Integrated Project Design and Management: the DRAM300 Project

The Integrated Project and Design Management method (IPDM), which was developed by Siemens Industrial Building Consultants (Siemens IBC) to realize fast track/low risk projects, was introduced in the last issue of Future Fab International[1]. The three key elements of the method – Project Programming, Conceptual Design including tendering/awarding and Project Management, Controlling and Coordination – were described and compared with traditional project management approaches. The latest article shows how the IPDM method was used to build the world's first 300mm front-end production facility for Infineon Technologies AG, Munich.

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By the same author…
'Integrated Project and Design Management (IPD&M): A Way to Build Fast-Track/Low Risk Semiconductor Fabs', Martin Weltzer and Heinz Gräber, Future Fab International, Issue 11, p.109-114. An online version can be found at http://www.future-fab.com/documents.asp?grID=211&d_ID=630

Introduction

The project DRAM300 differs in many respects from typical projects of the semiconductor business. The frontend production facility is the world's first 300mm Fab. This fact has significant impact on all planning activities. It is not possible to use the experience of an existing Fab as a blue print copy. Certain basic data was available from the SC300 pilotline, which was operated by Infineon and Motorola during the conceptual phase. However, due to the tool prototype character and the low production load, most of the data were not transferable to a future mass production facility. Furthermore, the process technology for the 300mm mass production with structure geometry of less than 0.15µm was still under investigation and the new Fab design was mainly based on assumptions. Important relevant planning parameters for the process infrastructure such as tool throughput, average consumption figures or tool connection loads were defined during the construction phase. It quickly became apparent that the key benchmark figures given in the i300i Factory Productivity Guideline[2] were not achievable in a new Fab right from the start.

The integration of the new production facility into the existing 200mm production site in Dresden was very challenging. Figure 1 illustrates the area restrictions and the confined space available to build the Fab and the support buildings. A very exact and detailed logistic concept and operational structure during construction was required.

The Fab of the new founded company Infineon Technologies SC300 GmbH & Co.

Figure 1. The picture shows the new 300mm fab complex (left hand side, front to back: Office buildings, Fab, Central Utility Building) and the 200mm Fab modules (middle and right hand side). The Support Building between the old and new Fab module was extended for process and testing activities.

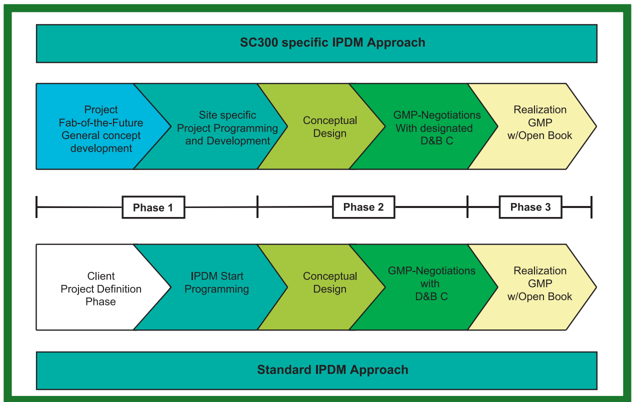

Figure 2. Project overview.

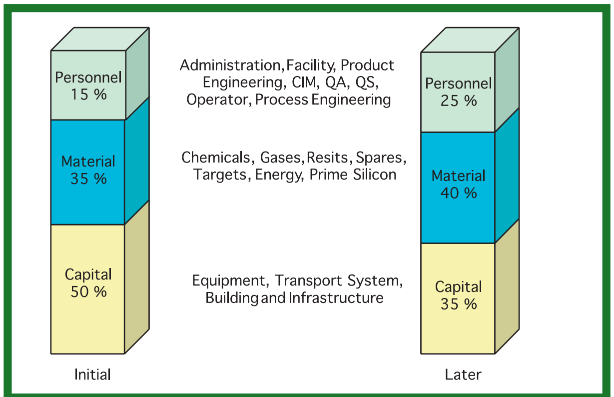

Figure 3. Wafer cost structure for a new fab (initial) and an old fab (later).

KG Dresden is a joint property between Infineon, the free State of Saxony and the General Contractor Meissner & Wurst Zander, Stuttgart (Germany, M&WZ). Expected difficulties because of natural interest conflicts of the GC were negligible and had no impact on the project success.

Figure 2 shows a comparison between the conventional IDPM approach as described before[1] and the specific processing for the project DRAM300. The single project phases are described below.

