
# Capacity Requirement Planning
# Master Data Solution Procurement at
# Qimonda Portugal SA

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**Projecto de Dissertação do MIEIG 2007/2008**

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**Mestrado Integrado em Engenharia Industrial e Gestão**

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*Aos meus pais*

## Resumo

O presente documento descreve o trabalho realizado durante o projecto de seis meses na Qimonda Portugal S.A., a única empresa de componentes em Portugal e a maior da Europa.
O título deste projecto é "*Capacity Requirement Planning Master Data Solution Procurement*" e o seu objectivo, como o próprio nome sugere, era procurar uma solução de Repositório Central de Dados ("Master Data") e Planeamento de Capacidade. Esta solução devia ser capaz de representar o modelo de dados de capacidade e os seus requisitos previamente definidos num outro projecto na Qimonda "*Data Modeling for Capacity Requirements Planning*"; pelo que estes se revelaram o ponto de partida do presente projecto. O resultado final devia ser uma pequena lista com algumas soluções propostas. Note que a implementação da solução não fez parte do âmbito deste projecto. Por outro lado, este projecto tinha aplicação não só na Qimonda Portugal S. A., mas sim em todos os sites de assemblagem e teste de componentes, pelo que foi seguido por uma equipa global constituída por planeadores de capacidade de todos os sites da Qimonda e pessoas dos vários departamentos de tecnologia de informação.

A solução podia ser a ligação entre um repositório de dados e uma solução de planeamento de capacidade ou uma única e integrada solução. Os principais utilizadores desta solução são outras aplicações informáticas que usam os dados desta solução como entrada.

O resultado deste projecto é uma lista de 2 soluções de planeamento de capacidade, *IPASS* e *Preactor APS*, sendo a primeira a principal e a segunda uma alternativa, e 2 soluções de repositório central de dados, *SAP Netweaver* e *Teradata*.

Internamente, haverá um próximo passo que será a apresentação dos resultados à gestão de topo a qual, posteriormente, tomará uma decisão no sentido de escolher a solução final.

## Abstract

The present document describes the work done during a six month project at Qimonda Portugal S. A., the only memory component producer in Portugal and also the biggest one in Europe.
This project title was “Capacity Requirement Planning Master Data Solution Procurement” and its objective, as the name suggests, was finding a capacity requirement planning master data solution. This solution should be capable of representing the capacity data model and its functionality requirements previously defined in other project at Qimonda - “Data Modeling for Capacity Requirements Planning”; thus this was the beginning point for the present project. The final result should be a short list with some proposal solutions. Note that the implementation was not within the scope of this project. Furthermore, this project did not only concern Qimonda Portugal S. A., but all the backend sites (package assembly and test), having been followed up by a global project team composed by capacity planners from all Qimonda sites and people from IT departments.

The expected solution could include a master data repository linked to a capacity requirement planning solution or a whole integrated solution. Moreover, the users won’t be humans, but other customer solutions that use the CRP master data information as input.

The result of this project is a list with 2 prioritized CRP solutions, IPASS and Preactor APS, respectively, and other 2 MDM solutions, SAP Netweaver and Teradata, respectively.

The further internal steps will be to present these results to the team steering and then a final decision will be taken.

## Agradecimentos

Em primeiro lugar, os meus agradecimentos são direccionados para os meus orientadores de projecto, o Sr. Eng. Peter Madera e o Sr. Prof. João Falcão e Cunha, por toda a disponibilidade e motivação oferecidas e acima de tudo pelos ensinamentos que me foram dados.
Agradeço, à Qimonda Portugal e à Faculdade de Engenharia da Universidade do Porto a oportunidade que me foi dada de realizar este estágio. Estar envolvido em um projecto com esta importância foi uma experiência muito gratificante e enriquecedora. A vivência destes 6 meses contribuiu, sem dúvida, em larga escala para a minha formação pessoal e integração no mundo de trabalho.
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Quero também agradecer aos meus pais, ao André e a todos os amigos pela ajuda e incentivo dado ao longo de todo o meu percurso académico.
A todos muito obrigada.

## Contents

# 1 Introduction

## 1.1 Scope and objectives of the project

The following report describes the project developed at Qimonda Portugal between September 2007 and March 2008. This project is equivalent to the last semester of the Industrial Engineering and Management course at *Faculdade de Engenharia da Universidade do Porto.*

The main objective of the project was to find a capacity requirement planning – CRP – master data solution capable of representing the capacity data model and functionality requirements which were defined previously in other project at Qimonda. The final result should be a short list with some proposal solutions.

Note that no system implementation is required in this project; which means the implementation is not in the scope of this CRP Master Data solution procurement project. However it is important to refer that this is a Qimonda global project and when the solution was found it will be implemented not only in Qimonda Portugal but also in other 3 sites. So the project team is mainly composed by the capacity planners from 4 Qimonda sites mentioned and some people from IT departments which help with the technical requirements.

## 1.2 Project Phases

The graphic below explains the project phases and milestones that were proposed at the beginning of the project and the period of time they were planned to occur.

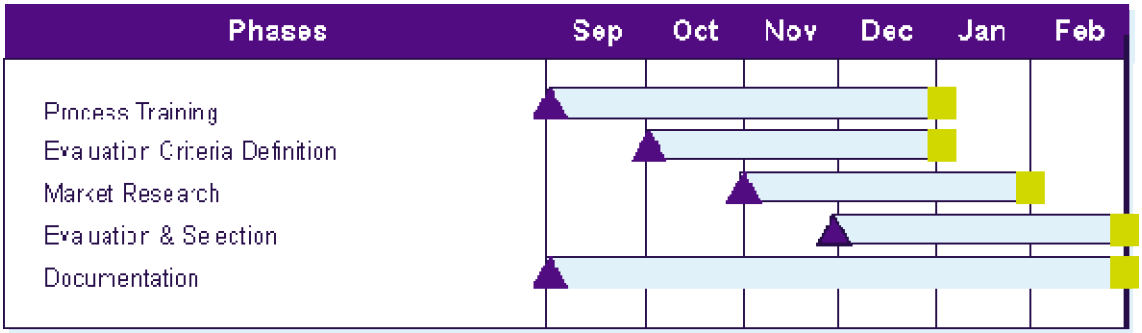



**Figure 1 – Gant Graph**

Since the beginning of the project until December process training was done. This included induction training which has the objective of introducing the company to new collaborators and also line training which was done in each production area so that all details in each area

were identified. This line training was an excellent way to initiate the project and a good opportunity to understand the whole environment of the enterprise.

Evaluation Criteria Definition started before it was planned – October – and the first objective was to analyze the previously defined capacity data model functionalities, modeling requirements and problems. Understanding all this detailed information was crucial for the project since it represented the beginning point of it; thus this phase took some time.

A very important phase in this project started still in October: market research or procurement phase. The objective was to procure solutions for the given problem. The largest search engine on the web was used – *Google* – but due to the amount of information that can be consulted it became a challenge to find relevant information. The picture below represents a detailed view of the project phases including the procurement phase and the evaluation and selection.

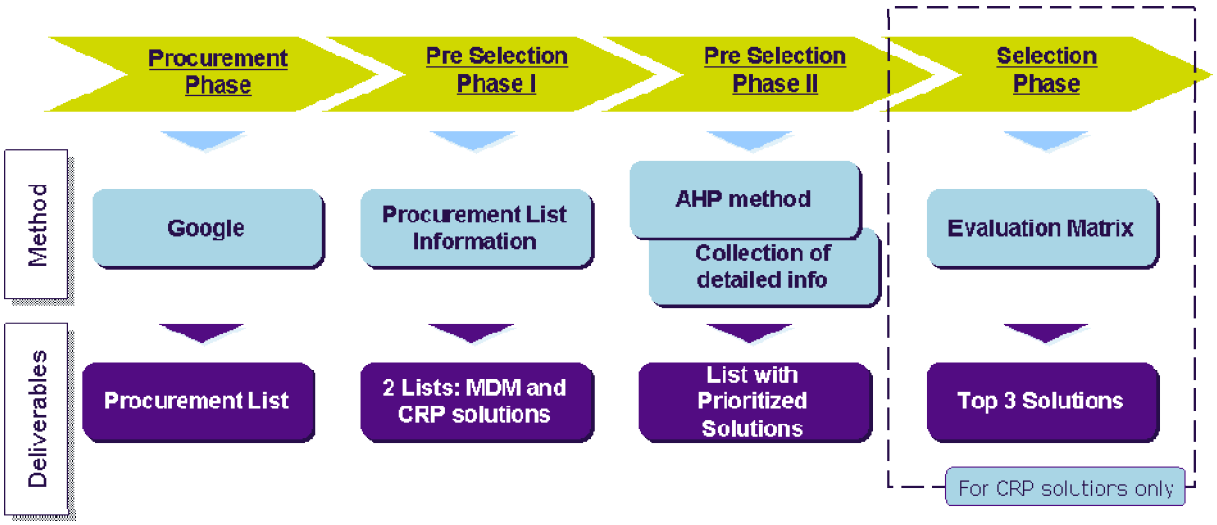



**Figure 2 – Project Phases**

Once a procurement list has been created with *Google's* help, its information was used to separate the solutions into two different lists – Pre Selection Phase I. The next step – Pre Selection Phase II – was the evaluation and prioritization of the solutions considering some technical, modeling and licensing criteria. This was done with a decision making technique - Analytic Hierarchy Process (AHP) - and by collecting detailed information. The selection ends in this phase, for MDM solutions. However, the top two CRP solutions went through another phase: Selection phase, in which they were evaluated with the help of a matrix.
This Evaluation and Selection (Pre Selection and Selection Phases) started before it was planned – December.

As this project involves a lot of concepts and assumptions the documentation started since the beginning of the project to make sure that nothing was omitted.

## 1.3 Structure of the report

The report is organized so that in the main body of the document can be found the most important topics and in the appendix, more specific information.

In this first chapter the scope and objective of the project as well as the milestones proposed for this project are presented. Furthermore, the reader can find some basic information about the company's history and products as well as the production of semiconductors at Qimonda. With this description of the organization will be easy to understand the project, the company's needs and the expected results.
Chapter 2 gives a description of this project; illustrates the present situation and what is expected to achieve with the project. Moreover, it shows the data model which is the beginning point of the project and briefly explains it.
Chapter 3 goes through each phase of the project: explains in a detailed way what was done and also the deliverables obtained.
The final results are presented and the conclusion and future projects can be found in Chapter 5, the final part of the main body of this report.

## 1.4 The Group Qimonda AG

Qimonda Portugal (QPT) is part of the group Qimonda AG, which was founded on May 2006. Until this date the same company was called *Infineon Technologies AG* but strategic decisions dictated Infineon's spun off and created this separated legal entity – Qimonda AG (still as part of the Infineon Group).
Infineon Technology AG was founded in 1999 and was also a spin off from *Siemens Technology AG*.
*Qimonda AG* is in the semiconductor industry, a very competitive industry where speed and innovation order the leaders. Nowadays, Qimonda is one of the biggest companies maintaining a strong market position. Its main competitors are Samsung and Hynix, amongst others.
The company produces a wide and growing range of DRAM products for infrastructure, graphics, mobile and consumer applications such as Standard DRAMs for use in PCs and workstations. It sells their products to strong costumers like Dell, Sony and Nintendo as can be seen in the picture below.


**Figure 3 – Portfolio of clients**

Production at QAG is done in two major production parts. This way, the company is divided in two types of sites: Frontend and Backend sites.
As can be seen in the picture below there are four Backend sites – Porto, Suzhou, Dresden and Malacca – and two Front End sites – Richmond and Dresden (this last one is both Frontend and Backend site). Qimonda also works with the join ventures Inotera and Winbond, both in Taiwan.


**Figure 4 – Qimonda's Sites**

At Frontend sites is done the first phase of the manufacturing of semiconductors, where the final product is a wafer. Wafers are a round, disc shaped piece of Silicon that contains the dies, brain of the chip. These are produced either in 200mm or in 300mm diameters. The number of dies in a wafer can be different depending on the kind of product and the size of the wafer.

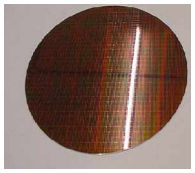


**Figure 5 – Wafer**

The Back End sites receive the wafers from the Frontend sites, and then produce the chips and/or modules (figures 6 and 7).


**Figure 6 – Chips**

**Figure 7 – Memory model**

1.5 Qimonda Portugal – Production Process

The Porto site was built in 1996 when it was still part of *Siemens AG*. Since it was raised until now, it hasn't stopped growing and this required a large headcount and production area. Nowadays, there are more than 1900 workers at Qimonda Portugal and a production area of 15 500 $m^2$.

**Figure 8 – Porto Site**

Qimonda Portugal, as mentioned before, is a Backend site, but also performs two Frontend operations that make it the most versatile Qimonda Backend site: WLA/RDL (Wafer **L**evel **A**ssembly/**R**e-**D**istribution **L**ayer) and Wafer Test, operations that will be better explain later in this chapter.

It is also important to refer that, since the first semester of 2007, Porto exchanged its production line: its modules line have been moved to Malacca, the same way as all component lines from Malacca have been transferred to Porto. So in this moment, Porto produces only components.

The production process at Qimonda Portugal can be divided into four main areas (figure 9): WLA/RDL, Wafer Test, Assembly and finally the Test area.

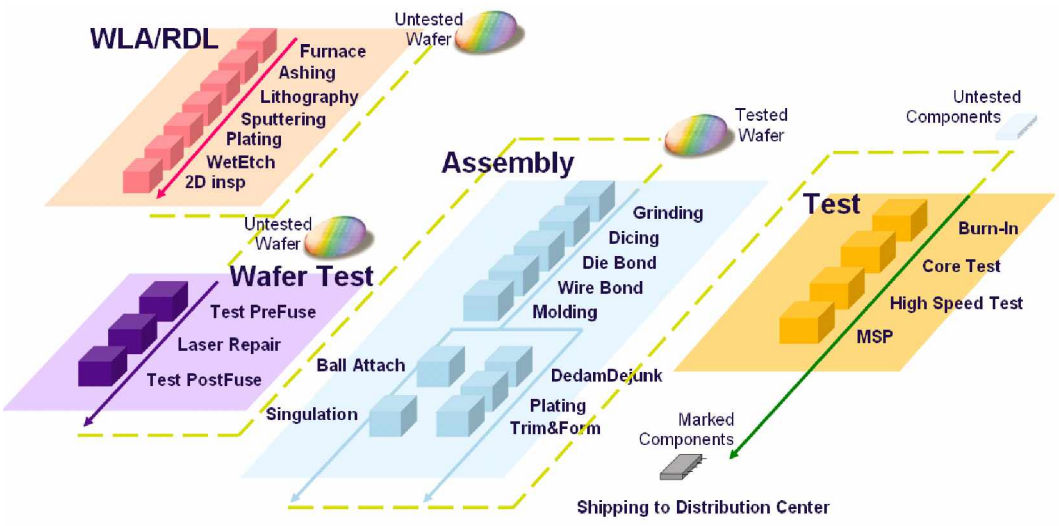



**Figure 9 – Manufacturing Areas at Porto Site**

### WLA/RDL (Wafer Level Assembly/Re Distribution Layer) and Wafer Test

In RDL area each die of the wafer is being prepared for multi-die packaging. This technology was recently introduced at Qimonda and it consists of making components with more than one die inside - Dual Die chips.

Since this production area is the most delicate and photosensitive, it is performed under yellow light and in a 1K clean room. This means that there are less than 1 thousand particles with a diameter no smaller than 0.5 micron per cubic foot in that area. There are also 10k

rooms (ten thousand particles per cubic foot) in Pre Assembly, Bond and Mold areas and 100k rooms in the others operations.

Wafer Test is the final Frontend area where all wafers are tested to make sure that, according to established standards of quality, they are physically and functionally healthy.

**Assembly**

The Assembly area is divided in three operations: Pre-assembly, Bond or Front of Line and End of Line.

In Pre-assembly operation the objective is to grind the wafer, put it in a carrying frame and cut the wafer so that all dies become individual. They still stay in the same form because they are above a tape that prevents them from falling down.

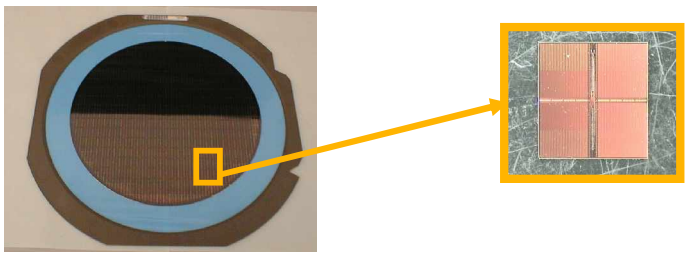


**Figure 10 – Wafer and individual die in Pre-Assembly**

From this stage onward, it is important to consider the type of package being dealt. Depending on whether the package is TSOP (Thin Small Outline Package) or BOC (Board on Chip) we will see different processes and raw materials. BOCs represent approximately 80% of the whole production at QPT as they are technologically improved, when compared to TSOPs: they are smaller, have the same capacity and lower energy consumption; and even better performance.

**Figure 11 –BOC products**


**Figure 12 – TSOP products**

Bond is the next operation and it is divided in two processes: Die Bonding and Wire Bonding. The purpose of Die Bonding is to attach the individual chips into the substrate electrical carrier (removing them from the wafer).

At **Die Bond**, BOCs are placed on substrates and TSOPs are placed on leadframes as shown in the figures 13 and 14.

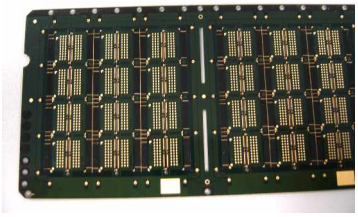


**Figure 13 – substrates with BOCs**

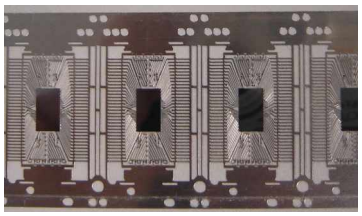


**Figure 14 – leadframe with TSOPs**

At **Wire Bond**, the die is connected to the substrate/leadframe through gold wire so that the electric contact could be established between the die and the exterior.

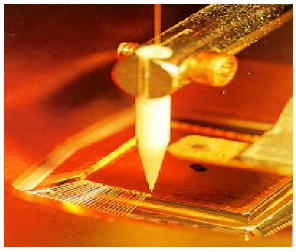


**Figure 15 – Wire Bond**

At the next stage of the process- End of Line- TSOP and BOC packages will perform one common operation- Molding- and them their flow is completely different. The purpose of Molding operation is to encapsulate the chips and protect the most sensitive areas of the component with Epoxy Mold Compound in order to prevent from mechanical and chemical damages.

After this stage, **BOC**s will go through two other stages- **Ball Attach** and **Singulation**- which will place the solder balls in the chips and will separate the substrates with the chips into individual chips. At this moment they have their final layout.

The **TSOP**s will go through three different operations: **DeDam/DeJunk, Plating** and **Trim&Form.** After these, the chips have their last layout with the "legs".

### Test Operations

At Test Operations, all components will have to go through a series of tests so that, according to their performance, they can be marked with the correspondent quality. There are two main operations, the Burn In operation and the Test operation. The objective of Burn In is to reduce the mortality fails of the chips, which is height at the beginning of their life, as it is shown in the graph below. Due to this and to simulate child mortality, the chips will be exposed to electric stress under high temperatures inside an oven.

