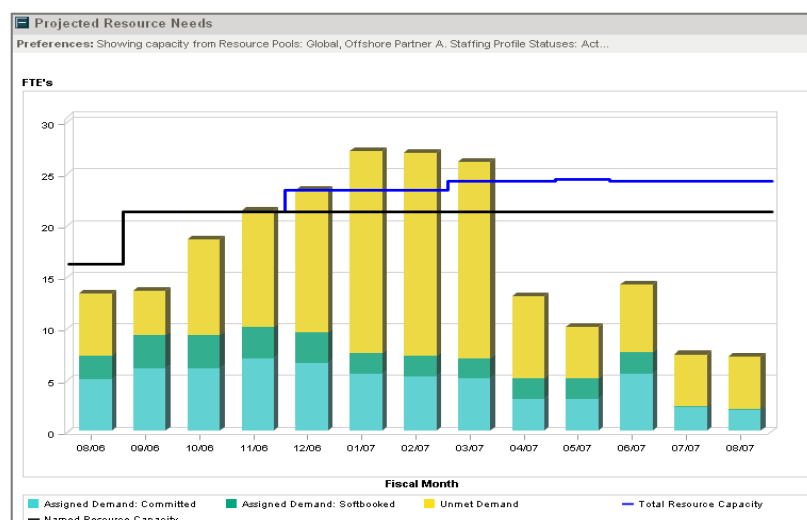
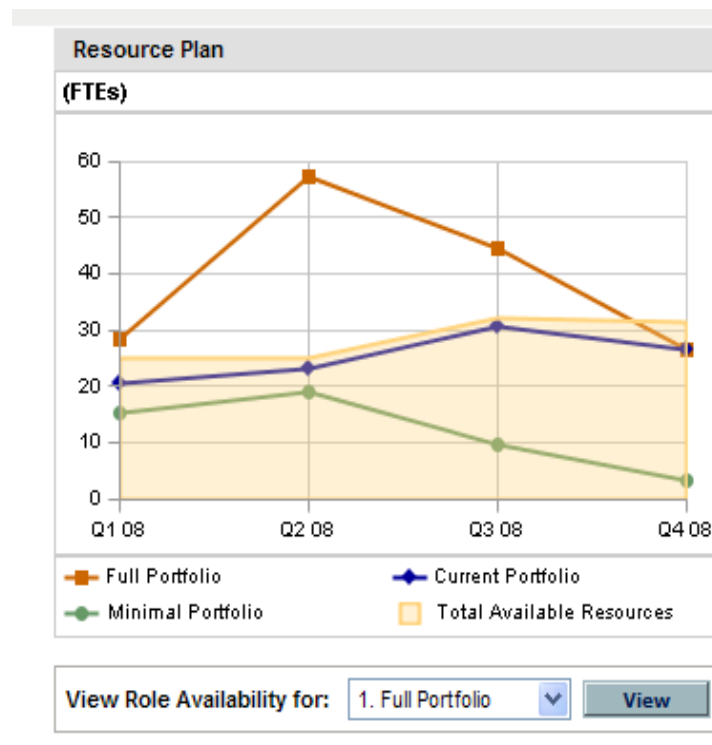


Figure 48. HP resource allocation<sup>40</sup>

<sup>40</sup> All figures from chapter 4.4. are from the HP questionnaire answers



**Figure 49.** HP long term resource planning

#### 4.4.2. Interfaces

“PPM provides an out-of-the-box bi-directional interface with Microsoft Project. Controls are set at project, project type, or global levels to determine the level of synchronization. Available synchronization modes are:

1. HP Project Management controlled
2. Microsoft Project controlled
3. Shared control

In the “*shared control*” mode, the project manager plans and schedules the project in Microsoft Project while using HP Project Management to track actuals. Participants in the project directly report actual data using the HP PPM My Tasks portlet, or a time sheet. Synchronization updates the Microsoft Project file with actuals data from HP Project Management. The HP Project Management work plan is updated with changes to its structure or schedule in Microsoft Project. It is additionally possible to import project plans

via XML or relational tables, to integrate different existing solutions. These interfaces require additional configuration during the implementation phase of the HP PPM solution.”<sup>41</sup>

PPM is not SAP certified, but a link can be established via standard API’s and web services to any open interface in order to exchange information.

#### 4.4.3. Controlling

EVM is standard in HP PPM and can be activated or deactivated by project or project type, using the project settings.

A total project buffer can be defined for the whole project, or a task buffer ratio can be defined at task level. The total buffer task could be used to collect the single task buffers and to follow up the overall status of the buffer consumption. Alternatively, the classical approach, having buffers on each task, is also supported.