Project Overview

Phase I: Project Programming

The fundamentals for the project DRAM300 were developed with the project 'Fab of the Future' (FoF). In spring 1998, several expert teams were commissioned to evaluate all aspects of a future 300mm front-end production facility in a then undefined location and to identify possibilities and methods, which would lead to lower wafer costs. The team members from all relevant disciplines were recruited from internal Siemens departments and external well-known companies. The timeframe to achieve the project goals was one year.

The main target was to decrease the wafer costs to a level, which minimizes the profit lost even in a downturning semiconductor market. Alternative tool layouts and automated material handling systems (e.g. sea of lots[3]) were evaluated as well as arrangements to lower the direct or indirect material costs. New Facility Management structures were discussed and cost efficient innovative technologies for the infrastructure were investigated. With regards to the current weakness and price pressure, especially for DRAM chips, the initialization of the FoF project demonstrated an extremely visionary view of the Infineon management. One of the biggest advantages for all participants was the lack of the usual project time pressure. It is not surprising that several patents were developed in such a creative atmosphere.

Figure 3 shows the average wafer cost ratios for personnel, material and capital costs[4]. For a new Fab, the capital costs for equipment, automated material and handling systems, building and infrastructure are dominant and reduced capital costs will help to achieve the break-even point faster.

The complete building and infrastructure spectrum of the project FoF was overseen and managed by the later IDPM-Coreteam of Siemens IBC. The engagement of the IPDM-Coreteam in the early project development and definition phase represents a major difference to other projects, which were realized with the help of the IPDM method. The normally short but intensive programming phase had the character of a comprehensive study.

Based on a calculated 300mm Infineon business model and the experiences gained from earlier constructed 200mm frontend Fabs like Siemens Microelectronics Center (Dresden, 1995), Siemens Microelectronics Ltd. (North Tyneside, 1996) or White Oak Semiconductors (Richmond, 1997), the first step was to establish aggressive cost targets for the complete building and infrastructure package of a new 300mm Fab. Information from the i300i Factory Productivity Guideline was considered as well as first results from the 300mm pilotline. The costs for developed concepts were calculated in conjunction with external companies and afterwards discussed with facility staff to incorporate their operational experience. All discussions and considerations focused on the final wafer costs and a need for a well-balanced ratio between invests and operational costs.

The decision to build the Fab in Dresden was made in summer 1999. It enabled the IPDM-Coreteam to transfer the neutral FoF results and to adapt the Dresden site specialties. Based on the need to establish an independent legal entity of the new SC300 Company and risk management considerations, the decision was made to build the new Fab as a self-supporting unit beside the existing 200mm Fab. Possible synergy effects between both Fabs were restricted and only used for certain production facilities like parts clean and wafer testing. Up to the awarding of M&WZ, the IPDM-Coreteam activities were focused on the clarification of general construction and technical premises and the definition of the project structure, project organization and a milestone time schedule.

The construction approval of the project and the public supply and discharge capabilities were secured by involving local authorities and suppliers for utitlites such as natural gas, potable water,

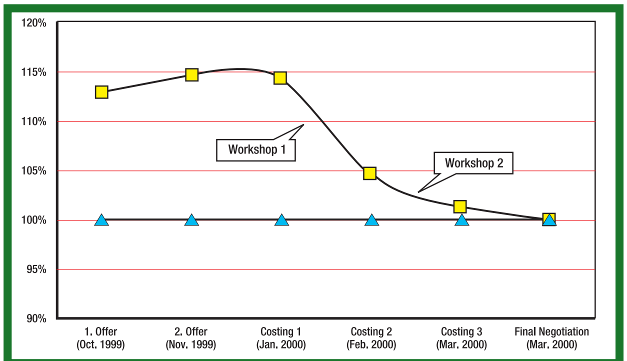

Figure 5. Change order management procedure.