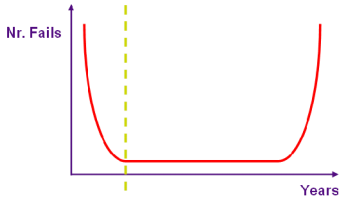



**Figure 16 – Fail rate curve**

In the Test Operation the chips will be exposed to more tests: first the components go through "stress tests". More specifically, the chips will be put through electric currents at extreme temperatures (high and low) to test their functionality and then they will do a High Speed Test where the speed of response of each component will be tested.

At Mark, Scan & Pack, the components will be marked with the brand and the sales description and then they will be scanned to make sure that they are correctly marked. Finally they will be packed in reels or trays. Each reel has 1500 or 2000 chips depending on the specification and if packed in trays will have 1500 chips. The reels final aspect is represented in the picture below.

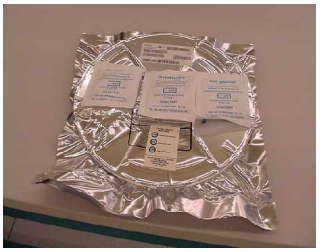


**Figure 17 – Reels package**

# 2 CRP - Capacity Requirement Planning - Master Data Project

In the first part of this chapter, the current situation is presented. The objective is to explain the problem so that the user can understand the reason for the present project.

In the next part, a brief overview of what is expected from a capacity planning solution as well as from a master data management solution is given. Moreover, it is presented a short comparison between the actual capacity planning tool – dCp – and the future situation.

Finally, the last component of this chapter illustrates the given capacity data model as well as some of its most important requirements.

## 2.1 Current Situation: dCp tool

In fact, Qimonda already has a solution for capacity planning – dCp, dynamic capacity planner – with its own databases integrated which was created in the 90's by the enterprise Nimble specifically for Qimonda AG.

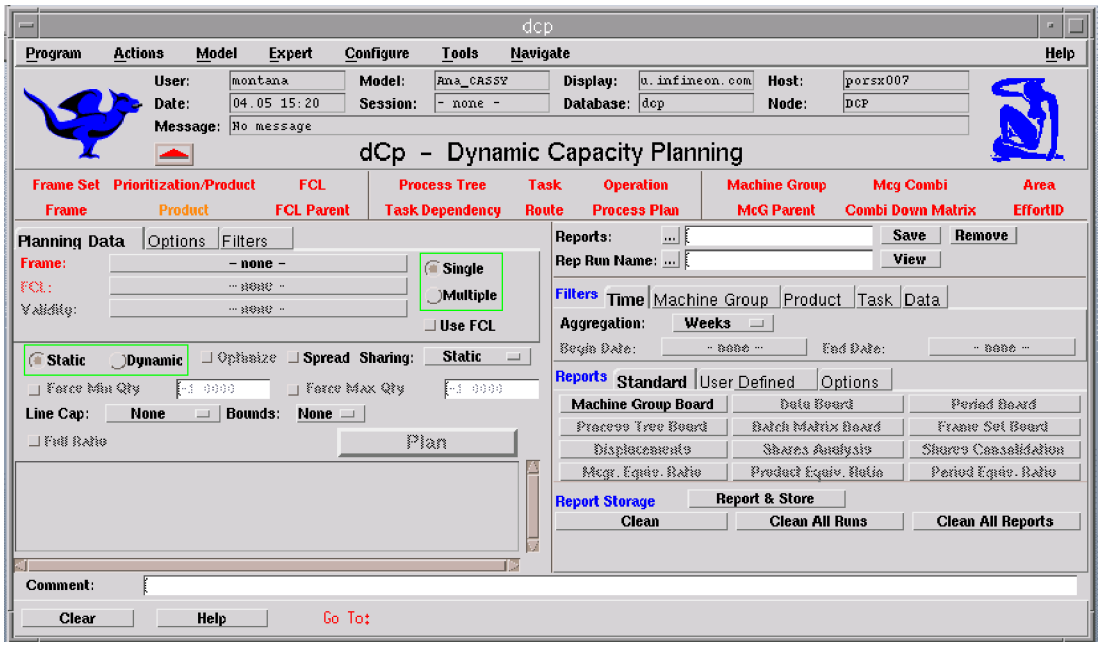



**Figure 18 – dCp GUI**

dCp is connected to a lot of other softwares in Qimonda – FPL (Factory Planning), MPL (Master Planning), SPL (Supply Planning), etc. - that use its information as input. The problem is that dCp was created as a planning solution for Frontend sites (where it is very

useful) and only later it was adapted to Backend sites. The result of this update was a solution that doesn't work as well as it was expected: dCp doesn't have the most appropriated data model, many transformations must be done so that the customer applications can recognize data from dCp and finally it doesn't have a global repository where all applications can pull their information (instead of that, dCp has many distributed information which is stored in various tables but which belong to the same object class). This fact implies that there is no way to guarantee the consistency between all data and the relationships between them. And as new data is introduced, the scenario can be worst. Basically, this explains the need of having a master data management solution.

Due to all problems and limitations, dCp is used as an auxiliary feature in Porto site. In fact, capacity planners use spreadsheets to do their capacity planning, as most people in the semiconductor industry. Data must be maintained in multiple locations due to the variety of spreadsheets and usually this is done manually. In many cases, different people in different organizations maintain this data and it is not necessarily even consistent between them. A wide variety of complexity exists in current capacity planning models. Some include only a few simple formulas; others have a wide variety of links with others sheets or even macros for easing data entry and conducting "what if" analysis [6] [7].

Actually, although excel is a reference software for its customization and versatility it has these disadvantages in terms of consistency and data reliability, information security and also speed of calculation.

## 2.2 Future Situation – a CRP Master Data Solution

### Capacity Requirement Planning (CRP)

Capacity planning is the process of determining the production capacity needed by an organization to meet changing demands for its products. In the context of capacity planning, "capacity" is the maximum amount of work that an organization is capable of completing in a given period of time.

Behind a capacity planning solution there are complex models with the objective of modeling the capacity of all manufacturing area's flows. The solution should be able to simulate the process of each manufacturing area according to some critical parameters of the process and of each equipment/group of equipments.

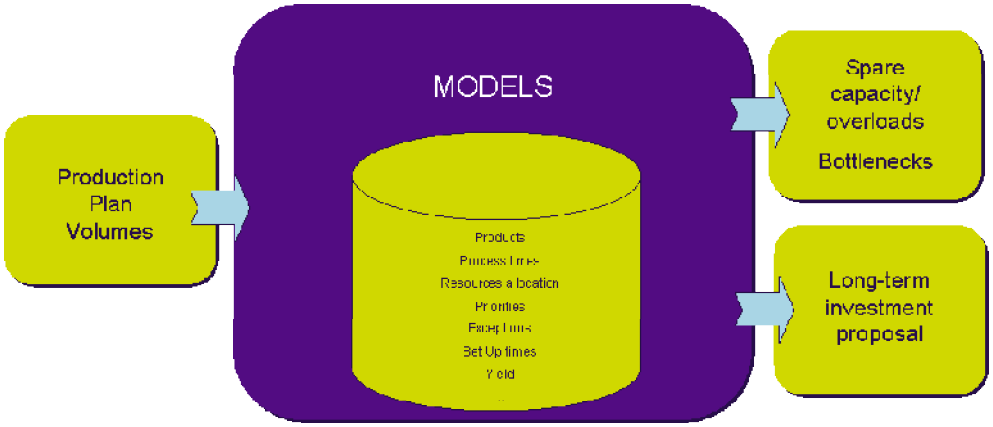



**Figure 19 – CRP solution example**

Each model receives as input a production plan for a specific period of time with the volumes of each product that is supposed to produce and the output should be an overview of the overloaded areas/equipments or the spare capacity. The spare capacity is the excess of capacity that is not necessary for the production. If in one hand, is fundamental to decrease the spare capacity because this means that there are equipments not utilized, on the other hand if there is any spare capacity and a problem occurs the line can not react. For example, if we have only one equipment in an operation and no spare capacity exists, in case of a shop floor problem we cannot produce. So it is necessary to balance this situation.

Due to the large complexity of each manufacturing area and the different granularity they have, there is a need of having one model for each of them: a model for Assembly area (including Pre-Assembly) and another one for Test area.

The Capacity planner, the person that plans capacity, has to analyze the output which means the loads/overloads and to take some actions: reject the demand, improve production times or do an investment in new resources in case of need. That is the reason why the output of CRP solution should also be a long-term investment proposal.
Figure 20 is an example of spare capacity output. For example, in the last week of October there are 5 equipment groups with insufficient capacity to produce. At the same time, it is easy to identify a bottleneck situation which, in this week, is the Plasma before Wire Bond equipment with the highest overloaded value of 8168 millions. This value means that the volume requested to produce exceeds the equipment capacity in almost 4 millions in equivalent units (when compared to the reference product: 256M D11 P-TFBGA-60). The equipment with more spare capacity is the group of Bond Cure ovens.

| | B | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM | AN | AO | AP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Qimonda Uptime Spare | | | Q1 0607 | | | | | | | | | | | | | Q2 0607 | | |
| 2 | Reference Product | | | Oct-06 | Oct-06 | Oct-06 | Oct-06 | Nov-06 | Nov-06 | Nov-06 | Nov-06 | Dec-06 | Dec-06 | Dec-06 | Dec-06 | Dec-06 | Jan-07 | Jan-07 | Jan-07 |
| 3 | 256M D11 P-TFBGA-60 | | CW | 0640 | 0641 | 0642 | 0643 | 0644 | 0645 | 0646 | 0647 | 0648 | 0649 | 0650 | 0651 | 0652 | 0701 | 0702 | 0703 |
| 4 | x8 QC 6ns IFDD 200mm | | FW | 0701 | 0702 | 0703 | 0704 | 0705 | 0706 | 0707 | 0708 | 0709 | 0710 | 0711 | 0712 | 0713 | 0714 | 0715 | 0716 |
| 115 | | | | | | | | | | | | | | | | | | | |
| 117 | Equiv. Spare Capacity | | | | | | | | | | | | | | | | | | |
| 119 | DBG Laminating 300mm [wfr] | | | 436 | 1430 | 1146 | 1220 | 3913 | 406 | 1879 | 1370 | 1606 | 1932 | 92 | 1856 | 548 | 284 | 960 | 5176 |
| 120 | DBG Laminating 200mm [wfr] | | | -3182 | 3003 | 938 | 2791 | -5286 | -438 | 628 | 1454 | 681 | -538 | -947 | 48 | -182 | -438 | -388 | 1526 |
| 123 | GMP (300mm) [wfr] | | | 177 | 2679 | 767 | 1465 | 164 | -196 | 1536 | 3509 | 2359 | 417 | 3456 | 1243 | 2217 | 3169 | 428 | 1704 |
| 124 | GMP (200mm) [wfr] | | | -5211 | -4188 | -4706 | -3948 | -8671 | -6793 | -4851 | -2637 | -1722 | -1222 | -6995 | -1326 | -3253 | -3884 | -165 | 1050 |
| 125 | DBG Dicing 200mm [wfr] | | | 391 | 2349 | 2899 | 870 | 904 | 193 | -228 | 55 | -557 | 1564 | -428 | 2741 | 2208 | 288 | 1894 | 2308 |
| 127 | DBG Dicing 300mm [wfr] | | | 551 | 2556 | 67 | 2168 | 32 | 821 | 2790 | 4607 | 4947 | 2956 | 2356 | 1731 | 1455 | 2356 | 2568 | 3588 |
| 129 | Substrate PRINTER | | | 715 | 1168 | 1133 | 695 | 768 | 498 | 588 | 1028 | 901 | 1036 | 300 | 1755 | 794 | 2006 | 2485 | 2064 |
| 131 | Die Bond TSOP 200mm | | | 373 | 449 | 408 | 134 | 111 | 478 | 400 | 404 | 951 | 585 | 506 | 587 | 280 | 28 | 170 | 192 |
| 132 | Die Bond TSOP 300mm | | | 63 | 92 | 75 | 103 | 24 | 184 | 75 | 287 | 362 | 96 | 124 | 362 | 215 | 224 | 444 | 330 |
| 133 | Die Bond FBGA 200mm | | | 1849 | 1568 | 1044 | 1328 | 739 | 952 | 1541 | 2520 | 2741 | 2250 | 1538 | 1936 | 1722 | 1635 | 1462 | 1359 |
| 134 | Die Bond FBGA 300mm | | | -185 | -21 | -3 | -161 | -41 | -104 | -212 | -288 | -168 | -253 | -186 | -11 | -32 | -180 | -324 | -241 |
| 135 | Die Bond HITACHI | | | -1340 | -1472 | -839 | -854 | -860 | -893 | -1209 | -1819 | -2389 | -1441 | -1150 | -1771 | -1367 | -1378 | -1180 | -1066 |
| 137 | Die Bond Dual Dies 300mm | | | 162 | 960 | 48 | 200 | 200 | 200 | 170 | 180 | 200 | 390 | 200 | 663 | 351 | 306 | 675 | 466 |
| 138 | Die Bond Face ups | | | 307 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 244 | 229 | 121 | 200 |
| 140 | Bond Cure Ovens | | | 5990 | 6242 | 5981 | 5877 | 5417 | 5475 | 5558 | 5715 | 5820 | 5726 | 5428 | 5630 | 4240 | 4147 | 5578 | 5437 |
| 141 | Wire Bond TSOP | | | -1338 | -1346 | -1488 | -1058 | -806 | -1012 | -718 | -131 | -472 | -575 | -346 | -462 | 73 | -107 | -1 | -124 |
| 142 | Wire Bond FBGA | | | 206 | 2331 | 1763 | 1383 | 961 | 795 | 3209 | 1808 | 2073 | 2274 | 1646 | 2638 | 1788 | 1792 | 2349 | 1645 |
| 143 | Plasma before Wire Bond | | | -7696 | -7840 | -8248 | -8168 | -8152 | -8148 | -7925 | -7813 | -7992 | -7678 | -7882 | -7379 | -2628 | -2477 | -3074 | -3149 |
| 144 | Plasma before Mold | | | 735 | 615 | 342 | 472 | 363 | 429 | 715 | 799 | 619 | 1358 | 1154 | 6172 | 4297 | 4349 | 6483 | 6279 |
| 145 | Mold TSOP | | | 359 | 940 | 815 | 640 | 581 | 617 | 440 | 128 | 130 | 109 | 103 | 22 | 127 | 43 | 120 | 76 |

**Figure 20 – Spare capacity per equipment**

## Master Data

The other component of this required solution is to be a global repository; a master data management solution.

Master Data Management (MDM), also known as Reference Data Management is a discipline in Information Technology (IT) that focuses on the management of reference or master data that is shared by several disparate IT systems and groups. MDM is required to warrant consistent computing between diverse system architectures and business functions [4].

MDM enables organizations to ensure that enterprise master data (assets, people, locations) across multiple systems and departments is accurate and consistent and share that information securely with trading partners. It ensures that the necessary processes, policies, and procedures are put in place so that the benefits gained are not lost as new data is introduced or if existing information is updated. Finally, it allows organizations to manage the complex hierarchies and relationships within their data such as the relationships between two products, a client and an account, a customer and a vendor, a part and a product, and so on.

Through effective MDM, organizations can eliminate errors, become more efficient in their business activities, and accelerate critical processes such as new product introductions, service provisioning, cross-sell/up-sell, and customer service.

Successful MDM also depends on a solid data governance framework. Appendix B represents a research on data governance topics.

The CRP MD solution (figure 21), will collect all the information the customer applications – FPL, MPL, SPL, F… – need so that they can pull them without any problems. Furthermore, the master data solution will be linked with a capacity planning solution. This can be done in three ways:

- **MD solution + dCp:** this means that the solution that will be found in this project will be just a master data system. This MD will be connected to dCp, which will just be used as a capacity planning application.
- **MD solution + CRP Solution:** this is a similar case compared to the first one but with a difference: instead of using dCp, another capacity planning solution will be used, which should be found according to market availability.
- **CRP MD with integrated solution:** as the name explains this solution won't need any other application for capacity planning purposes, it will be at the same time a repository of all information and also a capacity planning solution.

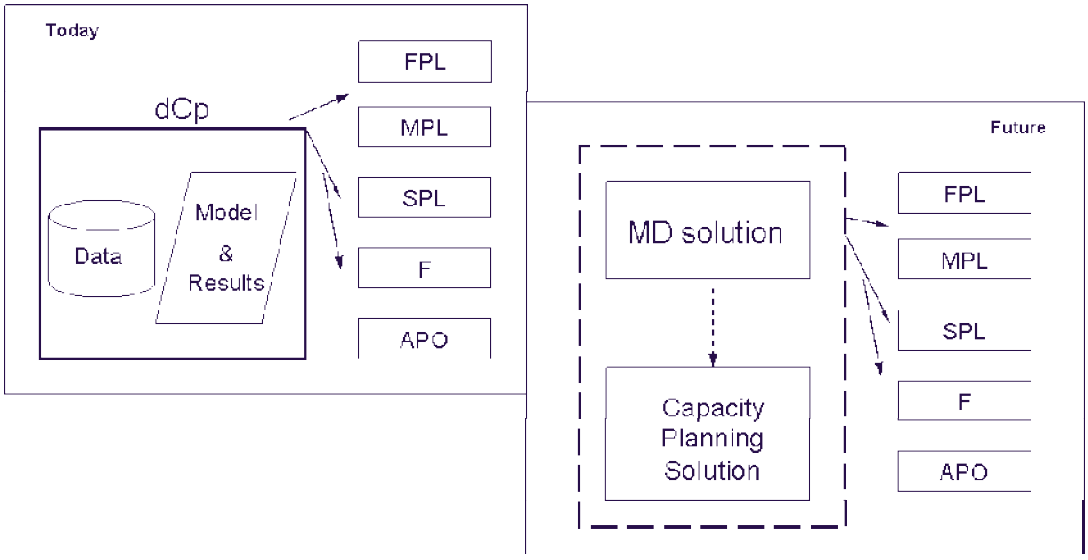



**Figure 21 – dCp versus CRP MD**

## 2.3 CRP Data Model

### 2.3.1 Data Model Overview

As mentioned before, the objective of this project is to find a solution capable of representing the capacity data model and functionality requirements which were earlier defined in other project. So, since the CRP data model is the starting point of this project it makes sense to give an overview of it. First of all, the objective of that project was to collect requirements and specify a data model that could improve the production capacity planning and equipment investment business processes. Simultaneously, that tool aimed to simplify the production processes, especially concerning production controlling and shop floor control processes.

The picture below represents the CRP data model. There are three different kinds of classes, the main classes, the result classes and the complementary classes. The main classes can be understood as the basis of the project, with these classes the model can be completely understood and the main functionalities can be kept. The complementary/secondary classes have the objective of keeping information about a specific part of the model and complement it with the information kept by the main classes. The result classes as the name explains keep the information about the results that the model produces [3].