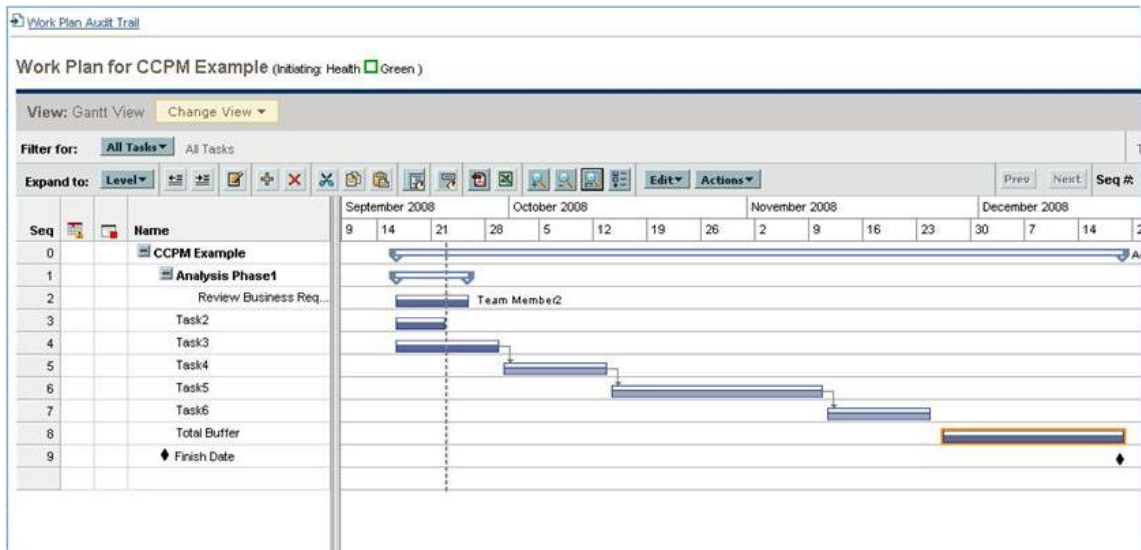


Figure 50. HP CCPM

<sup>41</sup> HP questionnaire answers

View Task Audit Trail

### Task Details: 4 - Task3

**Name:** Task3

**Project Path:** CCPM Example > Task3

**Status:** Ready

**Description:**

**% Complete:** 0 **Activity:**

☐ **Mark task as milestone**

☐ This is a major milestone

☐ Milestone automatically completes

**Delete Task**

Schedule | Resources | Notifications | Notes | References | User Data

**Task Buffer:**

Figure 51. HP buffer calculation

CCPM Example

Preferences: Active Budget Total Greater Than: ; Active Budget Total Less Than:

Project #	PM	End Date	Name	Objective	Planned Costs	Actual Costs	used Buffer
31668	Joseph Banks	April 2008	Projekidee1234	10% Increase in Revenue	\$758,403	\$41,393	34.0%

Figure 52. HP project buffer display

HP PPM highlight the project constraints using the Critical Path Methods. Standard notifications are provided for task violating constraints (like available resources, resource consumption above thresholds etc.). The notification for extra buffer consumption requires additional configuration during the implementation phase of the HP PPM solution.

Standard notifications are provided in the project overview dashboard. This dashboard shows a traffic light for overall health, including cost and schedule problems.

#### 4.4.4. Settings

HP PPM provides role-based and user-specific configurable dashboards, that show only information important for the specific user. The dashboards can be centrally defined and shared to the users and/or personalized by the users themselves.