Table 1. Project Tasks - Programming and Conceptual Phase

		Client	IPDM CT	GC
General Tasks	Clarification IFS300 Topics	Input	Driver	No Action
	Clarification Site Wide Topics	Input	Driver	No Action
	M&WZ Contracting	Driver	Driver	Driver
	Milestone and detailed Time Schedule	Input	Input	Driver
	Client Controlling (Quality, Costs, Schedule)	No Action	Driver	No Action
Project Concepts	Programming	Input	Driver	No Action
	Masterplan Development	Input	Driver	No Action
	Construction and Functional Programming	Input	Driver	No Action
	Securing Approval Ability w/ Local Authorities	Cooperation	Driver	No Action
	Securing Local Supplier Capabilities	Cooperation	Driver	No Action
	Definition Milestone Time Schedule	Input	Driver	No Action
	Definition Quality and Scope of Work for GC	Input	Driver	No Action
	Concept Review	Cooperation	Driver	Driver
	Cost Estimation	No Action	Cooperation	Driver

No Action · Input · Cooperation · Driver · Controlling ✓

wastewater and electricity. The site master plan was adjusted and the project was integrated into the existing site construction permit. Activities like vibration measurements or construction ground investigations were arranged to complete the knowledge of the site environment.

The very limited construction area required a detailed study of the complete construction logistics, including the necessary construction infrastructure (e.g. containers, lay-down areas and material storage). It was essential to prevent any restrains of the ongoing 200mm production facility.

The developed area and functional programming for each building was discussed with internal and external specialists to cover environmental, safety and health (ESH) aspects and to meet local code requirements.

A very important point with regards to the aspired-to ready for equipment date (30 April 2001) was the development of time schedule structures and time schedule dependencies between individual work packages. The execution quality on the due date was raised significantly compared to former projects and included a facility burn-in-phase and a prefacilitisation to accelerate the tool hook-up. The Fab start up and ramp up schedule was much faster than for the existing 200mm Fab.

Phase II: The Conceptual Design

The extensive results of the Programming Phase were transposed into the Conceptual Design and completed with a detailed cost budget calculation. The budget was derived from the cost optimization studies performed during the FoF project. The CD was given exclusively to M&WZ as designated General Contractor to submit a proposal. The approach to choose a designated contractor is different to the usual IPDM-method with an open competition (compare Figure 2), but it offers considerable advantages in respect of time and integration of planning partners into the concepts and developed leading ideas.

The usual cost benefit associated with an open competition must now be achieved in direct negotiations with the GC. Figure 4 shows a comparison between the estimated M&WZ project costs (yellow squares) and the IPDM target costs (blue triangles). Both curves break even on the IPDM cost level. The graph shows that the first M&WZ bids were about 15% higher than the finally fixed Guaranteed Maximum Price (GMP). The breakthrough was achieved about five months after awarding of the GC. Two intensive workshops steered by the IPDM-Coreteam were held to identify cost differences and to optimize the technical solutions proposed by the GC.

Phase III: Project Controlling and Coordination

The following tables (1-3) show the scope of work for the client, the IPDM-Coreteam and M&WZ during the single project phases. The work was split up into four different categories: Input, Cooperation, Controlling and Driver.

Input functions included contributions to inform the planning partner about project objectives or to clarify requirements. Cooperation functions required a deeper involvement as an active partner on a continuous basis. The Driver was responsible for fulfilling the task and to coordinate the planning participants. Control functions included the examination of the work results with respect to the original task, cost, time schedule and quality. These functions were executed either by the client or the IDPM-Coreteam.

The scope of work reflects the IPDM-method described in the first Future Fab article. Firstly, the client requirements were transferred into concepts and summarized in a Conceptual Design. Secondly, after awarding the GC, the concept transformation into a basis of design and later into the detailed design is accompanied and not only controlled. Thirdly, the definition of start up programs and the final project acceptance is carried out in conjunction with the client.

The awarding of qualified subcontractors is essential for the overall project success. The procurement for DRAM300 was organized and scheduled by M&WZ, but the final awarding was a joint effort of the client, the IPDM-Coreteam and the GC.

Costs, schedule and quality were continuously monitored over the entire project. But despite all efforts during the Programming Phase a lot of change order notifications (CON) had to be implemented because of the high project complexity and the dynamic process technology developments.

Table 2. Project Tasks - Basis of Design, Procurement (legend see Table 1)

		Client	IPDM CT	GC
Basis of Design (BOD)	Project Update and Site Integration	⇔	✥	⊘
	Concept Review	⇔	✥	✥
	Definition Scope of Work IPDM Team, GC	⇔	✥	✥
	Cost Estimation, Budgeting	✓	⇔	✥
	Definition BOD (e.g. systems, components)	⊘	⇔	✥
	Negotiations w/ Local Authorities	⇔	✥	⇔
	ESH Integration	⇔	⇔	✥
	Prepare Construction Approval Documents	⇨	⇨	✥
	Wind-up Construction Approval Procedure	⇔	✥	⇨
	BOD Cost Calculation	⊘	✓	✥
	Plausibility Check BOD	⇔	✥	⇨
Procurement, Awarding	Setup Request for Proposal	⊘	✓	✥
	Definition of Bid Packages	⊘	⇔	✥
	Definition Bidders List	⇨	✥	✥
	Bid Request	⊘	⊘	✥
	Bid Evaluation and Comparison	✓	✓	✥
	Interviews w/ Subcontractors	⇔	⇔	✥
	Awarding Proposal	✥	✥	✥
	Awarding	✓	✓	✥