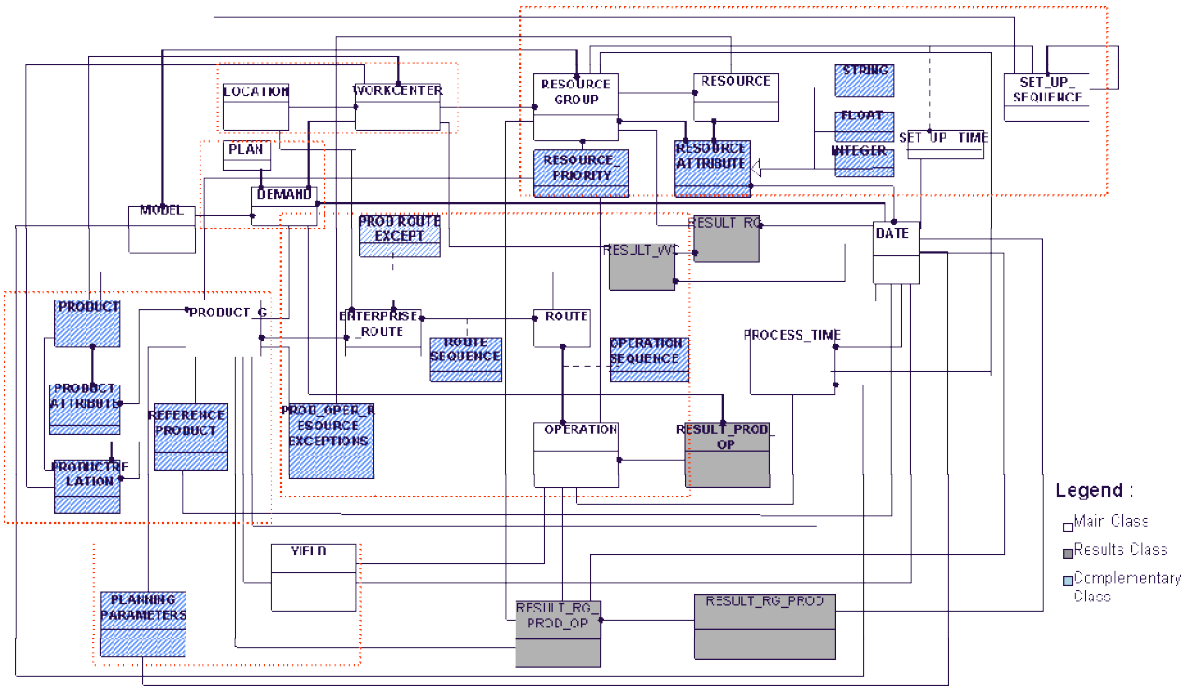



**Figure 22 – CRP data model [3]**

### 2.3.2 Data Model Functionality and Requirements

Once the data model is presented it makes sense to illustrate some of its most important functionality, which was specified in a previous project, as mentioned before.

**Manufacturing Hierarchy**

Qimonda has a Manufacturing Hierarchy which is composed by:

- Location – the location is the top level of the Manufacturing Hierarchy. A Location means a physical construction which can be a production site or not. QIMONDA_PT is a Location.
- Manufacturing Level (ML) – A Location has diverse Manufacturing Levels. ML is the first way as line production is divides. Here in Portugal there are five ML – WTEST, RDL, CPREASSY, CASSY and CTEST.
- Area – A ML has diverse Areas. For example CTEST has three Areas – Burn-in, Test and Mark Scan and Pack (MSP).
- Work Center (WC) - A Work Center is a cluster of different Resource Group with the same functionalities. An Area has a group of WC.
- Resource Group (RG) – It is a group of resources with equal or comparable attributes or behaviors.
- Resource (R) – is an equipment, a machine, a tooling, or a fixture.
- Operation (OP) – A Work Center usually has only one operation, nevertheless sometimes has more than one. In Burn-in the operation can be load or unload.

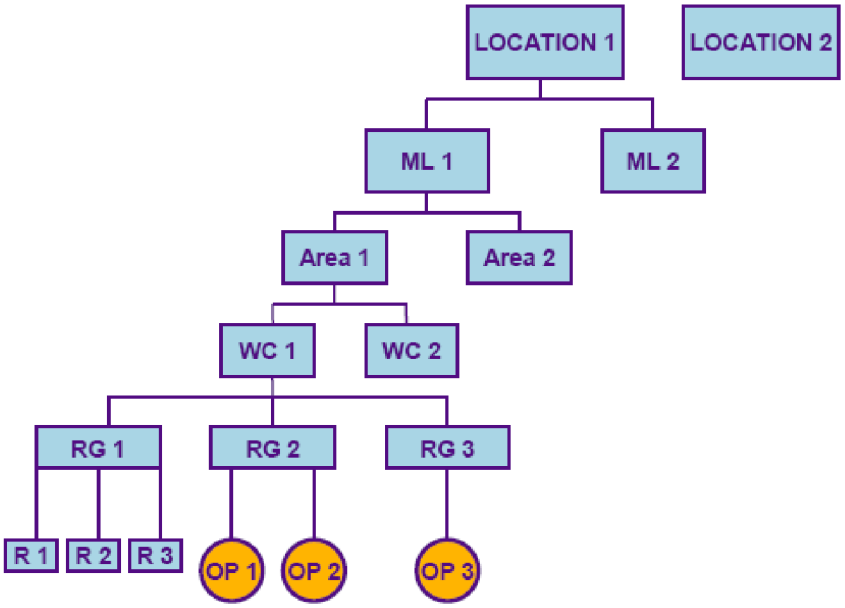



**Figure 23 – Manufacturing Hierarchy [3]**

### Resource Exceptions Modeling

A product in an operation can be processed in more than one Resource Group. This is a problem of resource allocation. But there are more considerations that should be taken. In a resource group not all the resources can process all the products that are consider for the resource group. In this scenario, it is not a problem of resource allocation but a problem of Exceptions. In the Exceptions model there are the permissions and the exclusions.

To better illustrate this problem an example will be used. There are three products (Product A, Product B and Product C) and all of them can be processed in the Resource Group A. But the Resource Group A has the Resource 1 and the Resource 2. If an exclusion is considered so all the products can use both resources unless the Product A that can not use the Resource2. On the other hand other situation can be considered. It happens when all the products can use the Resource 1 but only the Product B can use the Resource 2, in this way this is a permission.

For this new concept be specified in the model is needed a new class - Exceptions Class.
This class will be linked with product, operation and resource. And the class returns if this relation between the resource the operation and the product is allowed, disallowed or for engineering only.

### Resource Conversions and Set up times

Qimonda Portugal produces daily a range of different products. It is frequent that different products in the same day need to share common resources – so resources conversions are needed.

The resource conversions give to Qimonda an increase of flexibility but decrease the efficiency because they consume time, thus reduce available capacity. If on the one hand it is mandatory to have flexibility, and only this way it is possible to produce a range of different products, on the other hand if the conversions are too much the output will decrease. Consequently, the conversion time (Set Up Time) is a variable that needs to be optimized.

The Set Up Sequence Class keeps the information about the products that can be produced in a resource group.

### Investment Planning

Investment planning is one of the crucial parts of this model. In order to investment planning be consistent it is essential to keep in an efficient way as much information as is possible.

The resources from the same resource group along the time have different prices. The price of each resource is an attribute that might be modeled. The resource price will be an attribute of the resource attribute class.

The investment done per Resource Group will be stored in a new class the Capacity Resource Group Class. This class will keep the money invested until now in the resources from a specific resource group. In the same way that is needed to keep the information about the Resource Group the information about the investment of a Work Center might be also kept.

The introductions of new products involve costs. These costs come from new tools for each specific product and sometimes from completely new equipment. It is interesting to keep the information about the investment necessary to introduce a new product. This information will be stored in the class – Capacity per Resource Group per Product.
With all this information the company can keep all the information with a format that is easy to understand.

### Resource Priorities

Machines usually have more than one tool group associated to make the production more flexible. With this potentiality, a specific equipment can produce a range of different products only changing the tool.

Not only the machines have more than one tool- but also some operations have more than one resource group associated, so in one operation the same product can be done in more than one equipment group and each equipment group can use more than one tool group.

This flexibility is very positive for production although sometimes the information is not as organized as desired and sometimes it is not obvious which resource should be chosen. This situation can be improved with a relation between equipment and tools.

With the objective of satisfying this necessity (alternative combinations) it was created a Resource Priority Class that relates the machine, the tool and priority. This can be done if a sorted number is associated to each resource and tool. The machines and tools with the same number belong to the same group.

### Distinction of main resources and tooling

As previously mentioned, production needs equipments and tools. Each equipment group can have more than one tool group. And a tool group can be in more than one equipment group.

Nevertheless both, equipment and tools are resources and can be included in the resource group. Though this is a good simplification, it is necessary to create an attribute in resource group to distinguish them. Thus, it is necessary to create the attribute Resource Type where the machine has the definition of main resource, and the tool the definition of “tooling”.

This distinction is essential for capacity planning since without this the capacity planners could not distinguish them.

### Alternative Scenario

As mentioned before, Qimonda PT receives a production plan that defines what the site should produce in the next weeks. Although, the Semiconductors Industry is very fast and sometimes needs to change the initial plan, every time it is necessary to change the plan the Capacity Planners receive an e-mail asking if it is possible to produce a specific quantity of a product in a specific date and if for this demand to be possible is necessary abdicate to produce any other product. This analysis is vast and in this fast industry it is very usual.

Every time the Capacity Planners want to simulate the capacity with the new instructions they need to create a new file and specify it. It is pretended that this model will be able to do an alternative scenario without a big effort.

Alternative scenario, in this model, will be the opportunity for the Capacity Planners to insert in the model the new data that they received and the model returns the capacity that this new specification will spend. Although the example of the new volumes of products will probably be the most usual scenario, the model will be flexible enough to analyze with other data, such as with a different number of resources, or different process times.

Certainly this solution will optimize the Capacity Planners work and will be a great improvement in the company.

### Capacity Necessary to Produce per Operation in Equivalents

This functionality will calculate the available capacity to produce per operation in equivalents. This result is expressed in the class Result per Product and Operation (RESULT_PROD_OP) in the attribute Equivalent Volume In. This attribute is a result (product) between the Physical Volume In and the complexity of that product.

Keeping the information in equivalents transmits more sensibility because all the operations have the results in the same unit.

### Spare Capacity

To calculate the spare capacity is needed the help of a functionality. The Spare Capacity is the result between the maximum capacity that one resource group can produce less the value of the local starts result in equivalents for the same resource group. If the spare capacity is positive it means that is possible to do the plan, if it is negative it means that there is not enough capacity to do the plan. The area with less spare capacity is the bottleneck

An additional option is to divide the spare capacity by the maximum capacity of a resource group. Thus the result is given in percentage and transmits more sensibility.

# 3 Procurement, Evaluation and Selection of CRP Master Data Solution

## 3.1 The Procurement Phase over the internet

This section describes a very important phase of this project: market research or solution procurement. As mentioned before, the objective was to research solutions for the given problem, which means, try to find commercial or open source CRP master data solutions capable of representing the capacity data model and functionality requirements.
The first source for this research was *Google*, the largest search engine on the web, and for that some keywords were used: master data management, capacity planning, enterprise asset management, manufacturing resource, capacity requirement planning master data, etc. Much information was given with these keywords (or a combination, thereof) and it was necessary to filter some of the findings, for example, many documents were related to IT, such as planning capacity for networks or servers.
The result of this research, as can be seen in the table below, was a large list of softwares/applications that seem to be possible solutions for this problem – Appendix A gives a brief explanation of each solution.

| ID | **Software's Name** | **Link** |
|---|---|---|
| 1 | Eyelit Manufacturing Asset Management | http://www.eyelit.com/mfg_asset.html |
| 2 | Asset Management Repository Software:WiseTrack 5.5 | http://www.asentrix.com/repository_software.htm |
| 3 | Zoomix accelerator | http://www.zoomix.com/mdm.asp |
| 4 | IBM Master Data Management | http://www-306.ibm.com/software/br/db2/data/masterdata/index.shtml |
| 5 | IBM Tivoli Maximo AM | http://www-306.ibm.com/software/tivoli/solutions/asset-management/index.html |
| 6 | TIBCO MDM | http://www.tibco.com/software/master_data_management/default.jsp |
| 7 | Lawson Enterprise Asset Management (EAM) software | http://www.lawson.com/WCW.nsf/pub/EAM_EBD711 |

| | | |
|---|---|---|
| 8 | TMA Enterprise | http://www.tmasystems.com/products_tma_enterprise.asp |
| 9 | Datastream 7i | http://www.datastream.net/english/products/datastream7i.aspx |
| 10 | Kalido MDM | http://www.kalido.com/solutions/software/masterdatamanagement/ |
| 11 | MIMOSA | http://www.mimosa.org/ |
| 12 | Giraffe Scheduling System | http://www.giraffeproductionsystems.net/gsshome.htm |
| 13 | Job Master manufacturing software | http://www.the-job-master.com/index.php?reqTab=PC |
| 14 | Manufacturing Plus | http://www.verticent.com/products/erp/mfg_plus.htm |
| 15 | NRX aMDM: Asset Hub(TM) v4.5 | http://news.thomasnet.com/fullstory/522374 |
| 16 | i2 Master Data Management | http://www.i2.com/solution_library/ng_v_Master_Data_Management.cfm |
| 17 | Teradata Master Data Management Solution | http://www.teradata.com/t/page/148161/index.html |
| 18 | OpenBravo | http://www.openbravo.com/product/ |
| 19 | CRP – Capacity Requirement Planning | http://crpcapacity.sourceforge.net/ |
| 20 | FabTime Capacity Planning Module | http://www.fabtime.com/capplan.shtml |
| 21 | Exact Software | http://www.exactamerica.com/macola/progression.html |
| 22 | Exact Alliance - Material and Capacity Requirements Planning | http://www.exactamerica.com/alliance/capacity_requirements_planning.html |
| 23 | Answer Capacity Requirements Planning | http://www.answersolutions.com/solutions/manufacturing/crp/ |
| 24 | GNU ERP | http://www.gnu.org/software/gnue/project/what.html |
| 25 | Oracle: PeopleSoft Supply Planning | http://www.oracle.com/applications/peoplesoft/scm/ent/module/supply_planning.html |
| 26 | Izaro grey APS | http://www.softi9.pt/products/details.php?id=iGreyAPSpor |
| 27 | Atlas Planning Suite: capacity module | http://www.atlasplanningsuite.com/rough_cut_capacity_planning.shtml |
| 28 | Siperian MDM Hub | http://www.siperian.com/index.cfm?page=body&crid=28 |
| 29 | SAP SCM | http://www.sap.com/solutions/business-suite/scm/featuresfunctions/planningandcollaboration.epx |

| | | |
|---|---|---|
| 30 | SAP ERP | http://www.sap.com |
| 31 | SAP Netweaver | http://www.sap.com/platform/netweaver/index.epx |
| 32 | Open MFG | http://www.openmfg.com/ |
| 33 | IPASS APS | http://www.idimensionsystems.com/solutions_in_detail/solutions_02.html |
| 34 | Informatica | http://www.informatica.com/solutions/integration/mdm/default.htm |
| 35 | Hyperion | http://www.hyperion.com/products/foundation_services/mdm_services.cfm |
| 36 | EBX Platform MDM | http://www.orchestranetworks.com/product/features_models.cfm |
| 37 | Xtentis MDM | http://www.amalto.com/amalto/index.php?id=21 |
| 38 | Compiere | http://www.compiere.com/ |
| 39 | Preactor | http://www.preactor.com/ |
| 40 | QAD Manufacturing | http://www.qad.com/ |
| 41 | FPS | (solution got internally at Qimonda) |

**Table 1: List with all solutions found**

On the other hand, it was essential to collect as much as possible information about each solution. This was done through the information available in their websites, such as in whitepapers, documentation or brochures. This information allowed building a huge list of information as can be seen in the picture below. This information will be used in the next phases of the project.

| ID | Software/ Application's name | MDMS | CRP | Modeling | Technical Req. | Interfaces | Functionality (Capa Planning) | Reporting |
|---|---|---|---|---|---|---|---|---|
| 6 | TIBCO MDM | x | - | flexible and extensible data model | available for Oracle, MS SQL S | web user interface;friendly | no capacity planning module | included |
| 10 | Kalido MDM | x | - | flexible data model changes during the stage of implementation; manages any type of master data | | web based interface | no capacity planning module | included |
| 14 | Manufacturing Plus (capacity planning f | - | x | WHAT-IF Simulations included, alternate routings for manufactured items, forecast/plan comparison | MS SQL server/Oracle | user interface | capacity planning feature | included |
| 15 | NRX: Asset Hub(TM) v4.5 | x | - | data model with prebuilt but customizable templates, open architecture to facilitate access to relevant data, Web-based portal, Data and document collection and validation | | user interface | no capacity planning module | included |
| 16 | i2 Master Data Management | x | - | flexible data model, data validation rules | | | [i2 MDM for Planning Data: can manage data staging and maintenance for supply chain planning implementations] | |
| 17 | Teradata Master Data Management Sol | x | - | model-driven, open standards, service-oriented architecture | teradata database solution | user interface | no capacity planning module | included |
| 18 | OpenBravo | - | - | definitely no sufficient data model | database Oracle and PostgreSl | user interface not so friendly Exports records to excel, CSV & PDF files | web-based ERP, process plan feature, no CRP module | included |
| 19 | CRP - Capacity Requirement Planning | - | x | process times, demands, products, resources, res.groups,res. Priorities, Choice between absolute dates or named calendars | | user interface, Class export to CVS, Element export to XML | CRP Model that keeps the master and model data, CRP Logic that provides the calculation rules and algorithms | included |
| 20 | FabTime Capacity Planning Module | - | - | Dispatching Module: able to define priorities, Quickly run scenarios | | web-based digital dashboard sy | capacity planning module only based only bas | included (charts, tables) with W |

**Figure 24: Example of the information collected for each software**

### 3.2 Solution Pre-selection I: identification of CRP versus MDM solutions

After the procurement phase, a pre-selection was done. Once there is a long list of solutions it was necessary to reduce it: each solution was analyzed in terms of some topics: modeling, interfaces, reporting, functionalities and technical requirements. However, in this pre-selection phase the most important points were to analyze if the solution was a master data management (MDM) or a capacity requirement planning (CRP) solution or even both and also to verify if the software company has any know-how in semiconductor industry.