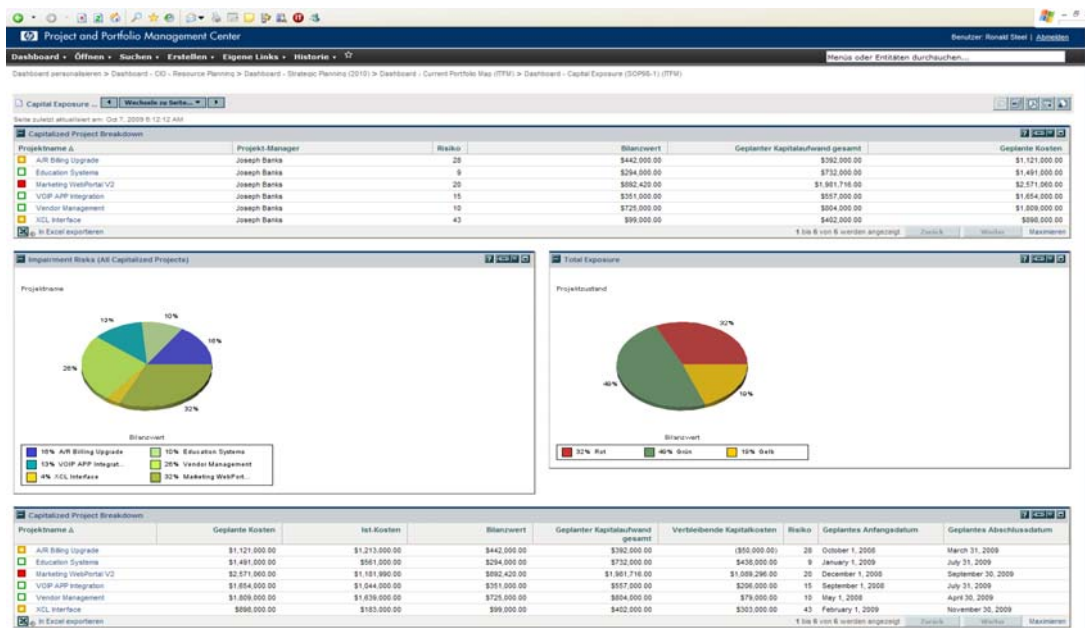


Figure 53. HP dashboard

Reports can be defined at dashboard or work plan (WBS) level. Both can be manually adjusted by end-user, depending on their needs. Figure 54 shows a project overview report.



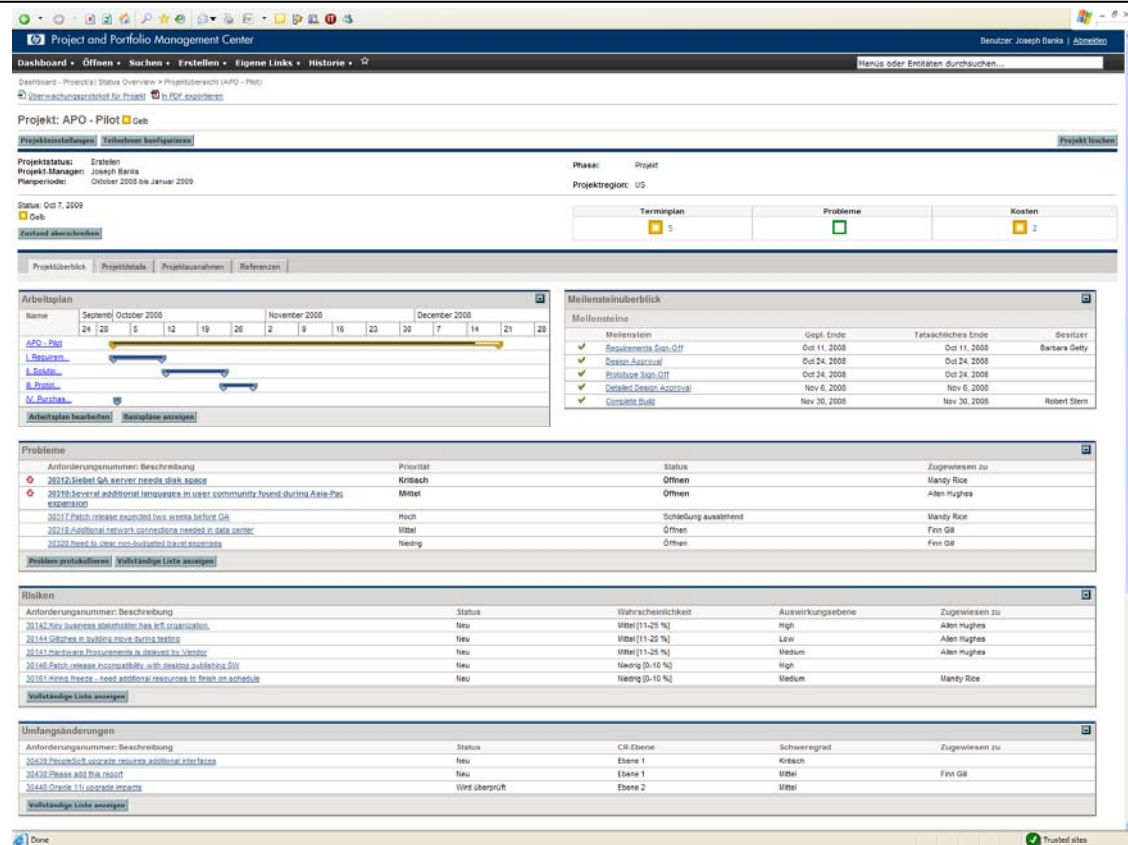


Figure 54. HP overview report

“The project lifecycle in HP PPM is made of 3 different phases: proposal, project and asset. Asset represents the output after a project has been closed (services, products etc.), proposal represents projects in offer. Furthermore, proposal, project and asset have a workflow governing the different lifecycle customer-specific statuses (e.g. gates etc.).