Table 3. Project Tasks – Detailed Design, Start up and Change Management (legend see Table 1)

		Client	IPDM CT	GC
Detailed Design	Detailed Engineering	⊘	✓	✥
	Coordination of Working Packages	⊘	✓	✥
	Client Plausibility Check	⇔	✥	⇨
	Controlling of Execution	⊘	✓	✥
	Coordination Site Security and Safety	⊘	⊘	✥
	Controlling (Cost, Schedule, Quality)	⇔	✥	⇨
	Check & Approval of Subcontractor's Scope of Work	✓	✓	✥
Start Up	Definition of Requirements (Areas, Work Packages)	✥	⇔	⊘
	Definition of Setup Programms	⇔	✥	⇔
	Detailing Setup Programms, Execution	✓	✓	✥
	System Hand-Over	✥	⇨	⇔
	Final Project Acceptance	✥	⇔	⇔
Change Management	IFS 300 internal Change Management	⇔	✥	⊘
	GC internal Change Management	⊘	✥	✥
	Placing of Change Order Notification (CON)	⇨	✥	⇨
	Bid Request for Subcontractors	⊘	⊘	✥
	Contracting, Negotiations Subcontractors	⊘	✥	✥
	Release of Change Order Notification	✥	✥	⊘
	Documentation	✓	✓	✥

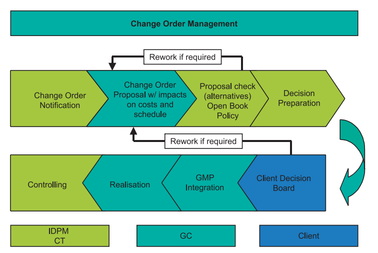

Figure 5. Change order management procedure.

Only the IPDM-Coreteam had the authority to issue a CON. Requests with a 'nice to have' character were filtered and M&WZ stayed focused on necessary changes to secure the required functionality and quality. Ideas for possible solutions were discussed upfront to accelerate the procedure. The CON proposal was prepared by M&WZ and included a valuation on cost and schedule impacts. Non-acceptable proposals were rejected by the IPDM-Coreteam and alternative solutions to minimize the implication on cost and schedule were developed.

The chosen open-book-approach made it possible to achieve a high cost transparency and to avoid time consuming negotiations. Accepted CON proposals were presented and explained to the client decision board for approval. In exceptional cases, the client decision board was also used as a forum to decide controversial or disputed CONs. Time critical changes with uncertain costs were released with the proviso to negotiate the final price.

The consequent use of the change management procedure made it possible to achieve the cost goals set in the beginning of the project and to balance adders and deducts.

The facility start up programs were defined according to the client requirements. The final acceptance of the M&WZ scope of work was spilt up into single technical intermediate examinations because of the project complexity. The completeness and the lack of substantial faults or defects were a precondition for an intermediate examination of a single work package. A 72-hour test was used to proof the stability, performance and quality of the facility system. The handover of all necessary documents to run and maintain the system were mandatory.

The formal acceptance of the complete GC package including all deliveries and executions as well as the transfer of risk to the client will take place with the final technical intermediate examination.

References

[1] Martin Weltzer, Heinz Gräber, Future Fab International, Issue 11, p.109, (2001). For an online version see http://www.future-fab.com/documents.asp?grID=211&d_ID=630

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Biography

Martin Weltzer

Martin Weltzer received his Doctorate in Chemistry at the University of Cologne and joined Siemens in 1991. He was in charge of developing and realizing Process Facility systems for several 200mm Fabs such as SIMEC Dresden, Siemens Microelectronics North Tyneside and White Oak Semiconductor (a joint Venture between Siemens and Motorola). Between 1998 and 2000, he was leading a team to develop advanced concepts for a future 300mm Fab. As part of the IPDM-Coreteam in Dresden he was responsible for Process Systems.

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