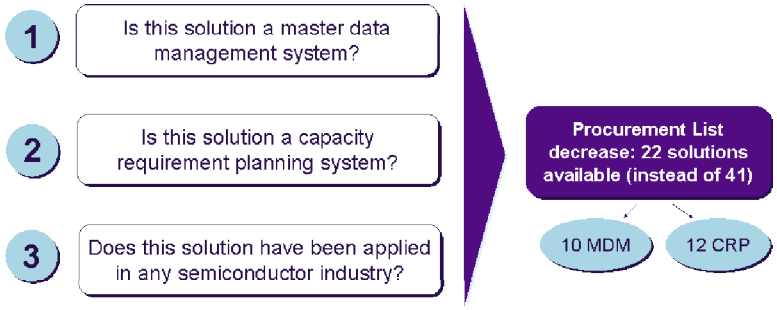



**Figure 25: Summary of this phase analysis and result**

After the analysis, many solutions were removed from the list presented above, e.g.: Zoomix Accelerator, WiseTrack, IBM master data management, Xtentis, Izaro Grey APS, SAP SCM, etc. All solutions eliminated, except Xtentis, didn't suite because they were neither master data management nor capacity requirement planning solutions. For example, MIMOSA is a standardization group (related to maintenance) but no software was found; so, once again it doesn't perform the requirement of being a MDM or/and CRP. The same occurred with both Supply Chain Management and ERP SAP solutions, although they have a planning module (but which is not enough). The solution Xtentis is a MDM solution. However it has a technical requirement which doesn't suite with the solution required: do not use a relational database to store data but a native XML storage solution. This was the reason why this solution was eliminated from the list.
In conclusion, the deliverable of this pre-selection phase is a procurement list smaller than the first one, with 22 possible solutions. Two lists were created according to type of software each one represents, which means, the CRP solutions will correspond to one list (table 2) and the MDM solutions to another list (table 3).

| | |
|---|---|
| 14 | Manufacturing Plus |
| 19 | CRP |
| 21 | Exact Software |
| 22 | Exact Alliance - Material and Capacity Requirements Planning |
| 23 | Answer Capacity Requirements Planning |
| 24 | GNU ERP |

| | |
|---|---|
| 25 | Oracle: PeopleSoft Supply Planning |
| 27 | Atlas Planning Suite: capacity module |
| 32 | Open MFG |
| 33 | IPASS |
| 40 | Preactor APS |
| 41 | QAD manufacturing |

**Table 2: List with CRP solutions**

| ID | Software's Name |
|---|---|
| 6 | TIBCO MDM |
| 10 | Kalido MDM |
| 15 | NRX aMDM: Asset Hub(TM) v4.5 |
| 16 | i2 Master Data Management |
| 17 | Teradata |
| 28 | Siperian MDM Hub |
| 31 | SAP Netweaver |
| 35 | Hyperion |
| 36 | EBX Platform MDM |
| 41 | FPS |

**Table 3: List with MDM solutions**

Note that one of the proposals solutions for this project, as mentioned in the second chapter, was a **CRP MD with integrated solution.** However, according to the results obtained until now this option should be eliminated because none of the solutions listed below is both MDM and CRP solution. This situation was somehow predicted because the CRP solution required is very specific for the semiconductor industry. So, hereafter we will be searching two independent solutions.

## 3.3 Solution Pre Selection II: prioritizing solutions with AHP method

After this step, a decision making technique will be used with the objective of prioritizing the solutions. The decisions will be taken by the author and a person with a many year's experience in the enterprise.

The **Analytic Hierarchy Process** (AHP) is a technique for decision making where there are a limited number of choices, but where each one has a number of different attributes, some or

all of which may be difficult to formalize. It is especially applicable when decisions are being made by a team.

AHP can assist with identifying and weighting selection criteria, analyzing the data collected for the criteria, and expediting the decision-making process. It helps capture both subjective and objective evaluation measures, providing a useful mechanism for checking the consistency of the evaluation measures and alternatives suggested by the team [2].

The first part is very important and has 3 steps:

1. State the objective: in this case, the objective is to select a solution;
2. Define the criteria: the criteria chosen will be explained below;
3. Pick the alternatives: as mentioned before there are two lists of softwares- CRP solutions and MDM solutions- which means the AHP will be applied twice.

This information is then arranged in a hierarchical tree; in this specific case there will be two trees (figures 26 and 27), one for CRP and a separate one for potential MDM solutions.

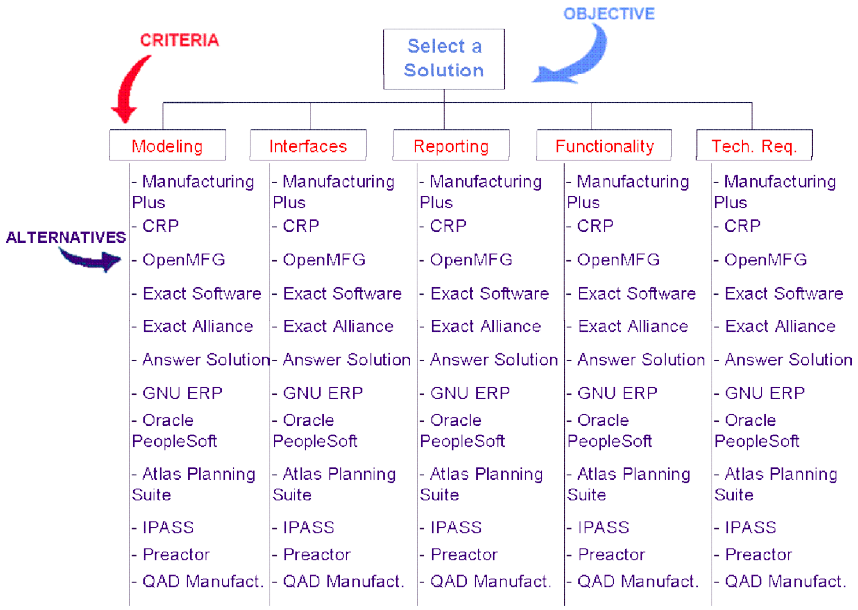



**Figure 26: Hierarchical Tree for CRP solutions**

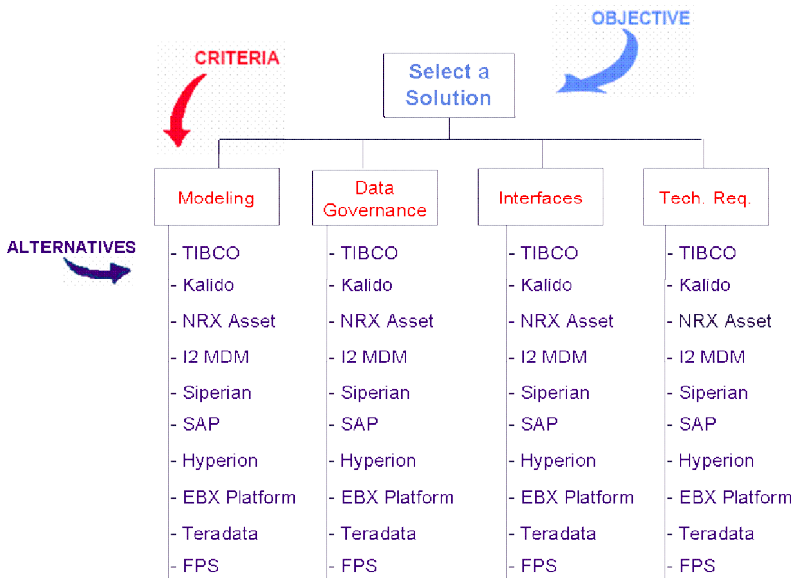



**Figure 27: Hierarchical Tree for MDM solutions**

**Criteria**

The definition of the criteria will be different for CRP solutions and for MDM solutions as there are some topics that don't make sense in one case or in the other.

For CRP solutions 5 criteria were defined. Modeling and functionality are the most important criteria, although the first one might be even more significant than the second. Note that behind a good CRP solution should be a very robust and flexible model, otherwise it won't be possible to perform all the requirements. Functionality is definitely linked with modeling as there are some modeling questions/problems that can only be assured with the help of a functionality. Other criteria should be technical requirements since there are some relevant IT questions that should be evaluated: e.g. type of database the system uses or authentication of users. Considering the importance of each criterion, the following is interfaces. Analyzing the solution in terms of the type of interface it uses, as well as if it is user friendly or graphically intuitive is important when searching any type of solution. And finally, evaluate the variety of reports the solution provides should be also done since reports are one of the outputs expected.

For MDM solutions 4 criteria were defined. To evaluate the flexibility of modeling is still an important topic but at the same time it is also crucial to verify if the system is aligned with data governance policies because, as mentioned before, a successful MDM depends on a solid data governance framework. Thus, these two criteria are the most important for MDM solutions. In addition, the interfaces and technical requirements criteria explained for CRP solutions are also relevant for these solutions, so they should also be evaluated.

Note that none of the solutions will be evaluated in terms of pricing. Although costs could have been included, they were set aside until technical and functional benefits of the alternatives are evaluated. In fact, discussing benefits together with costs can sometimes bring out many political and emotional responses. Thus, once that semiconductor is a very specific industry the most important objective is to find and propose a solution that best fulfills our requirements separately from the price it costs.

Although pricing won't be evaluated in the present project some ways to do it together with benefits can be cited:

- Graphing benefits and costs of each alternative and choose the alternative with lowest cost and highest benefit
- Benefit to cost ratios
- Linear programming
- Separate benefit and cost hierarchical trees and then combine the results

The next part of the method is to determine the ranking of the criteria. Using pairwise comparisons, the relative importance of one criterion over another can be expressed. According to the explanations given above, the rankings of the criteria for each AHP method were made. Table 4 is an example of this comparison, for CRP solutions in this case.

| | Modeling | Interfaces | Reporting | Technical R | Functionalit |
|---|---|---|---|---|---|
| **Modeling** | 1.00 | 7.00 | 9.00 | 5.00 | 3.00 |
| **Interfaces** | 0.14 | 1.00 | 3.00 | 0.33 | 0.20 |
| **Reporting** | 0.11 | 0.33 | 1.00 | 0.20 | 0.14 |
| **Technical Req.** | 0.20 | 3.00 | 5.00 | 1.00 | 0.33 |
| **Functionality** | 0.33 | 5.00 | 7.00 | 3.00 | 1.00 |

**Table 4: Criteria Comparisons for CRP solutions**

The following phase of the process is to use the same type of pairwise comparisons but this time between the relative importances of each alternative over another. These comparisons were done according to the information collected about the softwares: based on the requirements specified some decisive questions about each criterion were made and according to the answers given by each software (if it fulfils the requirements or not) ranking tables were constructed, each one representing each criterion. An example of this table is presented below; in this case for modeling criteria.

| Modeling | Manufacturi | CRP | Exact Soft | Exact Allianc | Answer Solut | GNU ERP | Oracle | Atlas Pla | openMFG | iDIMENSION | Preactor | QAD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manufacturing Plus | 1.00 | 1.00 | 0.33 | 0.33 | 0.33 | 1.00 | 0.20 | 3.00 | 3.00 | 0.14 | 0.14 | 0.20 |
| CRP | 1.00 | 1.00 | 0.33 | 0.33 | 0.33 | 1.00 | 0.20 | 3.00 | 3.00 | 0.14 | 0.14 | 0.20 |
| Exact Software | 3.00 | 3.00 | 1.00 | 1.00 | 1.00 | 3.00 | 0.33 | 5.00 | 5.00 | 0.20 | 0.20 | 0.33 |
| Exact Alliance | 3.00 | 3.00 | 1.00 | 1.00 | 1.00 | 3.00 | 0.33 | 5.00 | 5.00 | 0.20 | 0.20 | 0.33 |
| Answer Solutions | 3.00 | 3.00 | 1.00 | 1.00 | 1.00 | 3.00 | 0.33 | 5.00 | 5.00 | 0.20 | 0.20 | 0.33 |
| GNU ERP | 1.00 | 1.00 | 0.33 | 0.33 | 0.33 | 1.00 | 0.20 | 3.00 | 3.00 | 0.14 | 0.14 | 0.20 |
| Oracle | 5.00 | 5.00 | 3.00 | 3.00 | 3.00 | 5.00 | 1.00 | 7.00 | 7.00 | 0.33 | 0.33 | 1.00 |
| Atlas Planning Suite | 0.33 | 0.33 | 0.20 | 0.20 | 0.20 | 0.33 | 0.14 | 1.00 | 1.00 | 0.11 | 0.11 | 0.14 |
| openMFG | 0.33 | 0.33 | 0.20 | 0.20 | 0.20 | 0.33 | 0.14 | 1.00 | 1.00 | 0.11 | 0.11 | 0.14 |
| iDIMENSION | 7.00 | 7.00 | 5.00 | 5.00 | 5.00 | 7.00 | 3.00 | 9.00 | 9.00 | 1.00 | 1.00 | 3.00 |
| Preactor | 7.00 | 7.00 | 5.00 | 5.00 | 5.00 | 7.00 | 3.00 | 9.00 | 9.00 | 1.00 | 1.00 | 3.00 |
| QAD | 5.00 | 5.00 | 3.00 | 3.00 | 3.00 | 5.00 | 1.00 | 7.00 | 7.00 | 0.33 | 0.33 | 1.00 |

**Table 5: Alternative comparisons for CRP solutions**

After the application of the method, which means some matrix algebra, the result is a list of prioritized solutions from the highest to the lowest score.

Firstly, this method was applied to MDM solutions. The answers obtained for these solutions can be seen in table 6.

| | | Data Governance | | Modeling | Interfaces | Technical Req |
|---|---|---|---|---|---|---|
| ID | Questions / Application's name | Does your system make use of any initiatives on data governance? | How many topics on data governance does the system ensure? | is your system flexible in terms of modeling issues? | Does your system have an user interface? | Does your system make use of an Oracle database server? |
| 6 | TIBCO MDM | yes | 2 | yes | yes | yes |
| 10 | Kalido MDM | yes | 2 | yes | no info but probably yes | probably yes |
| 15 | NRX Asset Hub aMDM | yes | 2 | yes | yes | no info |
| 16 | i2 Master Data Management | yes | 2 | yes | no info but probably yes | yes |
| 28 | Siperian MDM Hub | yes | 3 | yes | no info but probably yes | probably yes |
| 31 | SAP Netweaver | yes | 6 | yes | yes | yes |
| 35 | Hyperion | yes | 1 | yes | yes | probably yes |
| 36 | EBX.Platform MDM software | yes | 3 | yes | yes | yes |
| 17 | Teradata | yes | 4 | yes | yes | no |
| 39 | FPS | yes | 2 | no | yes | yes |

**Table 6: Answers of each MDM solution to each criteria**

Then, four ranking tables were created, the first related to data governance requirements, the second about modeling, the third related to interfaces and the last one about technical requirements. The ranking obtained is presented in the table below.

| | **1st Ranking** |
|---|---|
| 1st | SAP Netweaver |
| 2nd | Teradata |
| 3rd | EBX |
| 4th | Siperian |
| 5th | TIBCO |
| 6th | Kalido, i2 |

| | |
|---|---|
| 7th | Hyperion |
| 8th | NRX |
| 9th | FPS |

**Table 7: List with 1st ranking of AHP**

As mentioned before this method is a little subjective because there are some uncertain answers due to missing information, as it is shown in table 6. Thus, different scores can be created according to the way the answers are combined, e.g.: Kalido MDM solution has a "probably yes" answer in the technical requirement question, which means this solution probably makes use of an Oracle database. So, this software can be scored the same way as those with a simple "yes" as an answer or as those with "no info" in this criteria. According to these different combinations, different scenarios were created in order to test the sensibility of this method and also to try to achieve the most realist final ranking. The rankings obtained for each scenario are shown in the tables below.

| | **Ranking_2nd scenario** | **Ranking_3rd scenario** |
|---|---|---|
| 1st | SAP Netweaver | SAP Netweaver |
| 2nd | Teradata | Teradata |
| 3rd | TIBCO, EBX | Siperian, EBX |
| 4th | Siperian, Kalido, i2 MDM | TIBCO, Kalido, i2 MDM |
| 5th | Hyperion | Hyperion |
| 6th | NRX | NRX |
| 7th | FPS | FPS |

**Table 8: List with 2nd and 3rd ranking of AHP**

| | **Ranking_4th scenario** | **Ranking_5th scenario** |
|---|---|---|
| 1st | SAP Netweaver | SAP Netweaver |
| 2nd | Teradata | Teradata |
| 3rd | EBX | EBX |
| 4th | Siperian | Siperian |
| 5th | TIBCO | TIBCO |
| 6th | i2 MDM, FPS | i2 MDM, Kalido |
| 7th | NRX | Hyperion |
| 8th | Kalido | NRX |
| 9th | Hyperion | FPS |

**Table 9: List with 4th and 5th ranking of AHP**

With the objective of having the finally and single ranking, a weighed average ranking of all the scenarios shown was done. The result is exposed in the table below and the truth is that it is not much different from the first ranking obtained.

| | **Final Ranking** |
|---|---|
| 1st | SAP Netweaver |
| 2nd | Teradata |
| 3rd | EBX |
| 4th | Siperian |
| 5th | TIBCO |
| 6th | i2 MDM |
| 7th | Kalido |
| 8th | Hyperion |
| 9th | NRX |
| 10th | FPS |

**Table 10: List with Final ranking of AHP**

Secondly, the AHP method was applied to the CRP solutions. Due to the missing information it was necessary to proceed with a collection of detailed information. For this, a questionnaire based on an evaluation matrix (that will be used in the next phase) was created which was then sent to the CRP enterprises (it can be seen in Appendix C). This questionnaire has a list with detailed questions which will be very useful to clarify some features about each solution and therefore to update the AHP table (table 11). Note that in this questionnaire is represented, not only the requirements from Porto site but from all 4 Qimonda sites which make part of this project.

| Criteria | | Modeling | | | | Interfaces | Reporting | Technical Req | Functionality | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Questions / Application's name | Is your system able to validate/assure the consistency | Is your system able to model manufacturing hierarchies? | Does your system provide the distinction between main resource and tooling, both from the resource group? | Does your system allow what if scenarios/simu | Is your system an user interface? | Does your system provide reports? | Does your system make use of an Oracle database server? | Is your system able to calculate capacity | In case that a resource group has no resources, is the system able to ignore resource attribute and keep the | Is the system able to assure that first and then an exception | Is your system able to aggregate results from low levels (e.g. resource, product operation) into a higher level class (e.g. resource)? |
| 14 | Manufacturing Plus/Vertices | n/a | n/a | n/a | yes | yes | yes | no | yes | n/a | n/a | n/a |
| 19 | CRP | no | yes | yes | no | yes | yes | no | no | probably no | no | no |
| 21 | Exact Software | no | no | no | yes | yes | yes | no | yes | no | no | no |
| 22 | Exact Alliance | no | no | no | yes | n/a | yes | n/a | yes | no | no | no |
| 23 | Answer Solutions | n/a | n/a | n/a | yes | think so | yes | yes | yes | n/a | n/a | n/a |
| 24 | GNU ERP | no | n/a | n/a | no | yes | yes | yes | n/a | n/a | n/a | n/a |
| 25 | Oracle PeopleSoft SP | n/a | n/a | probably yes | yes | n/a | yes | yes | yes | n/a | n/a | n/a |
| 27 | Atlas Planning Suite | yes | no | no | no | no | yes | yes | no | no | no | no |
| 32 | openMFG | no | yes | no | no | yes | yes | no | yes | no | no | no |
| 33 | IPASS | no | yes | yes | yes | yes | yes | yes | yes | no | yes | yes |
| 40 | Preactor | no | yes | yes | yes | yes | no | no | yes | no | yes | yes |
| 41 | QAD Manufacturing solutio | probably yes | probably yes | n/a | yes | yes | yes | yes | yes | n/a | n/a | n/a |

**Table 11: Answers of each CRP solution to each criteria**

In fact, the feedback given by each enterprise allowed us to update the AHP method and therefore to eliminate some of the subjectivity that the missing information was giving to the method. It was done a great effort to try to contact some of the enterprises but in some cases it

wasn't possible, the communication was not established even after numerous attempts. The solutions with less information are Manufacturing Plus, Answer Solutions and GNU ERP. The first solution gave us a feedback. However, the enterprise responded that they are not able to invest time or capacity to answer the questionnaire. The other solution providers simply didn't answer. As GNU is an open source solution and the existing documentation is very simplistic, from what could be investigated, the model does not seem to present many of the required modeling and functionality features.