There are two standard representations of a master plan, a tabular and a graphical form. In the tabular form it is possible to show the project lifecycle phase (e.g. proposal or project) and additionally, the particular workflow status of each project. Additionally, the content of a portfolio can be graphically displayed using different colors for proposal, project and assets.”<sup>42</sup>

<sup>42</sup> HP questionnaire answers

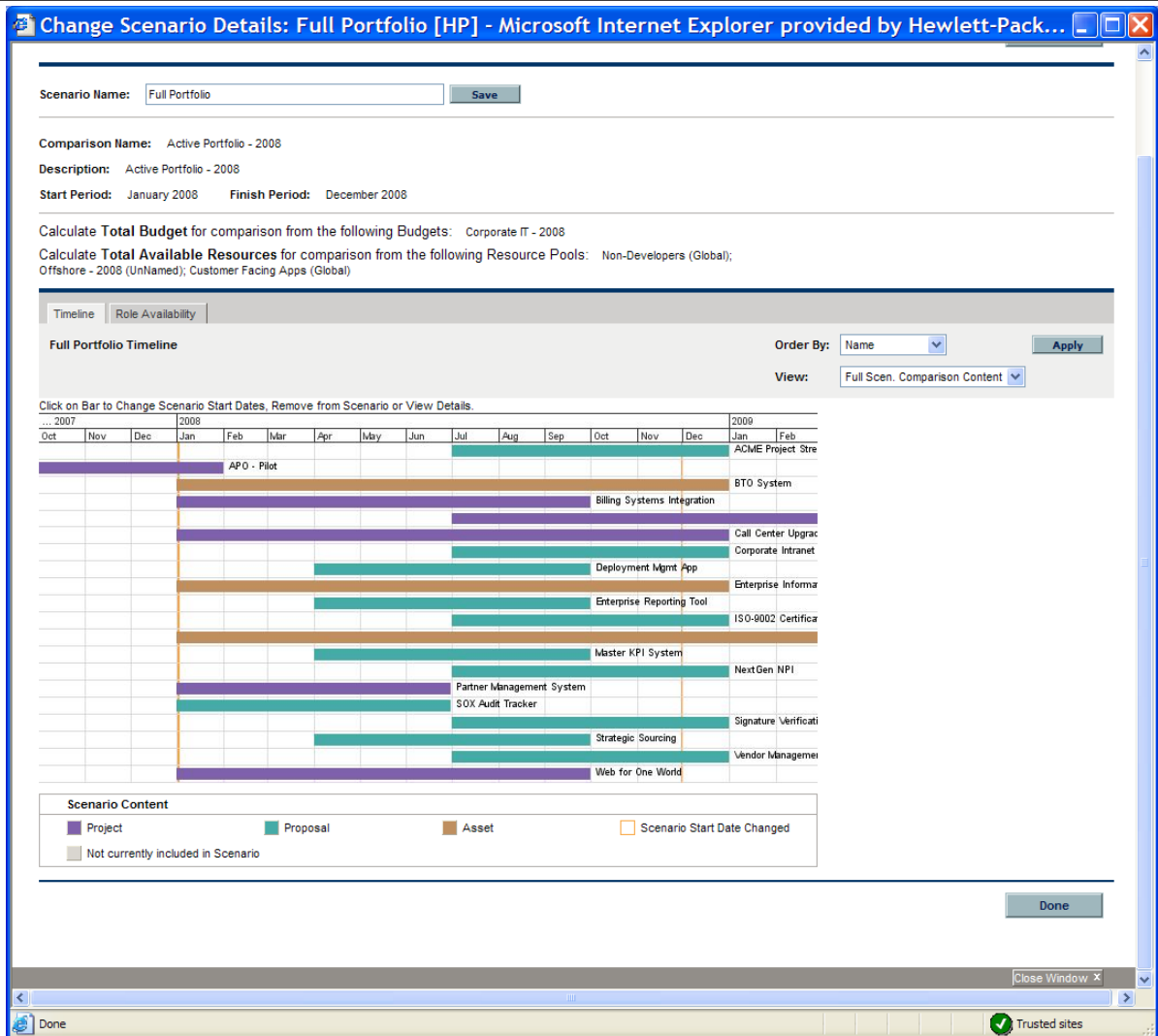


Figure 55. HP full portfolio timeline

#### 4.4.5. Miscellaneous

- HP PPM supports National Language Support (NLS) and UTF8 and can be run, on the same instance, on the following different languages: English, Brazilian Portuguese, French, German, Italian, Japanese, Korean, Simplified Chinese, Spanish, Russian and Turkish.
- Programs have an additional security layer that specifies who is able to see the information of the related projects, including or excluding project managers and project stakeholders.

- 
- High availability is achieved by leveraging horizontal scaling of the application environment to provide failover capabilities, and by implementing technologies such as clustering at the database level.
  - The HP PPM application server tier has been designed to be highly scalable, and the software has been optimized for performance and stability.
  - Standard user groups are project manager, summary task owners, program manager, project staff, project stakeholders, workflow participants, user group with access to financial data (project funding, baseline costs, forecast costs, actual).
  - HP PPM tracks all changes into logs to provide strong audit capabilities. Log information can be displayed also directly to end users, or displayed in audit reports.