The final ranking of AHP method for CRP solutions can be seen in the table below. It is, definitely, according to the information table: the solutions placed in 10th and 11th – Exact Alliance/Exact Software and OpenMFG – were someway predictable because they don't fulfill many of the modeling and functionality requirements which are crucial. Actually, the Exact Solutions, as the enterprise mentioned, don't have the detail necessary for a project with this level of specification; they recommend Preactor Solution in these situations.
In the first places of the ranking are located the solutions with more positive answers, as expected.

| | **Ranking** |
|---|---|
| 1st | IPASS |
| 2nd | Preactor APS |
| 3rd | Oracle PeopleSoft |
| 4th | QAD Manufacturing Solution |
| 5th | Answer Solutions |
| 6th | Manufacturing Plus |
| 7th | GNU |
| 8th | CRP |
| 9th | Atlas Planning Suite |
| 10th | Exact Alliance, Exact Software |
| 11th | OpenMFG |

**Table 12: List with Final Ranking of AHP for CRP solutions**

## 3.4 Evaluation and Selection of candidate solutions

### Evaluation Matrix

Once semiconductor is a very specific industry, it is necessary to carefully look at the data model requirements and functionality, previously defined and presented in chapter 2. In fact, the 2 solutions with higher score in AHP method – IPASS and Preactor - will be evaluated according to their fulfillment on these specifications. For this, an evaluation matrix was prepared. It represents a huge list with more than 80 questions related to modeling problems, functionality, interfaces, reporting and technical requirements, as for example:

Modeling

- Does your system provide the distinction between main resource and tooling, both from the resource group? And also that each equipment group can have more than one tool group and a tool group can be in more than one equipment group?
- Does your system provide the possibility to model yield on the operation level? Does the system consider yield for calculation of capacity?

Functionality

- Is the system able to assure that first a generic rule is evaluated and then an exception rule?
- Is your system able to make a list of products that can be produced in each resource group and in each specific resource?

Interfaces

- Does your system provide an user interface (UI) for model maintenance?
- Is your system able to load model data from flat files (txt, csv) or xls files?

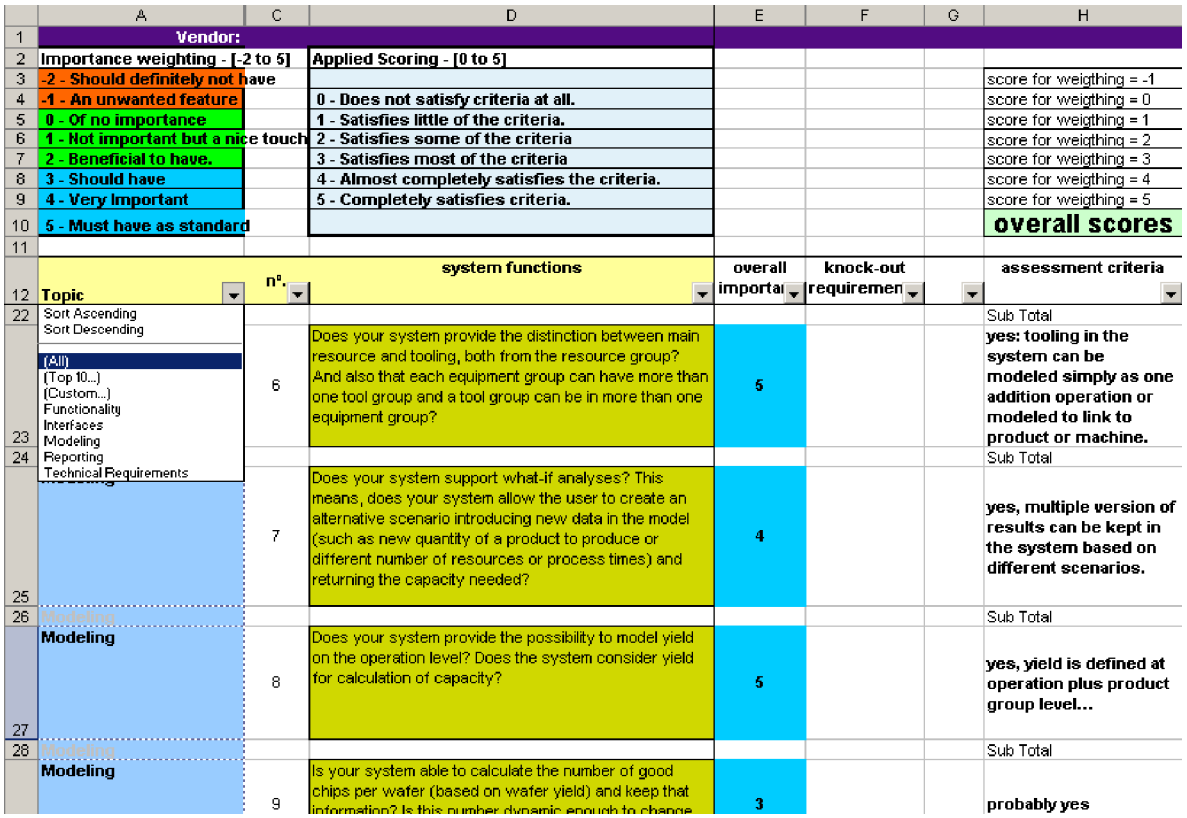
Reporting

- Does your system provide reports? What type of reports? Charts? Tables?

Technical Requirements

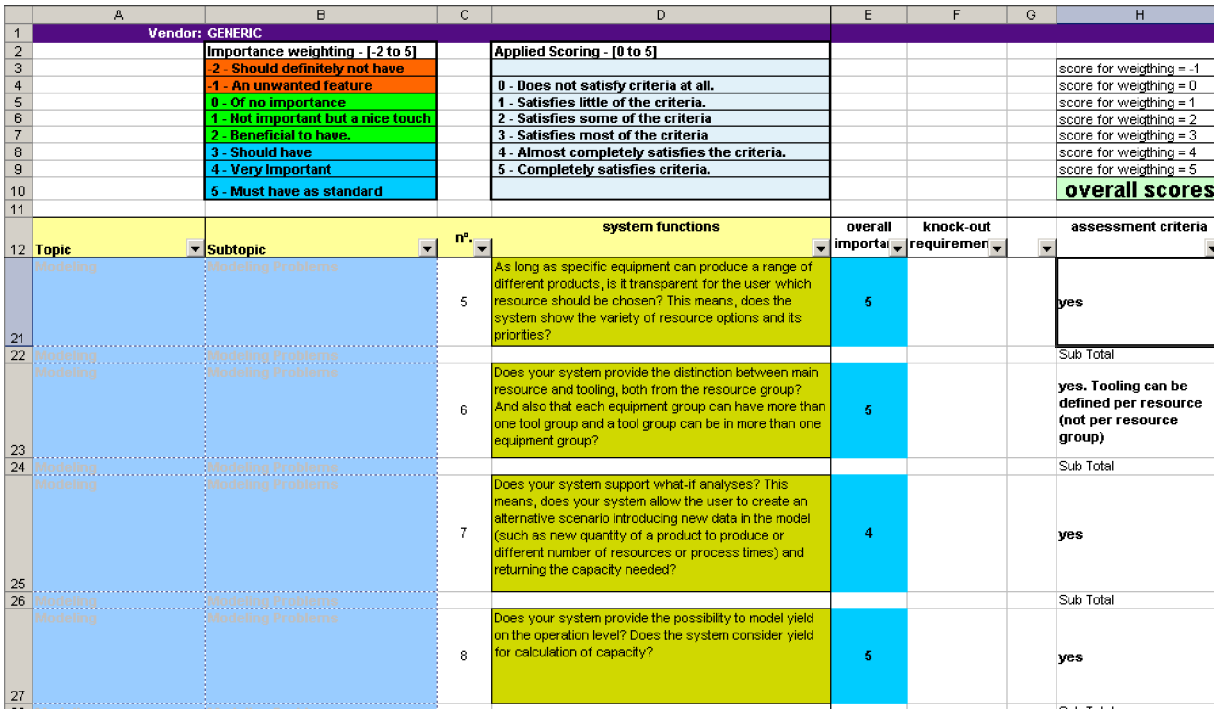
- Does your system fulfill following user friendliness requirements:
  - Direct editing in Lists
  - Export / import to excel
  - Graph / copy - paste functions / standard Microsoft features
  - Auto validation

As there are some requirements more important than others it was necessary to score them with different weights and for that the experience and knowledge of the whole project team was welcome and needed.
An example of the matrix obtained for each of the solutions, IPASS and Preactor is presented in figures 28 and 29, respectively. As can be seen, these solutions fulfill all 4 requirements presented which are scored with higher level of importance.



| | A | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 1 | Vendor: | | | | | | |
| 2 | Importance weighting - [-2 to 5] | | Applied Scoring - [0 to 5] | | | | |
| 3 | -2 - Should definitely not have | | | | | | score for weigthing = -1 |
| 4 | -1 - An unwanted feature | | 0 - Does not satisfy criteria at all. | | | | score for weigthing = 0 |
| 5 | 0 - Of no importance | | 1 - Satisfies little of the criteria. | | | | score for weigthing = 1 |
| 6 | 1 - Not important but a nice touch | | 2 - Satisfies some of the criteria | | | | score for weigthing = 2 |
| 7 | 2 - Beneficial to have. | | 3 - Satisfies most of the criteria | | | | score for weigthing = 3 |
| 8 | 3 - Should have | | 4 - Almost completely satisfies the criteria. | | | | score for weigthing = 4 |
| 9 | 4 - Very Important | | 5 - Completely satisfies criteria. | | | | score for weigthing = 5 |
| 10 | 5 - Must have as standard | | | | | | overall scores |
| 11 | | | | | | | |
| 12 | Topic | nº. | system functions | overall importa | knock-out requiremen | | assessment criteria |
| 22 | Sort Ascending / Sort Descending / (All) / (Top 10...) / (Custom...) / Functionality / Interfaces / Modeling / Reporting / Technical Requirements | | | | | | Sub Total |
| 23 | | 6 | Does your system provide the distinction between main resource and tooling, both from the resource group? And also that each equipment group can have more than one tool group and a tool group can be in more than one equipment group? | 5 | | | yes: tooling in the system can be modeled simply as one addition operation or modeled to link to product or machine. |
| 24 | | | | | | | Sub Total |
| 25 | | 7 | Does your system support what-if analyses? This means, does your system allow the user to create an alternative scenario introducing new data in the model (such as new quantity of a product to produce or different number of resources or process times) and returning the capacity needed? | 4 | | | yes, multiple version of results can be kept in the system based on different scenarios. |
| 26 | Modeling | | | | | | Sub Total |
| 27 | Modeling | 8 | Does your system provide the possibility to model yield on the operation level? Does the system consider yield for calculation of capacity? | 5 | | | yes, yield is defined at operation plus product group level... |
| 28 | Modeling | | | | | | Sub Total |
| | Modeling | 9 | Is your system able to calculate the number of good chips per wafer (based on wafer yield) and keep that information? Is this number dynamic enough to change | 3 | | | probably yes |

**Figure 28 – Example of IPASS matrix**



| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | Vendor: | GENERIC | | | | | | |
| 2 | | Importance weighting - [-2 to 5] | | Applied Scoring - [0 to 5] | | | | |
| 3 | | -2 - Should definitely not have | | | | | | score for weigthing = -1 |
| 4 | | -1 - An unwanted feature | | 0 - Does not satisfy criteria at all. | | | | score for weigthing = 0 |
| 5 | | 0 - Of no importance | | 1 - Satisfies little of the criteria. | | | | score for weigthing = 1 |
| 6 | | 1 - Not important but a nice touch | | 2 - Satisfies some of the criteria | | | | score for weigthing = 2 |
| 7 | | 2 - Beneficial to have. | | 3 - Satisfies most of the criteria | | | | score for weigthing = 3 |
| 8 | | 3 - Should have | | 4 - Almost completely satisfies the criteria. | | | | score for weigthing = 4 |
| 9 | | 4 - Very Important | | 5 - Completely satisfies criteria. | | | | score for weigthing = 5 |
| 10 | | 5 - Must have as standard | | | | | | overall scores |
| 11 | | | | | | | | |
| 12 | Topic | Subtopic | nº. | system functions | overall importa | knock-out requiremen | | assessment criteria |
| 21 | Modeling | Modeling Problems | 5 | As long as specific equipment can produce a range of different products, is it transparent for the user which resource should be chosen? This means, does the system show the variety of resource options and its priorities? | 5 | | | yes |
| 22 | Modeling | Modeling Problems | | | | | | Sub Total |
| 23 | Modeling | Modeling Problems | 6 | Does your system provide the distinction between main resource and tooling, both from the resource group? And also that each equipment group can have more than one tool group and a tool group can be in more than one equipment group? | 5 | | | yes. Tooling can be defined per resource (not per resource group) |
| 24 | Modeling | Modeling Problems | | | | | | Sub Total |
| 25 | Modeling | Modeling Problems | 7 | Does your system support what-if analyses? This means, does your system allow the user to create an alternative scenario introducing new data in the model (such as new quantity of a product to produce or different number of resources or process times) and returning the capacity needed? | 4 | | | yes |
| 26 | Modeling | Modeling Problems | | | | | | Sub Total |
| 27 | Modeling | Modeling Problems | 8 | Does your system provide the possibility to model yield on the operation level? Does the system consider yield for calculation of capacity? | 5 | | | yes |

**Figure 29 – Example of Preactor matrix**

Over this chapter, all solutions found through the internet were presented; after that some of them went through two pre-selection phases where they were divided in two lists and also prioritized according to their characteristics. In a last phase, the CRP solutions with higher score were evaluated with the help of a matrix with the most important requirements that the solutions should fulfill.
According to all the information collected and the results from the methods used, the final results will be present in the next chapter.

# 4 Results

This chapter aims to describe the final results of this capacity requirement planning master data solution process. During the project all requirements and functionality of each, Master Data Management Solution and Capacity Requirement Solution, and representing all 4 sites involved in this project, were analyzed and as a result of this the top scoring solution plus one alternative solution were proposed. These solutions, which are from different suppliers, are those that best correspond to Qimonda's needs.
In terms of master data management solution, the first proposal is SAP Netweaver and as a second choice there is Teradata solution. Regarding CRP solutions, there is IPASS on top of the list; followed by Preactor APS solution.

| | Ranking |
|---|---|
| 1st | SAP Netweaver |
| 2nd | Teradata |

**Table 13: Results for CRP solutions**

| | Ranking |
|---|---|
| 1st | IPASS |
| 2nd | Preactor APS |

**Table 14: Results for MDM solutions**

## 4.1 Master Data Management Solution

### 4.1.1 SAP Netweaver

The first MDM proposal solution is the Netweaver platform from the German enterprise SAP. Qimonda already uses many of SAP solutions which is definitely an advantage. There is a specific IT group of people in Qimonda (not only in Porto) with a large know-how on SAP solutions (not only about those that Qimonda works with but also about others) and which are responsible for maintaining the good performance inside Qimonda. We have had the opportunity to speak with some people from this SAP team and they provided us a small workshop explaining some capabilities and functionality of the Netweaver platform. They have also made a proposal of how would be our CRP MD specific solution. As figure 30 shows SAP XI is the core part of the solution responsible for modeling, data quality, etc and on the other hand SAP Portal provides the user interface. Our CRP solution would be linked to SAP XI as well as other solutions we need. Finally this core part is linked to the database, which is Oracle, another positive point once that Oracle data base systems are standard at Qimonda.

Another advantage of this platform is that Qimonda already has the license for one of the modules, the SAP Portal.

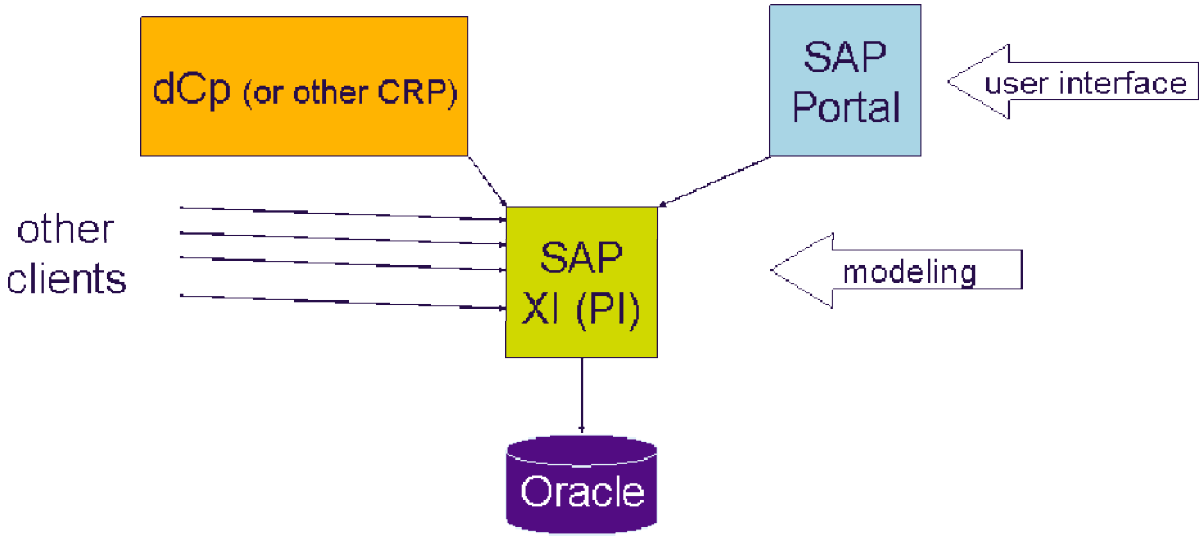



**Figure 30: CRP MD proposal by SAP team**

This solution has some essential capabilities which guarantee high quality standards throughout the enterprise:

- **Mapping & Conversion:** Normalize and Standardize information
- **Validations & Assignments:** Ensure compliance according to defined criteria
- **Enrichment Architecture:** Achieve more complete and meaningful master data
- **Workflows:** Leverage built in workflows to manage compliance process
- **Matching & Merging:** De-duplicate records for unambiguous and consistent master data
- **Key Mapping:** Provide cross-system identification to ensure enterprise-wide data quality

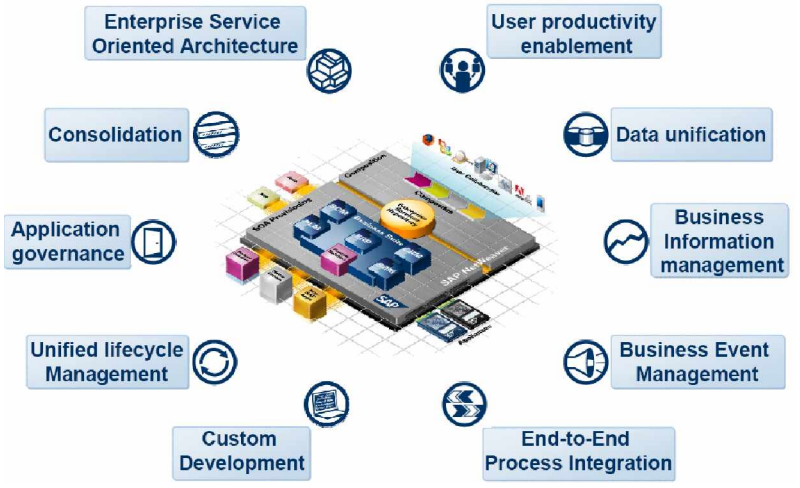



**Figure 31 – SAP Netweaver capabilities**

### 4.1.2 Teradata

The alternative solution proposed for this project is Teradata from Teradata Corporation. This solution also fulfill most of the requirements presented for MDM solutions such as having policies on data governance and completely customizable model.
Some of its benefits include:

| Value | What does MDM Provide? | Business Benefit |
|---|---|---|
| Data Quality | • Data validation and error checks to ensure input data is clean | • More accurate inventory customer order commitments and improved service levels |
| Data Integrity | • Centralized data management for important entities; single portal for multiple users across multiple organizations | • More reliable reporting and analysis<br>• Reduced cycle time for introducing new products and vendors |
| Data Synchronization | • Enables consistent data flow throughout the enterprise and with your trading partners | • Faster integration architecture for reduced latency |

**Table 15: Benefits of Teradata Solution[1]**

Although Teradata has some clear advantages, it has a specific database which can be a disadvantage for the selection at Qimonda.

4.2 Capacity Requirement Planning Solutions

### 4.2.1 IPASS solution

The first proposal solution in terms of CRP is IPASS which is an Advanced Planning and Scheduling System from the Singaporean enterprise iDimension. The biggest advantage of this solution is that it was designed ground up for semiconductor manufacturing companies and its customer base is composed of more than 10 semiconductor manufacturing companies in the business of test and assembly operations. This means that the solution was designed for factories very similar to Qimonda: it certainly has the same or at least similar manufacturing areas, machines, or constraints. This is a great advantage once that many of our specific requirements are already integrated in this solution; as the evaluation matrix presented in the last chapter illustrates. At the time of writing iDimension is negotiating a contract with one of the top 5 semiconductor manufacturers.
After some contacts with this enterprise, they gave us the possibility to have a web demonstration of IPASS solution and at the same time to clarify some questions.
Figure 32 gives us an idea of the capacity planning module flow. This module has two main objectives which are identifying the overload/under-load and to do a realistic commitment to customer forecast.

[1] http://www.teradata.com/t/page/148161/index.html. Accessed 2008 February

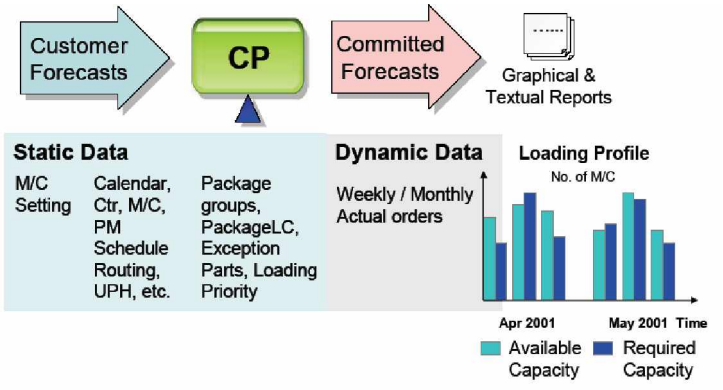



**Figure 32: Capacity Planning Module Overview**

Although it is not easy to summarize all the functionality of this module, some of the most important features can be cited:

- Forecasts in weekly / monthly buckets
- Priority by product and customer
- Manpower resources assignment
- Checks for tooling and machine constraints
- Flexible machine settings: machine groups, UPH…
- Default at product group level (Can be exception for special products by attributes e.g. pad size, device, etc.)
- Flexible number of operations (on / off)
- Separate calendars for machines, center or unit
- Suite of standard and customized reports
- What-If analysis
- Production calendar definition

The figure below is an example of two IPASS windows where we can configure, for example, the planning bucket (weekly or monthly) or the capacity planning period of time.

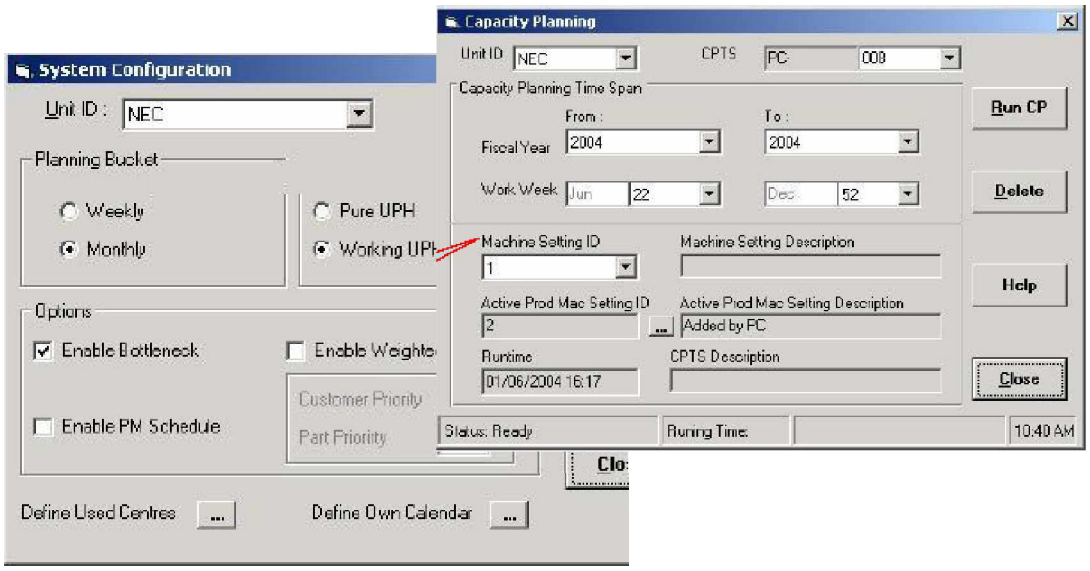



**Figure 33: Printscreen of IPASS windows**

In the picture below there is a graphic with IPASS's output: the capacity of each manufacturing area for a specific product family, in this case TSSOP. However, IPASS reports are very diversified; for example, we can see the capacity allocation by operation and by product/product group or the capacity by operations against forecast by product/product group.

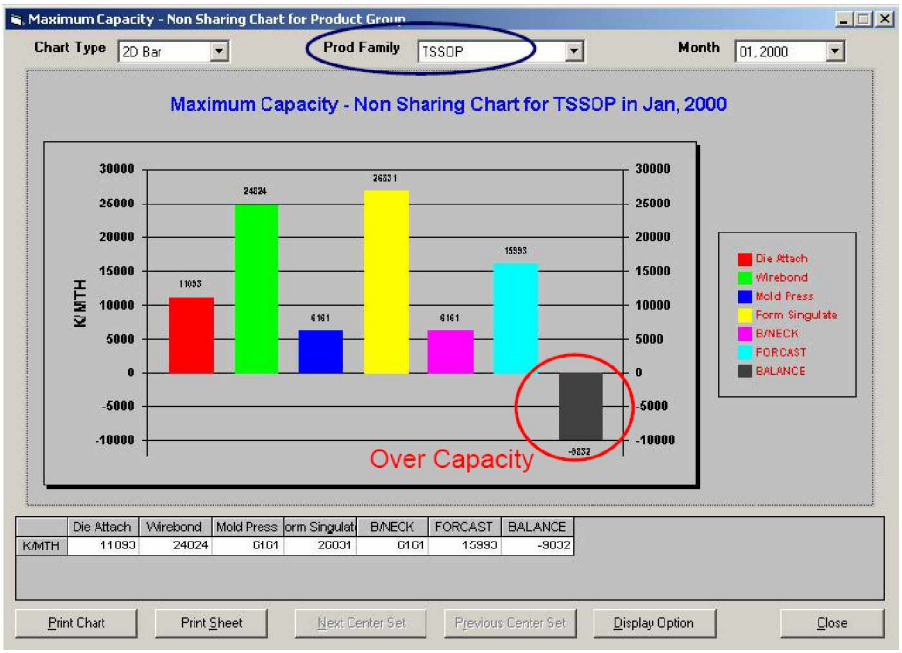



**Figure 34: Printscreen of IPASS output**

A disadvantage of this solution is the fact that it was designed only based on backend semiconductor industry and, as mentioned before, Qimonda Portugal also performs some frontend operations, namely WLA/RDL and Wafer Test. Although IPASS appears to be very flexible, it can be a little difficult to model in one model together with assembly and test areas, because there is a change of production units between these areas (the unit is a wafer) and the others (the unit is a chip). This topic was already discussed with iDimension but a priori this seems not to be an obstacle.

### 4.2.2 Preactor APS

Alternatively to IPASS solution, there is Preactor APS.
Although Preactor doesn't have any know-how in semiconductor industry, its solution was shown to be very flexible in terms of modeling and can be easily further customized. It has some of the required functionality as for example:

- Modeling of various manufacturing locations in one supply-chain model.
- Integration with other systems;
- What-if scenarios;
- Tooling defined per resource and product;
- Programming based on bottleneck;
- Modeling of exception

Even though this is a solution that focuses on scheduling, it is also able to do capacity planning. This capacity can be seen at a macro level or more detailed at a micro level where it is possible to visualize the available capacity by resource, tooling, etc.
We have also the chance to have a demonstration of this solution and it seems to be a good second choice.

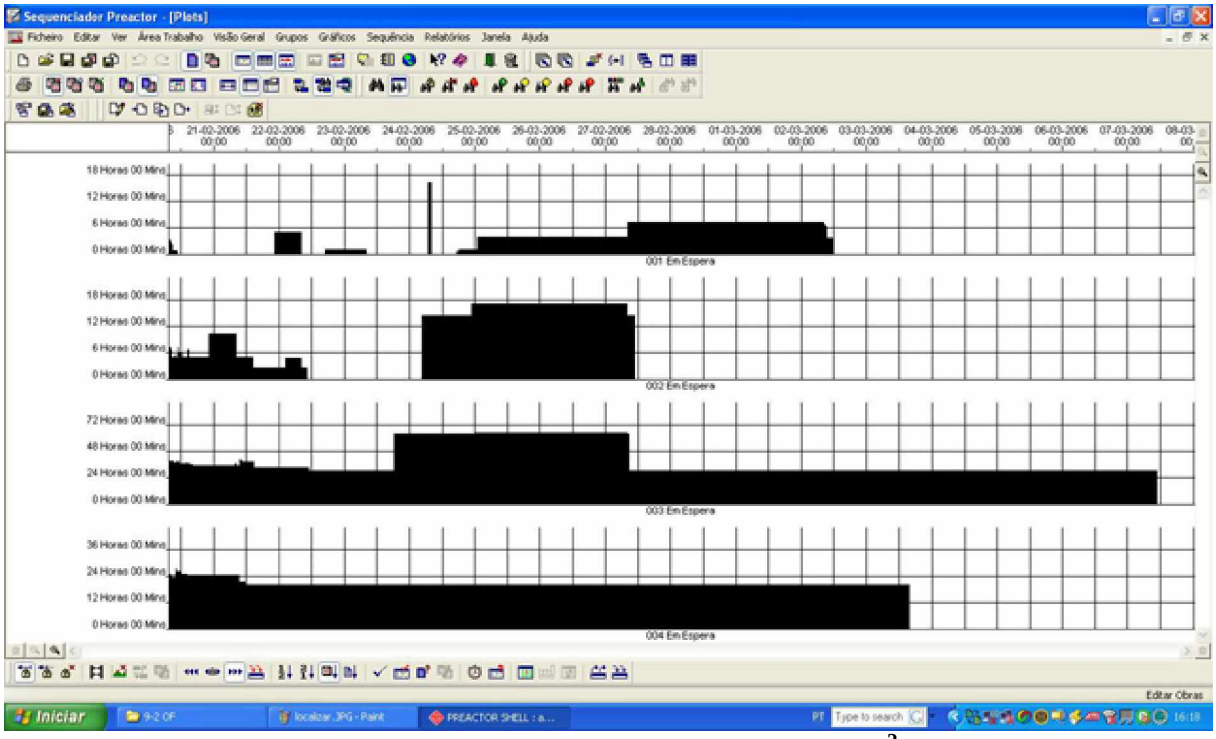



**Figure 35: Printscreen of Preactor output**[2]

These results of the project will be presented to the steering team and then a decision will be taken. This decision will be to evaluate these advantages and disadvantages of each solution as well as financial requirements. In a further stage, as mentioned before, the solutions chosen will be implemented in 4 sites of Qimonda. In fact, the requirements evaluated represent not only the needs of Porto site but, instead of that, the needs of all of them.

[2] http://www.primesystems.pt/?op=conteudo&pid=135&id=139. Accessed 2008 February

# 5 Conclusion and Future Projects

The proposed project objective was finding a capacity requirement planning master data solution which should be capable of representing the data model and some requirements previously identified. The results were successfully achieved in the way that some possible solutions were found.

In this procurement project some difficulties were found, mainly because of the high complexity of this industry called for a very customizable, flexible, and specific solution in terms of modeling and functionality requirements specially for capacity planning. That is the reason why one of the solution's option of having an integrated capacity requirement planning and at the same time a master data solution was found to be inexistent on the market. In fact, the results of this project are two prioritized lists with a preferred solution and an alternative, each for CRP and MDM solutions.

A key point to achieve these results was the contact made with the CRP enterprises because it allowed a close understanding of their solutions, their capabilities and functionality. Unfortunately, it was not possible to work together with all of them, since many requests went unanswered even after many contact attempts.

The end of this project doesn't mean the end of this subject. In fact, there will be further steps taken up within Qimonda: the solutions obtained will be presented to and evaluated by the steering team in terms of the advantages and disadvantages of each solution as well as financial requirements. Then a final decision will be provided and if the decision would be to proceed with one of the proposed solutions, its implementation will be prepared for all Qimonda backend sites: Porto, Suzhou, Dresden and Malacca.

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## Appendix A: Market Research

- **Manufacturing asset**

### 1. Eyelit Manufacturing Asset Management

http://www.eyelit.com/mfg_asset.html

The eyelit Manufacturing™| Asset Management application is a comprehensive, stand-alone, solution used to monitor, manage and control key equipment and spare parts, and other assets used in the manufacturing enterprise. From facilities to production Eyelit's Asset Management solution arms executives, managers and technicians with information on how assets are performing, real-time status of scheduled/unscheduled maintenance and spare part activities, as well as complete history for process and cost analysis.

Eyelit Asset Management's built-in modeling application makes configuring complex equipment easy. Create parent/child relationships and corresponding capabilities and state transition mappings. Manage every component of the equipment and control its behavior during manufacturing and maintenance. Associate relational "indirect" equipment such as a facility chiller where a disruption in the "indirect" device may affect the performance of the manufacturing device. Or add "direct" relationship whereby a child may automatically change the state/status of the parent tool.

### 2. Asset Management Repository Software: WiseTrack

http://www.asentrix.com/repository_software.htm

Asentrix Systems provides comprehensive, turn-key asset management solutions including award winning asset data repositories.

Asset Management Repository Software is the core of a well designed asset management solution. The repository is essentially a relational database capable of storing, indexing, and retrieving hundreds of thousands of data elements associated with your organization. The more powerful the Asset Management Repository Software, the more granular and informative its reporting capabilities.
The single most important element of any asset management solution is the central data repository. Failing to invest in the right software solution will limit effectiveness, productivity, accuracy, accountability, and result in an underutilized system, lost time, and skyrocketing costs. The major complaint about existing asset management software is that most products are expensive and burdensome to install enterprise-wide.

Asentrix Systems provides comprehensive, turn-key asset management solutions including the award winning asset data repository, WiseTrack. WiseTrack, from TVL Software, has been designed to offer superior functionality and stability, ease of use, ease of implementation, and scalability from small businesses to global enterprises. WiseTrack gives direct Return on Investment (ROI) by providing decision makers with the specific information they need when they need it, and it does it out-of-the-box. WiseTrack distinguishes itself from other asset data repositories in two major ways: a richer feature set and powerful integration capabilities. Based upon Microsoft's SQL Server Database, the application is built upon proven, open, and scalable architecture.

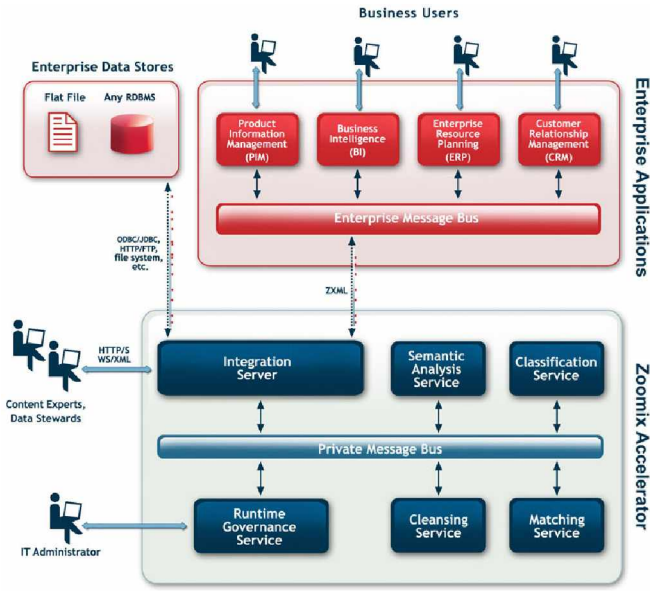
- **Master data management**

### 3. Zoomix Accelerator

http://www.zoomix.com/mdm.asp

Enterprises suffer from considerable business inefficiencies, operational failures and financial loss due to duplicated, inaccurate, inconsistent and mis-classified master data spread across numerous enterprise applications. The dangers and costs of this critical business problem are multiplying as globalization, data sharing with trading partners and regulatory compliance requirements are all increasing. Many enterprises will attempt to solve these issues by implementing a Master Data Management (MDM) solution.

The challenge of synchronizing and perfecting product, part, customer, supplier and financial data originating in multiple source systems is daunting. Some MDM solutions excel at aggregating the data from its various sources, but without much focus on the data itself. Other systems place more focus on the data itself, but require massive projects to formulate the rules, dictionaries and scripts that will allow software to automatically de-duplicate, standardize and classify the enterprise's complex data. Since no set of manually defined rules can address every conceivable situation, accuracy is less than optimal and ongoing manual rule and script development efforts are required.



### 4. IBM Master Data Management

http://www-306.ibm.com/software/br/db2/data/masterdata/index.shtml

**Master Data Management** é um middleware baseado em SOA (Service-Oriented Architecture), que fornece uma estrutura corporativa flexível para suportar dados estruturados ou não e serviços de negócios. As ofertas IBM Master Data Management reúnem todos os componentes chave em uma estratégia MDM corporativa bem-sucedida, incluindo o gerenciamento principal de dados para objectos de dados específicos — incluindo produtos, clientes e fornecedores — e soluções principais de dados para segmentos de mercado específicos.