#### ***4.4.6. Customer Reference: Exactitude Consulting for BHP Billiton***

BHP Billiton is a British-Australian mining and oil and gas company that has mining sites all over the world. Their mining division in South-Africa wanted to implement a PPM tool to improve their project delivery, and turned to an independent consultant from Exactitude Consulting. He shared his experiences with us about how BHP is using HP PPM.

BHP launched the project of implementing PPM with a kick-off in June 2008. The software went live in July 2009 and it took a year, until July 2010, for the implementation to become stable. The aim was to obtain a central planning tool for a global view. In ABB, this would not be the case as the implementations would be done in several smaller business units.

The tool was used for managing capital and business improvement projects i.e. internal projects. As a part of the project, they abolished all other PM tools like MSP and Excel sheets, in order to have all the information only in the HP PPM. The implementation was successful and a further upgrade is planned for 2011.

ABB has, however, different needs and it was important to find out if the tool provides to BHP the support that ABB is looking for. There is no automatic interface to SAP and the information update in BHP is done manually once a week. There is an interface to MS Project, but in order to connect PPM to Primavera they must use MSP as a link between the

two. To summarize this, they are not using the tool for resource management in customer projects, and in the discussions it was concluded that the PPM doesn't provide what-if simulations, resource administration or decision support.

The ratings for HP PPM are the following:

HP	Score
<b>Multi-Project Planning</b>	
What-if multi simulation	1
Optimizer	1
Resource allocation	2
<b>Interfaces</b>	
MS Project + Primavera	1
SAP closed-loop	1
<b>Controlling</b>	
EVM or buffer status	3
Adjustable alerts	2
Constraint identification	2
<b>Settings</b>	
Individual dashboard, flexibility	2
Report wizard/templates	1
Single Project settings	2
Communication between users	1
<b>Miscellaneous</b>	
Language selection	3
Accessibility	3
Scalability	3

**Table 4. HP ratings**

#### 4.5. *Realization/Concerto*

Realization offers a complete solution for project management and execution, where their Concerto software is only part of the product. The software cannot therefore be purchased separately, nor is any information about it made available.



- Based on critical chain method and theory of constraints
- Aims to reduce cycle time and thereby improve on time delivery
- Offers a full on-site support until results are obtained
- No information about the software functionalities is available, the company provides only a description of their methods and obtained results
- Used for project management in some ABB BUs

Realization uses the critical chain method to shorten the project cycle times. The focus is in changing the way the organization works. The implementation process requires full commitment and resources from the client. As a reward, they promise life cycle reductions and increased throughput, around 20%. They reveal very little about the software that they use: this is only supporting their task in teaching a new method of working, which relies on prioritizing on the task level and synchronization of the tasks more efficiently. What we were able to find out, is that Concerto has MSP embedded but ERP limits to materials management module in SAP. Only success stories without specific information about the tool, are used as advertising material.

They present three rules for implementing their method<sup>43</sup>:

**Rule 1:** Limit the number of projects in execution, even if it means keeping some resources idle. Concentrating resources on fewer projects at a time not only allows them to be executed faster, but also reveals overall capacity to undertake more projects.

---

<sup>43</sup> Realization Homepage [www.realization.com](http://www.realization.com)

---

**Rule 2:** In execution, allow individual tasks to be late against the plans. That way, people won't have to hide safeties inside their estimates, and tasks will get executed faster, because work won't have to expand just to fill the time available (Parkinson's Law)<sup>44</sup>.

**Rule 3:** Provide uniform task priorities across all departments and levels of management. When everyone knows what to do and when, and is working on the same priorities, projects get done much faster.

As a result of the feasibility analysis in Ludvika, Realization responded that: "Engineering is not a bottleneck at this time" and "is not likely to become a bottleneck in the next year or so". "The best time to implement Critical Chain is when organizations can least afford to undertake a major change. In lean times there is not incentive for operations managers to set aggressive goals or to make the changes. On the other hand, Critical Chain can be implemented and results achieved quickly (within 6-8 weeks) when there is a real need."<sup>45</sup> They believe, therefore, that it doesn't make sense to start a project there at the moment.

I believe the senior engineers in certain departments are a bottleneck, not all engineers as such. This is a crucial difference to manufacturing companies, where individuals are replaceable, and it seems that Realization is more familiar with manufacturing business, where the critical chain works at its best.

---

<sup>44</sup> Parkinson's Law, taken from a 1955 essay in *The Economist* by Cyril Parkinson says that, "Work expands so as to fill the time available for its completion".

<sup>45</sup> E-Mail from Sanjeev Gupta, Realization CEO

### 4.6. Results

Although most of the tools have pretty much the same basic functionalities, there were some differences to be found. This summary of the ratings shows the strengths and weaknesses of each tool compared to the others. The maximum total score would be 300 points and, as already mentioned, the ratings were done from 1 (satisfactory) to 3 (ideal solution). The partial weightings were decided based on the relative importance of these functionalities to us. The total score of each row is obtained by multiplying it with the fractional weighting of the row, and with the category weighting.