### 5. IBM Tivoli Maximo AM (Asset Management)

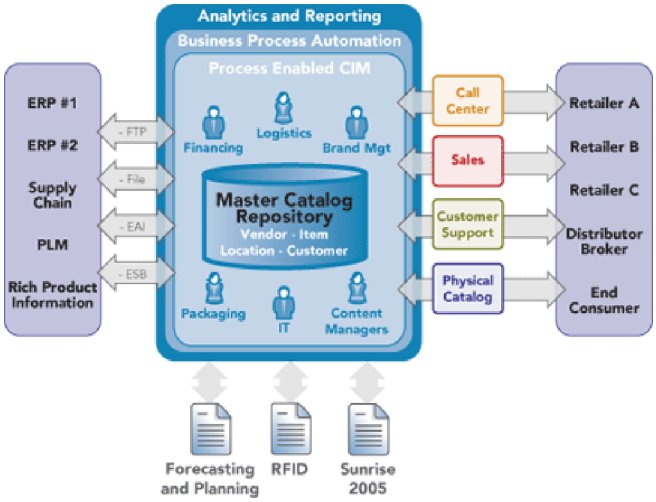
http://www-306.ibm.com/software/tivoli/solutions/asset-management/index.html

Asset Management from IBM Maximo takes the power, performance and possibilities of asset management to an entirely new level. Built on a single software platform, Maximo Asset Management delivers a comprehensive view of all asset types — production, facilities, transportation and IT — across your enterprise. This holistic perspective allows you to see all of your assets, as well as identify all of the untapped potential within them. You gain the knowledge and control you need to closely align your organization's goals with the overall goals of your business.


### 6. TIBCO Master data management Software

http://www.tibco.com/software/master_data_management/default.jsp

MDM enables organizations to ensure that enterprise master data (assets, people, locations) across multiple systems and departments is accurate and consistent and share that information securely with trading partners. It ensures that the necessary processes, policies, and procedures are put in place so that the benefits gained are not lost as new data is introduced or existing information is updated. Finally, it allows organizations to manage the complex hierarchies and relationships within their data such as the relationships between two products, a client and an account, a customer and a vendor, a part and a product, and so on.




- **Enterprise asset management**

**7. Lawson Enterprise Asset Management (EAM) software**
http://www.lawson.com/WCW.nsf/pub/EAM_EBD711

The Lawson M3 Enterprise Asset Management (EAM) software is a best-of-breed maintenance solution that can be easily integrated with your other business operations. It helps you to maximize equipment availability, minimize downtime, increase operational capacity and efficiency and corporate profitability.

**8. TMA Enterprise**
http://www.tmasystems.com/products_tma_enterprise.asp

Utilizing TMA Enterprise, these organizations account for, maintain, and extend the useful life of their physical assets throughout their entire life cycle — from purchase through disposal. TMA Enterprise provides an entire array of advanced functionality that will make it the ultimate solution for organizations that want their operations to perform with the highest level of customer satisfaction possible by managing the work-flow process from planning stage to completion of the job. Most importantly, these efficiencies can be benchmarked and measured in both cost and time.

**9. Datastream 7i™**
http://www.datastream.net/english/products/datastream7i.aspx

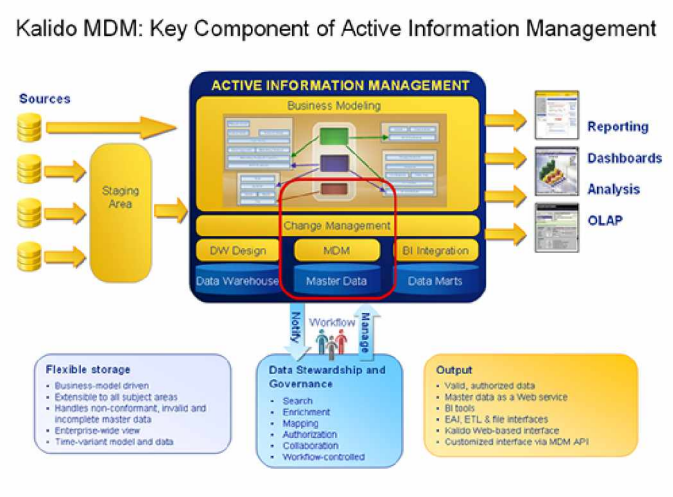
Datastream 7i™is the most widely-deployed, technically advanced solution for asset performance management. Offering superior technology with a modular design, Datastream 7i helps companies incorporate Asset Performance Management into every aspect of their operations and manage capital assets with unprecedented efficiency. And with the addition of Datastream 7i Analytics, customers gain in-depth, flexible reporting and graphing capabilities for analyzing key metrics, forecasting performance and maintenance issues, and taking preventive measures for optimum performance.

- **Data management**

### 10. Kalido MDM

http://www.kalido.com/solutions/software/masterdatamanagement/

Kalido MDM is an enterprise-wide master data management software solution for harmonizing, storing and managing master data over time. Kalido MDM software increases the consistency and accuracy of corporate performance reporting by enabling business people to collaboratively control and manage master data in a workflow-driven web-based environment. The master data management software produces a master data warehouse from which "golden-copy" master data can be distributed to business intelligence applications, data warehouses, enterprise applications and business people throughout the organization.




- **MIMOSA**

### 11. MIMOSA™

http://www.mimosa.org/

MIMOSA™ is an alliance of Operations & Maintenance (O&M) solution providers and end-user companies who are focused on developing consensus-driven open data standards to enable Open Standards-based O&M Interoperability

MIMOSA is a not-for-profit trade association dedicated to developing and encouraging the adoption of open information standards in manufacturing, fleet, and facility environments – information standards which enable collaborative asset lifecycle management. MIMOSA members come from process and discrete manufacturing companies, facility management companies, military organizations, capital equipment OEMs, and suppliers of asset management software systems.

The OpenO&M for Manufacturing Joint Working Group works to provide manufacturing companies with improved standards and technologies for exchanging manufacturing operations and maintenance data. The Manufacturing Joint Working Group covers all types of manufacturing from discrete to process, including non-traditional manufacturing processes such as oil fields and waste water treatment. This working group addresses the global manufacturing industry. The joint working group members are MIMOSA, The OPC Foundation, ISA88 and ISA95, WBF, and the Open Applications Group.

- **Manufacturing Resource**

**12. Giraffe Scheduling System**
http://www.giraffeproductionsystems.net/gsshome.htm

The Giraffe Scheduling System is used to prioritize and schedule production across manufacturing processes, machine capacity and labor resources. Giraffe Scheduling System automates clerical tasks and enables timely and consistent production scheduling.
The Giraffe Scheduling System enables forecasting and planning of manufacturing resource requirements and capacity utilization. This is to conserve resources, boost productivity and minimize production costs.
The Giraffe Scheduling System enables planning and tracking of manufacturing orders across multiple areas of processing. Priorities for production scheduling are assigned for each processing area on each shift. This is to boost customer service.

Resource Planning Benefits:

- Forecast and plan labour resource requirements and machine capacity utilisation.
- Improved productivity through effective resource planning.
- Reduced production costs.

**13. Job Master manufacturing software**
http://www.the-job-master.com/index.php?reqTab=PC

Job Master manufacturing software has everything needed to control and track production, from quote to shipping. Running your business requires you manage both production and job related administration. Job Master manufacturing software does it all…and it's designed for set up and implementation even by non sophisticated computer users. Need production control? See Job Master's production control features below. Need to better handle the administration, billing, and paperwork associated with your production jobs? Click on the Administrative Control tab above. Job Master manufacturing software is all the software you need to control and track your production jobs and inventory!

**Production Management** Numerous tools are provided for the monitoring of production and output. At any time, the job status of a particular order can be checked including where it is in the production cycle, and the work remaining. Date range reports can be pulled detailing how much product was actually shipped during a given time. Other reports detail such things as work in production and the dollar value of that work. Managers can also easily review missed or approaching deadlines.

**14. Manufacturing *Plus***
http://www.verticent.com/products/erp/mfg_plus.htm

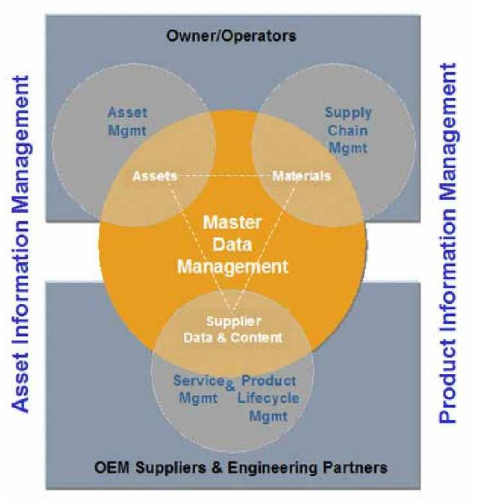
Manufacturing Plus is one of the most flexible manufacturing software management tools available today. As part of Verticent's ERP manufacturing software suite, Manufacturing *Plus* streamlines the efforts to meet customer demand so you can be a valued player in the supply chain.

| **Partial list of features:** |
|---|
| Forecasting - Options for loading forecasts from major Forecast Analysis Tools right into this ERP manufacturing software and then utilized in areas such as material requirements planning reports. |
| Master Production Scheduling - An option for the Manual Management of Shop Floor Orders within the manufacturing scheduling software of Manufacturing *Plus*. |
| Material Requirements Planning Reports - On-line, interactive, real-time item explosions and traditional regenerative MRP. Just one piece of the manufacturing simulation software available within Manufacturing *Plus*. |
| Capacity Planning – Manufacturing planning software that enables multiple capacity plans for maximum flexibility tightly integrated to the production planning software within Manufacturing *Plus*. |
| Material What-if Analysis - The ability to review multiple what-if options for an item. Just one component of the manufacturing simulation software available within Manufacturing *Plus*. |

- **Industrial Asset Master Solution**

**15. Asset Hub(TM) v4.5**
http://news.thomasnet.com/fullstory/522374

Offering functionality for engineering and supplier collaboration, Asset Hub(TM) v4.5 enables interoperability across Design, Operate, and Maintain spectrum of asset lifecycle. This asset master data management (aMDM) solution lets users meet strategic requirements for operational readiness for new and existing assets. It offers equipment classifications, maintenance program creation, and active directory user synchronization and hierarchical equipment type support.




**16. i2 Master Data Management**
http://www.i2.com/solution_library/ng_v_Master_Data_Management.cfm

**i2 Master Data Management** is designed to create a single enterprise thesaurus that can ensure data is consistently described, used, and stored within an organization. This approach can provide two key functions:

- Data management: can create a framework through which data is authored, monitored, and maintained
- Data synchronization: can ensure the coordination of business systems that touch the data

**17. Teradata Master Data Management Solution**
http://www.teradata.com/t/page/148161/index.html

Teradata's guiding principle for master data management is that core business data is an enterprise-wide resource and must be managed from an enterprise-wide perspective. By synchronizing master data, a common view of core business data across an enterprise is ensured. This dramatically shortens the time needed to analyze, review and drive changes to a business process.

Teradata Master Data Management enables companies to synchronize information across disparate systems, functional areas and business units to enable enterprise-wide data consistency and data visibility. This common view of product, customer, location, vendor, employee, purchase order, customer order or bill of material is a prerequisite for holistic decision making and efficient business operations. This results in increasing revenues, lowering costs and superior customer satisfaction.

Benefits include:

| Value | What does MDM Provide? | Business Benefit |
|---|---|---|
| Data Quality | • Data validation and error checks to ensure input data is clean | • More accurate inventory customer order commitments and improved service levels |
| Data Integrity | • Centralized data management for important entities; single portal for multiple users across multiple organizations | • More reliable reporting and analysis<br>• Reduced cycle time for introducing new products and vendors |
| Data Synchronization | • Enables consistent data flow throughout the enterprise and with your trading partners | • Faster integration architecture for reduced latency |
| TCO | • Standard workflows that can be quickly configured to business needs<br>• Most data management requirements are included<br>• Customization ability | • Lower deployment costs<br>• Lower maintenance costs<br>• Less risk |

- **OpenBravo**

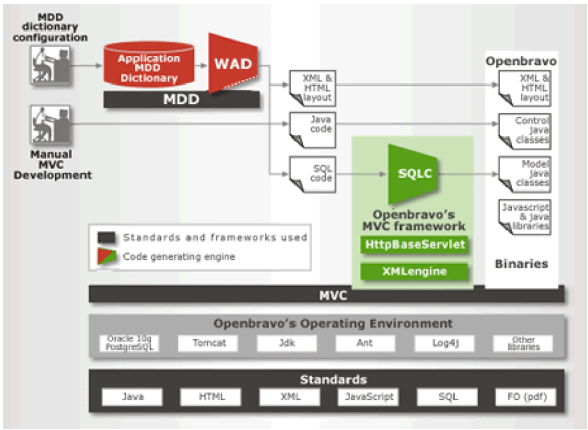
### 18. OpenBravo

http://www.openbravo.com/product/

Openbravo is a fully functional, integrated, web-based, open source enterprise management system (ERP) that offers a unique value proposition - a higher value at a lower cost.

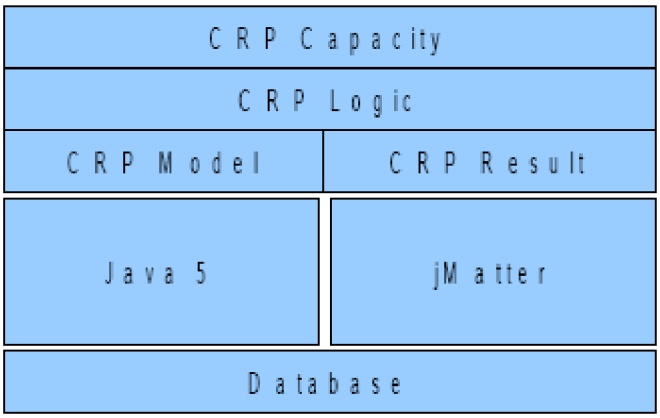
The system is for small and midsize enterprises that are looking for an integrated system to manage their business. One that is capable of managing daily operations, optimizing business processes, improving customer satisfaction and, ultimately, increasing profits.

Openbravo is a web-based application built on the MVC model. Most of the code is automatically generated based on the Data Model Dictionary by an engine that we call Wizard for Application Development (WAD). The engine executes and recompiles the application every time the system administrator changes the configuration to accommodate a user's request.



**19. CRP Capacity Requirement Planning**
http://crpcapacity.sourceforge.net/

The CRP-Capacity Requirement Planning, shortly "CRP Capacity", is a solution that is targeted for manufacturing enterprises with discrete production processes and currently allows the maintenance of resource related master data and interdependencies.




**20. FabTime Capacity Planning Module**
http://www.fabtime.com/capplan.shtml

Given a target product mix, do we need any new tools?
Given the tools that we have, and the products that we are running, how many wafers can we expect to produce?
Given our existing set of products and tools, what happens if the product mix changes? Where can we expect bottlenecks?

FabTime's capacity planning module leverages the data already stored in the FabTime digital dashboard software, to make it easier to build capacity planning scenarios. The only required manual inputs are: weekly ships per product and product line yield percentages.

FabTime Capacity Planning Module Benefits:
Eliminate the need to maintain offline capacity planning models.
Automatically update capacity planning data to reflect new conditions (process flows, tool uptime characteristics).
Quickly run scenarios to anticipate (and avoid) bottlenecks caused by product mix changes.

- **Capacity Requirement Planning Master Data**

**21. Exact Software**
http://www.exactamerica.com/macola/progression.html

Virtually every company has to deal with limited capacity. The infinite Capacity Requirements Planning (CRP) module shows the planner how well the existing capacity of the shop meets the anticipated load. It enables the user to merge shop orders, firm planned

orders and computer planned orders in from their packages of origin (Shop Floor Control, Master Scheduling and/or Material Requirements Planning).

Progression's Capacity Requirements Planning uses a visual interface that allows you to view and change the schedule for any shop order. It provides the capability to graphically display the load in each work center, highlighting the shop orders that have insufficient machine or labor hour capacity.

**What If Analysis:** Capacity Requirements Planning stores these orders in a separate Simulated Load file, so that the user may alter them without affecting the original orders. Along these same lines, CRP also provides the ability to add, modify and delete firm planned orders and to convert computer planned orders into firm planned orders. It also provides visual tools that enable the planner to adjust the schedule so that it better accommodates capacity.

### 22. Exact Alliance- Material and Capacity Requirements Planning

http://www.exactamerica.com/alliance/capacity_requirements_planning.html

The power of knowing what you must produce in order to achieve your goals is diminished if your work centers aren't capable of maintaining the appropriate production schedule. If you over-use a work center, the problems are obvious: backup and delays, unanticipated and costly overtime, and loss of quality due to production pressures.
By comparing the MRP schedule to the current capacity of each work center, the Alliance Capacity Requirements Planning function tells you if the work in your production schedule can actually be accomplished, and if the schedule is beyond your means, CRP will tell you where to make adjustments.

### 23. Answer Capacity Requirements Planning

http://www.answersolutions.com/solutions/manufacturing/crp/

*Answer Capacity Requirements Planning* makes it possible to recalculate the Capacity Plan and produce Capacity Planning reports and enquires.
*Answer CRP* uses the concept of a demand driver set of Answer objects that require an element of capacity of a particular work centre/resource.

Key Features:

- Produce capacity planning reports and enquiries
- Use Released and Planned Work Orders to predict requirements
- Use multiple demand inputs
- Backward and forward scheduling logic
- Full review and action processing in graphical formats

**24. GNU ERP**
http://www.gnu.org/software/gnue/project/what.html

GNU Enterprise is a meta-project which is part of the overall GNU Project (The GNU Project was launched in 1984 to develop a complete Unix-like operating system which is free software). It is three linked things:

- A set of tools, such as a data-aware user forms interface, a reporting system and an application server, which provide a development framework for enterprise information technology professionals to write or customize data-aware applications and deploy them effectively across large or small organizations. The GNUe platform boasts an open architecture and easy maintenance. It gives users a modular system and freedom from being stuck with a single-source vendor. GNUe supports multi-language interfaces and non-ASCII character sets.

- A set of packages written using the tools, to implement a full Enterprise Resource Planning (ERP) system. From human resources, accounting, customer relationship management and project management to supply chain or e-commerce, GNUe can handle the needs of any business, large or small. GNUe supports multi-currency processing (including euro support).

- A general community of support and resources for developers writing applications using the GNUe Tools (whether part of the 'official' GNUe Packages or not). It is designed to collect Enterprise software for the GNU system in a single location (much like the GNOME project collects Desktop software). GNUe is a Free Software project (released under the GNU General Public License) with a corps of volunteer developers around the world working on GNUe projects. This provides the added benefits of easy internationalization of applications. The project is working to provide a worldwide GNUe community, allowing everyone who is involved in the project access to other talented business information technology professionals.

- **Supply Chain Capacity Planning**

**25. Oracle**: **PEOPLESOFT SUPPLY PLANNING**
http://www.oracle.com/applications/peoplesoft/scm/ent/module/supply_planning.html

Using a powerful analytic calculation engine, PeopleSoft Supply Planning simultaneously balances material requirements, capacity limits, target inventory levels, forecasts, and customer commitments to craft feasible supply chain schedules. Since organizations demand that concise information be provided in an easy-to-understand format, we present information online both in graphical form and as user-definable spreadsheets. Violations in the plan are immediately available.

Key features include:

- Material and capacity feasible solvers
- Analytics to pinpoint violations and exceptions in the supply plan
- Intuitive user-friendly workbenches for fine tuning the plan and resolving issues
- High visibility to impacts on the transaction system prior to committing the plan
- In-depth inventory and resource reporting

- Data filtering capability by business unit, planner code, family, group, category, utilization type, and planned by type

**Capacity Plan Workbench**
Use the Capacity Plan Workbench to manage resources and determine the amount of capacity that is required to produce products in the future. With the capacity plan, you can view capacity by user-specified buckets and navigate to production details where you can add, delete, or cancel production, reschedule tasks, and change quantities.

### 26. Izaro grey APS

http://www.softi9.pt/products/details.php?id=iGreyAPSeng

- A fully graphical and intuitive tool for the Planner, it uses optimization and sorting criteria for scheduling the Production Orders. Its design allows for discrete or continuous finite capacity production, taking into consideration a wide range of production variables.
- Production Planning and Optimization: Izaro Grey is a powerful graphical tool for the planning and optimization of the production for Companies with continuous production;
- Allows the planning of different Plants, Divisions and Business Units, from a single workstation;
  Manages as many Planning Sessions as needed (Daily, Weekly, Simulation within the same day requests by the Sales Department);
- Manages an unlimited number of simulations or programmed Scenarios for each Session;
- Support for multiple languages.
- Planning Control Panel
- Based on KPIs , configurable by the user;
- Comparison of the programmed Scenarios based on the KPIs, so that the user can select the best scenario for each Session;
- The Algorithms calculate the sequence of Operations for the chosen Optimization Criterion (Minimize Stoppage times, Minimize preparation times, Deliveries after deadline, Maximize load level, Fulfil P.O.'s priorities).
- 100% Graphical Environment
- Templates for graphical display:
  Gantt Graph of Resources;
  Gantt Graph of Production Orders;
  Loadings Graph, with finite capacity.
- The result of the Optimization Algorithm can be manually adjusted by the user by using the mouse directly in the graph.
- Integrated in the Izaro products family and capable of being integrated with other ERP's, using XML Structures.

### 27. Atlas Planning Suite: capacity module

http://www.atlasplanningsuite.com/rough_cut_capacity_planning.shtml

**The Challenge of Capacity Constraints**

To meet production requirements, manufacturers must balance the limitations of their equipment against the needs of customer demand. Equipment, time constraints, and personnel limitations combine to limit the maximum capacity of any production environment. In order to put together an effective production schedule, manufacturers must consider equipment changeovers and capacity constraints to balance demand and optimize production.

**Plan Proactively For Production**

To maximize capacity, planners must experiment with resource combinations until they find a schedule that toes the line between capacity and demand. With effective capacity planning, users can be confident in their production schedule's ability to meet demand. Users also can see when they are unable to meet demand and plan proactively to escape the bottleneck.

**Experiment with Capacity Scenarios**

John Galt's Rough Cut Capacity Planning module offers planners the platform that they need in order to find an effective combination of resources. Using our intuitive graphical interface, planners can view a schedule of resources, understand which items fall within and outside of capacity, and move items to align major resources with demand. When a complete capacity plan is generated, Rough Cut pushes the completed production schedule back into the Atlas Planning Suite, allowing collaborative planners to integrate the constraints with the company's overall strategy

The Capacity Planning module features include:

- Intuitive graphics that provide visibility of factory resources
- Resource transfers
- Online product information
- Batch rescheduling for inventory planning
- Analytical reports for quick ad-hoc analysis
- Exception management reports to immediately identify bottlenecks
- Analysis of load and capacity for both planned and actual work loads
- Powerful what-if analysis for fast decision making
- Conversion factors that will allow for capacity to be calculated by any unit of measure

### 28. Siperian MDM Hub

http://www.siperian.com/index.cfm?page=body&crid=72

Siperian MDM Hub manages all types of master data—with an integrated, model-driven master data management (MDM) platform that adapts to your business requirements.

Only Siperian MDM Hub™ has a completely integrated, model-driven and flexible architecture that allows your organization to deploy any of the common master data management (MDM) architectural styles while coexisting with your existing data and IT environments.

The Siperian platform models all master data types; and if you make a change to the data model, everything else automatically changes—without requiring manual intervention. The

data model also conforms to the specific and typically unique needs of your MDM project, without imposing rigid or predefined business definitions or customization. In this way, project risk is reduced by letting you control the scope of the project and by enabling a phased approach to start small and add capabilities over time.

- **SAP**

**29. SAP SCM (Supply Chain Management)**
http://www.sap.com/solutions/business-suite/scm/featuresfunctions/planningandcollaboration.epx
http://www.sap.com/solutions/business-suite/scm/pdf/BWP_SB_Supply_Chain_Planning.pdf

**Demand planning and forecasting** – Forecast and plan anticipated demand for products or product characteristics. Use state-of-the-art forecasting algorithms for product life-cycle planning and trade promotion planning.

**Supply network planning** – Integrate purchasing, manufacturing, distribution, and transportation plans into an overall supply picture – so you can simulate and implement comprehensive tactical planning and sourcing decisions based on a single, globally consistent model. This can involve heuristics and capacity planning, optimization, and multilevel supply and demand matching.

**30. SAP ERP**
http://www.sap.com/solutions/business-suite/erp/index.epx

Improve alignment of your strategies and operations. Enhance productivity and insight for your enterprise. That's the power you get with enterprise resource planning (ERP) software from SAP – the power to adapt quickly to changing industry requirements.
SAP ERP addresses the core business software requirements of the most demanding midsize and large organizations – in all industries and sectors.
SAP ERP includes four individual solutions that support key areas of enterprise resource planning:

- SAP ERP Human Capital Management – Transform the role and value of HCM.
- SAP ERP Financials – Turn finance into a strategic business partner.
- SAP ERP Operations – Free up resources; budget for innovation.
- SAP ERP Corporate Services – Streamline business processes and costs.

**31. SAP Netweaver**
http://www.sap.com/platform/netweaver/index.epx
https://www.sdn.sap.com/irj/sdn/mdm

The SAP NetWeaver® Master Data Management (SAP NetWeaver MDM) component helps you clean, consolidate, and harmonize your master data – even within heterogeneous IT landscapes. As a key component of the SAP NetWeaver platform, SAP NetWeaver

MDM reduces data maintenance costs, ensures data consistency across the enterprise, and greatly improves business analytics and decision making. It also serves as a fundamental building block of enterprise service-oriented architecture (enterprise SOA).

### 32. Open MFG

http://www.openmfg.com/

The Schedule module (available in OpenMFG only) allows you to be proactive in managing your production and inventory levels. Your planners can build out your Master Production Schedule (MPS) with Production Plans and Forecasts, time-phased over standard calendars (absolute or relative) that you define (…).Use Capacity Planning to improve your production scheduling and utilization of labor and machinery by tracking activity at individual work centers over time. Identify bottlenecks and down time (by Item, by Work Center, or by Planner), and increase efficiency across the organization. The Buffer Management subsystem enables simplified Shop scheduling based on Lean and Theory of Constraints concepts.

**Schedule Module:**

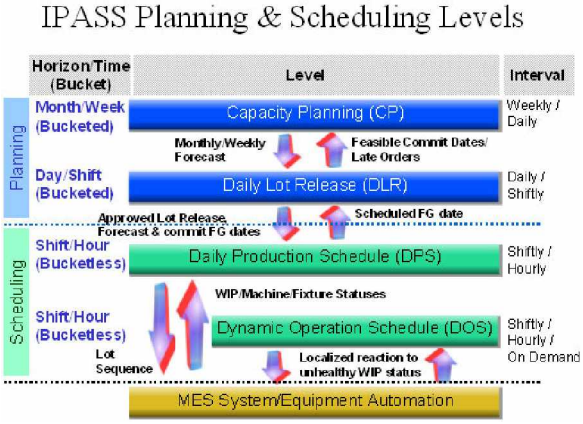
- Capacity Planning
- Time Phased Capacity
- Time Phased Load
- Time Phased Available Capacity
- Time Phased Production (by Planner Code, Item)
- by Planner Code
- by Item
- Time Phased Demand
- Capacity Buffer Status

### 33. IPASS: APS (Advanced Planning and Scheduling Systems)

http://www.idimensionsystems.com/solutions_in_detail/solutions_02.html

IPASS models the production floors and performs the desired planning and scheduling tasks. It has the capability to model both the single-stage and multiple-stage production environments, while integrating the planning and scheduling modules in a single platform to ensure that shop floor resources are working on the right customer orders at the right time.

IPASS consists of four main modules - Capacity Planning (CP), Daily Lot Release (DLR), Daily Production Scheduling (DPS) and Dynamic Operation Scheduling (DOS). Among these four modules, the CP and DLR are designed for planning purpose and the DPS and DOS for detailed scheduling.



**34. Informatica:** Data Integration Solutions for Master Data Management
http://www.informatica.com/solutions/integration/mdm/default.htm

While Informatica does not make a MDM application, we provide the enterprise data integration foundation that enables the MDM application to integrate with the existing business systems, delivering maximum value from a company's MDM application and its master data in spite of.
Informatica provides a single enterprise data integration platform to help organizations access, transform, and integrate master data from a large variety of systems and deliver that information to their MDM applications. The Informatica enterprise data integration platform offers the key capabilities that businesses need to access, integrate, migrate, and consolidate master data, which reduces complexity, ensures consistency, and empowers the business.

**35. Hyperion System MDM**
http://www.hyperion.com/products/foundation_services/mdm_services.cfm

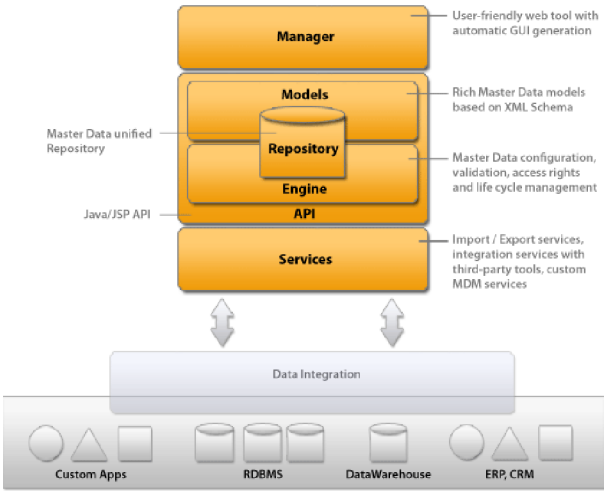
Hyperion® System™ 9 Master Data Management™ (Hyperion MDM) software is the industry's first master data management solution built to enable Business Performance Management (BPM). With its easy to use "point and sync" thin client interface, Hyperion MDM enables non-technical users to directly manage change in master data, while IT controls the process and enforces business rules.

Through a formal, rule-driven workflow process, Hyperion MDM synchronizes BPM master data—such as hierarchies, business dimensions, reporting structures, attributes, and business rules—across BPM, BI, and other enterprise systems, including data warehouses, data marts, analytic applications, financial applications, and transactional systems.

**36. EBX platform MDM software**
http://www.orchestranetworks.com/product/features_models.cfm

Today, Master Data are defined and stored into many different repositories, using various technologies, and are frequently duplicated across the Information System (for technical environments, subsidiaries, branches, partners). This lack of a unified and secure solution for Master Data Management can cause critical business transactions to fail.

EBX.Platform allows to design structured and rich data models. Based on XML Schema standard, data models unify Master Data description, whatever their type, their nature or their complexity. Master Data models describe objects and attributes (meta-data), documentation, localization, validation controls and integrity rules. Thanks to this flexible and structured approach, EBX.Platform can be used to manage any Master Data, including products, services, customers, organization, and regulation.




### 37. Xtentis MDM

http://www.amalto.com/amalto/index.php?id=21

Xtentis MDM enables your company to build a unique and centralized master data repository (customers, suppliers, products, employees, stores, plants): federating the data from internal and external systems and repositories in a non intrusive way, synchronizing the data across all systems, and displaying the data through a user-friendly interface with powerful search features.

- Define data models in a flexible manner
- Manage data updates and validation processes (automated or manual, scheduled or triggered by any event, with validation or not…)
- Guaranty data quality (validity control against the data model or against specific rules)
- Collect master data from producer systems and organize data deployment towards target systems (whatever the formats or protocols of those systems)
- Manage roles and rights precisely
- Perform master data exposition through web services
- Benefit from a powerful generic user interface or to have a customized one implemented

### 38. Preactor

http://www.preactor.com/

Advanced Planning and Production Scheduling, APS, and Supply Chain Management, SCM, are becoming increasingly important in manufacturing companies, as they look to enhance their enterprise applications to take account of real-time status of suppliers, customers and their own plant.

Some Preactor's features:

- Integration with other systems;
- What-if scenarios;
- Tooling defined per resource or product;
- Programming based on bottleneck;
- Exceptions

**39. QAD Manufacturing Solution**
http://www.qad.com/portal/site/solutioncenter/menuitem.fb5ba47419d63afef207bd170690307a/?vgnextoid=242f1ed5a8146010VgnVCM100000810903a7RCRD

Designed to speed operation, Manufacturing Planning enables faster decision-making and more effective resource deployment. Built on the standard APICS model for MRPII, Manufacturing Planning helps convert external and internal demands for products into detailed manufacturing, procurement and resource utilization plans. Modules provide Material and Resource Planning capabilities, ranging from enterprise-level strategic planning functions through plant-level Master Production Scheduling and Material Requirements Planning. Resulting plans are linked directly to the execution modules for a complete product manufacturing management process.

**Capacity Requirements Planning**
QAD Capacity Requirements Planning uses the planned manufacturing schedule to analyze the requirements placed on manufacturing work centers. It compares these planned requirements with the capacity available to determine if a production plan is feasible. If a work center is over capacity it will identify the production that is causing the problem to facilitate rescheduling or adding resources to the work center.

- Determines work center load and generates capacity-requirements plans for a department, work center, or machine by utilizing MRP planned orders, other work orders, and repetitive schedules

Expresses work centers/machine requirements in hours and reports within a user-specified time periods based on days, weeks, or months

## Appendix B: Research about Data Governance

1. **Data Profiling, Data Integration and Data Quality: The Pillars of Master Data Management**

http://www.initiatesystems.com/resources/exec_summary/Pages/pillars_of_MDM.aspx?_kk=data%20governance&_kt=25939b96-85f0-4f4f-b703-9f5c38afa9b8&gclid=COPt8Pzu7Y8CFQoiZwod3SUWFA

By David Loshin, President and Principal Consultant at Knowledge Integrity

Over the past ten years, data profiling, data cleansing and matching, and data integration tools have matured in concert with a desire to aggregate and consolidate "master data," but today's master data management (MDM) initiatives differ from previous attempts at enterprise data consolidation. An MDM program creates a synchronized, consistent repository of quality master data to feed enterprise applications. Successful MDM solutions require quality integration of master data from across the enterprise, relying on:

- Inventory and identification of candidate master data objects
- Resolution of semantics, hierarchies and relationships for master entities
- Seamless standardized information extraction, sharing and delivery
- A migration process for consolidating the "best records" for the master repository
- A service-oriented approach for accessing the consolidated master directory
- Managing enterprise data integration using a data governance framework

2. **Data Profiling, Data Integration and Data Quality: The Pillars of Master Data**

http://www.dmnews.com/cms/dm-news/database-marketing/41750.html

Master data governance is the overall management of the most important data entities and consists of the policies, processes, controls and audit functions required to manage and safe-guard these critical corporate data assets. As a result, data governance also includes oversight of the related domains of data availability, usability, integrity and security.

### 3. Data Governance and Master Data Management

http://en.wikipedia.org

By setting up a data governance practice, issues with data quality can be eliminated.

- Data mapping
- Data Profiling: process of examining the data available in an existing data source (e.g. databases) and collecting statistics and information about the data.
- Data Cleansing: act of detecting and correcting (or removing) corrupt or inaccurate records from a record set. Data cleansing differs from data validation because in the first case the data is rejected when there are batches of data.
- Monitoring data
- Metadata registry: central location in an organization where metadata definitions are stored and maintained in a controlled method.

MDM generally has a data governance component. Data governance means having to define clear **data owners** and users, having clear business policies regarding what is good master data and what is not. Master data management is also about providing continuous reports and alerts to master data owners and the stewards regarding the health of the master data.

# Appendix C: Questionnaire

## Capacity Modeling

1. How flexible is your system to allow for model adaptation to changing requirements (e.g. addition of attributes, user defined calculation results). How is the system handling schema updates? Can the updates be performed without server restart?

2. Is it able to model the resources, products, results, routes, manufacturing locations and the demand plan?

3. Is your system able to model manufacturing hierarchies? Does it understand and allow that: a location has different manufacturing levels which have diverse areas? Moreover, an area has a variety of work centers and a work center has different resource groups. Each of this group has more than one resource and a Work Center usually has only one or more operations.

4. Is your system able to model machine allocations? As long as specific equipment can produce a range of different products, is it transparent for the user which resource can be chosen? This means, does the system show the variety of resource options and allow the modeling of resource priorities for specific products?

5. Does your system provide the distinction between main resource and tooling? And does it allow that each equipment can use more than one tool (different tool for different product but on the same equipment) and a tool can be used by more than one equipment?

6. Is it possible to model individual equipment and group the equipment by different criteria (e.g. by equipment attributes)? What's the maximum number of resource attributes? Is your system able to model the 3 types of resource attributes (float, integer or string)?

7. Is your system able to model the change of production units within one model (e.g. 1st operation units is wafer and 2nd operation units is chip)?

8. Does your system define products through attributes? Does your system provide aggregation of products according to their attributes (product groups)? Is it possible to

model capacities on different product aggregation levels? What is the maximum number of attributes of a product?

9. Is it possible to model exceptions? For example, can we define a generic process time on a high product level and an exceptional process time for a specific product?

10. Is your system able to keep date information in different formats and is it able to make conversions between e.g. the Business Year and Calendar Year? Is it possible to define the start day of a particular week? Is it possible to model Business Week 53 as an exception?

11. Does your system provide the possibility to model yield on the operation level? Does the system consider yield for calculation of capacity?

12. Is your system able to model demand that is specific for one product in one location and for a particular period of time? Knowing that a location can have a variety of demands (depending on the number of products they have) is the system able to aggregate those demands which are related to the same period of time and therefore create a production plan?

13. Does your system support what-if analyses? This means, does your system allow the user to create an alternative scenario introducing new data in the model (such as new quantity of a product to produce or different number of resources or process times) and returning the capacity needed?

**Model Maintenance**

14. Is your system able to validate the consistency of the model? This means, does it guarantee that there is consistency between classes with the same information, e.g. Product Group and process Time Classes? How does the system make sure that relations are kept consistent when deleting an entry from some class?

15. Does your system provide an user interface (UI) for model maintenance? Is it possible to mass change values in a model (e.g. changing the uptime for various machine groups at the same time)?

16. Is your system able to load model data from flat files (txt, csv) or xls files? And is it possible to export model data to files and office applications?

17. Does your system provide reports? What type of reports? Charts? Tables? Is your system able to show capacity utilization for different aggregation levels of the 3 dimensions: time, machine/manufacturing hierarchy, product group? Is your system able to aggregate other results from low levels (e.g. resource, product and operation) into a higher level (e.g. resource group, work center or location, product group)?

## Technical Requirements

18. Does your system make use of an Oracle database server?

19. Does your system fulfill the following speed requirements: calculation speed less 30 mins for very large models (300 product groups, 100 machine groups, 300 product groups, 10 operations, 104 weeks, 7000 process time changes, 300 machine availability value changes in the planning horizon)?