	Weight	JDA		Planisware		Primavera		HP	
		Score	total	Score	total	Score	total	Score	total
<b>Multi-Project Planning</b>	<b>40%</b>								
What-if multi simulation	60%	2	48	3	72	2	48	1	24
Optimizer	30%	3	36	1	12	1	12	1	12
Resource allocation	10%	2	8	3	12	2	8	2	8
<b>Interfaces</b>	<b>25%</b>								
MS Project + Primavera	50%	2	25	3	37,5	3	37,5	1	12,5
SAP closed-loop	50%	3	37,5	3	37,5	2	25	1	12,5
<b>Controlling</b>	<b>15%</b>								
EVM or buffer status	50%	3	22,5	2	15	2	15	3	22,5
Adjustable alerts	20%	2	6	2	6	2	6	2	6
Constraint identification	30%	3	13,5	2	9	2	9	2	9
<b>Settings</b>	<b>10%</b>								
Individual dashboard, flexibility	40%	1	4	3	12	2	8	2	8
Report wizard/templates	20%	1	2	3	6	3	6	1	2
Single Project settings	10%	2	2	2	2	3	3	2	2
Communication between users	30%	1	3	3	9	2	6	1	3
<b>Miscellaneous</b>	<b>10%</b>								
Language selection	20%	1	2	2	4	2	4	3	6
Accessibility	50%	1	5	1	5	3	15	3	15
Scalability	30%	2	6	3	9	3	9	2	6
<b>Total</b>	<b>100%</b>		<b>220,5</b>		<b>248</b>		<b>211,5</b>		<b>148,5</b>

**Table 5. Value analysis**

When only the category ratings are compared in a visual graph (Figure 56), it becomes even clearer where the differences lie. For example, Primavera and HP provide everything else i.e. miscellaneous, but fail in the category of multi-project planning. In our weighting, this category was considered the most important one with 40%, which results in worse total scoring in

Table 5.

		JDA	Planisware	Primavera	HP
	Weight	Score	Score	Score	Score
<b>Multi-Project Planning</b>	<b>40%</b>	2,3	2,4	1,7	1,1
<b>Interfaces</b>	<b>25%</b>	2,5	3	2,5	1
<b>Controlling</b>	<b>15%</b>	2,8	2	2	2,5
<b>Settings</b>	<b>10%</b>	1,1	2,9	2,3	1,5
<b>Miscellaneous</b>	<b>10%</b>	1,3	1,8	2,8	2,7

Table 6. Category based scorings

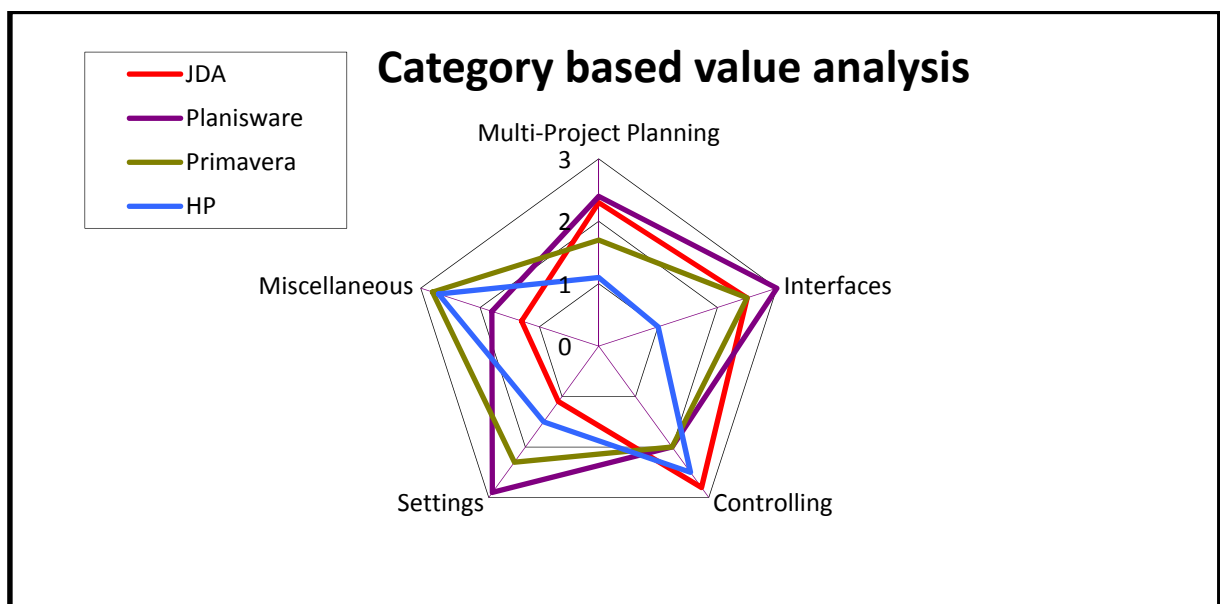


Figure 56. Category based value analysis



## **5. Implementation**

Of course it is important to choose the best software, but it plays only a small role in whether the implementation will be a success or not. The technical implementation of most of the tools can be done relatively fast, in the case of a SaaS, even within weeks. The JDA solution however, requires much longer; ca. 9 months for technical implementation, and two years before people learn to use it efficiently.

Before starting the implementation project, I would recommend the following issues to be carefully considered:

- Problem analysis: What is the actual problem? How should the tool help you to solve this? To which problems does the tool provide support?
- User commitment: Does everyone agree that there is a problem? Do they want to commit to solving it? Are they convinced that the chosen solution will bring an improvement?
- Who will be the assigned project owner? He must be fully engaged to the process.

There are some crucial points which contribute to the success of the implementation:

- Quality of input data: If the users are not committed to keep the information up-to-date, the software is useless. Therefore, the interfaces to the SAP or PM tool must be automated, or very easy to execute. No data should be required to be entered doubled, to ensure consistency.
- Letting go of the old systems: There must be a sufficient confidence that the new tool replaces all the functions of the old system, and that the old tool can be deleted. The necessity of the change must be justified and communicated.
- Gradual introduction of new functionalities. Install only the core modules addressing the problem, gradually expanding later. The user should never see the tool as too complicated or difficult to learn.

- Common understanding of the company methods of working.
- Communication and change management. Implementation fails within a few months if the system is not used.
- Keep in touch with the vendor for reassessments, updates, joint development of the tool for new functionalities etc.

## **6. Conclusion**

There are plenty of studies and software comparisons that will help a company in their task of finding a suitable project management tool. There is, however, no single solution that would suit for all, and therefore it is important to distinguish the needs of the organization. What works for IT or pharmaceutical companies will most likely not work in an engineering environment. The vendor should be aware of these differences, and provide a tool that will adjust to the working habits of the company and not the other way around.

All vendors provide a 100% web-based tool and the possibility to do a SaaS implementation. The software is generally open, so that interfaces to any other tools can be established. The question is, how well such interfaces work and how much work is required before the installation is finally completed. Therefore, I prefer software that has the solution already built in and working in a reference company.

The tools rely mainly on common project management methods which are not always ideal. Resource leveling, for example, is often possible but leads to push-out of the deadlines and doesn't make much sense for a better on time delivery. Even though EVM has also its downsides, it is the best known method to give at least some indication of the project development.

Even though the functionalities of our four software solutions are quite similar, there are some differences. Jda gives the power of planning to the recruited master planners, whereas Planisware tries to encourage the communication between project and resource managers via demand/supply model. Most of the tools prefer resource pools, where the users are classified according to their roles or skills. Planisware and Primavera are the only ones of the four where a resource can be a single individual. In many companies, it is not necessary to select individuals, but in ABB, where the line manager has worked for years, or even decades, with the same people, he knows who the best man to appoint for which job is. I believe this knowledge should not be neglected by standardizing the skill levels.

---

The HP PPM tool is good when it comes to IT projects, but they lack the experience in business-oriented customer project environment. The tool is, therefore, not developed for our needs and doesn't provide the support that the engineering centers require.

At first, Primavera wasn't able to convince us in resource scheduling for multiple projects. However, the new version 8 seems to have all the necessary improvements to cover the missing parts and is still an interesting candidate to look into. We hope to hear about the experiences of reference companies after they have been using the new version for their resource planning.

JDA and Planisware convinced us that they can provide the functionalities and support needed in ABB. This was also confirmed by discussions with their customers, as well as by other user experiences found online. The two solutions have very different approaches, which will hopefully let each business unit find their own favorite.

In general, the amount of functionalities in each of the software is far more than ABB would ever be using. The installation should not include all of them, but only the ones that are needed in daily work. Additional nice-to-have properties make the tool far too complicated in the beginning. It is, therefore, important to focus on which tool can provide the at-the-moment most crucial functions for improving project delivery in an easy-to-learn, simple and logical background.

The critical chain method from Realization has proven to give results in single project execution, when the pressure is great enough to reveal the implicit buffers. It is intended for manufacturing businesses, where the critical chain approach also works very well with multiple projects. Manufacturing, however, cannot be compared to engineering tasks. An experiment from Planisware showed that due to the uncertainties in the input and the irreplaceability of the engineers, MPCC cannot be applied effectively in an engineering environment.

Our discussions with the reference companies have shown that it is very difficult to measure the numerical success of the implementation. When project duration is several years, and

---

the transfer is done gradually starting with the new projects, the implementation isn't theoretically completed until years later. All other process improvements projects, increased efficiency or economical fluctuations, therefore also contribute to the company results.

The businesses are in a constant pressure of modernizing their working processes and to catch up with the development. Hence, it is my conclusion that a project portfolio management tool is vital for ABB engineering centers, and for any other ETO company struggling with resource planning in a multi-project environment. With the right software and a successful implementation, the investment will provide a definite return.

## References

### Books

**Goldratt, Eliyahu:** *The Goal: A Process of Ongoing Improvement*, North River Press, Great Barrington, MA, USA, 1948, ISBN 0-88427-061-0.

**Leach, Lawrence:** *Critical Chain Project Management*, 2<sup>nd</sup> Edition, Artec House Inc. , Norwood, MA, USA, 2005. ISBN 1-58053-903-3.

### Articles, Papers, Webcasts

**Bialas, Mayer:** *Schaltzentrale, Software für das Multiprojektmanagement*, an article in magazine C't; Vol. 15, 2007, p. 114-123.

**Brown, Timothy:** *Multi-project critical chain and buffer management for capital and innovation projects*, Unilever, South-Africa, A paper from the Critical Chain Symposium 2002.

**DeGennaro, Tim; Visitacion, Margo:** *The Forrester Wave™: Project Portfolio Management, Q4 2009*, a vendor comparison from Forrester Research Inc., 2009.

**Hans, E.W.; Herroelen, W.; Leus, R.; Wullink, G.:** *A hierarchical approach to multi-project planning under uncertainty*, an article in magazine Omega (International Journal of Management Science); Vol. 35, 2007, p. 563-577.

**Meyer, Mey Mark:** *Stand und Trend für Software Unterstützung für Project-Management Aufgaben*, Universität Bremen, a publication from GPM Gesellschaft für Projectmanagement, 2005.

**N.N.:** *Planisware, Inc. Continues Company Growth and Success in 2009*, announcement in magazine Business Wire, 30 Mar 2010.

**Powersteering:** *From promise to Payoff – Achieving Breakthrough Results with PPM Tools*, Webcast by Powersteering and Forrester Research, 2010. Available in <http://info.powersteeringsoftware.com/from-promise-to-payoff-ppm-tools.html?description=webcast-achieving-breakthrough-results-with-ppm-tools>.

**Stang, Daniel B.:** *Magic Quadrant for IT Project and Portfolio Management*, a comparative study from Gartner Inc. , 2010.

**Symons, Craig.** *The ROI of Project Portfolio Management Tools*, a publication of Forrester Research, Inc., 2009.

## Internet pages

**ABB:** <http://www.abb.com/cawp/abbzh252/56ba6a7efa6f571fc1256aed0032124f.aspx>, ABB Homepage / About us / History, Cited: 23 Jan 2011.

**Actano:** [http://www.actano.com/20911\\_EN-What%20s\\_new-Glossary.htm#P](http://www.actano.com/20911_EN-What%20s_new-Glossary.htm#P), Actano Project Management and Project Management Software Homepage, Cited: 31 Jan 2011.

**Ahlstrom:** <http://www.alstom.com/power/about/>, Ahlstrom Homepage, Cited: 16 Feb 2011.

**BARC:** <http://www.barc.de/>, Business Application Research Center.

**Caravel:** <http://www.caravelgroup.com/Caravel/Our-Approach/Critical-chain-vs-critical-path.asp>, Caravel Group Pty Limited, Cited: 11 Feb 2010.

**HP:** <http://www8.hp.com/us/en/hp-information/about-hp/index.html>, HP Homepage, Cited: 26 Jan 2011.

**JDA Software:** <http://www.jda.com/company/company-index/>, JDA Software Group Homepage, Cited: 6 Feb 2011.

**Oracle:** <http://www.oracle.com/corporate/story.html>, Oracle Corporation Homepage / History, Cited: 5 Feb 2011.

**Planisware:** <http://www.planisware.com/main.php?docid=14&plw=db9294cfd3f9eb96dafa10adfa88c08>, Planisware Inc. Homepage / About us , Cited: 15 Feb 2011.

**Realization:** [www.realization.com/criticalchain.html](http://www.realization.com/criticalchain.html), Realization Inc., Cited: 2 Nov 2010.

**Schaeffler Group:** <http://www.ina.com/content.ina.de/en/index.jsp>, Schaeffler Group Homepage, Cited: 21 Oct 2010.

## Private Documents

**Kaltenbrunner, Hans-Georg:** *Integrated planning at Krones July 2009: Challenges in performing a company wide master planning role at Krones AG*, Power Point presentation, JDA Software, 2009.

**Mennesson, Pierre-Maudez:** *Planisware for ABB Quality and Supply Chain OPEX*, Power Point presentation, Planisware, 1.9.2010.

**N.N.:** *ABB products, systems, services in power: An overview*, Power Point presentation from ABB Power Products division.

**N.N.:** *Enterprise Project Planner by i2 White Paper*, JDA Software.

## Appendix: HVDC Engineering process work flow

