Integrated Project and Design Management (IPD&M): A Way to Build Fast-Track/Low Risk Semiconductor Fabs

Modern semiconductor fabs are built much faster than in the past despite increasing demands and higher complexity of the process infrastructure. The timeframe between the decision to build a fab and the installation of the first tool (Ready for Equipment) is often less than 18 months. Traditional project management methods fail when carrying out these fast track projects which contain high risks with regard to quality and cost. The introduced Integrated Project and Design Management concept (IPD&M), developed by Siemens Industrial Building Consultants (Siemens IBC), helps to eliminate these risks and enables the user to successfully complete ambitious projects. The concept was used with great success to build the first 300mm fab for Infineon Technologies AG (Dresden, Germany).

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Introduction

The traditional way to complete projects is characterized by a sequence of mostly individually developed separate planning steps (Figure 1). After defining the program the owner starts to select architects and engineers (A/E) based on their qualifications. The A/Es develop the preliminary and detailed designs and prepare the procurement procedure for selecting a General Contractor (GC) or Work Package Contractor (WPC). After being awarded the contract, the GC or WPC steps into the project with no prior knowledge of and little subsequent control over the basic objectives. This precludes the possibility of providing valuable input to optimize the design, cost structure or time schedules.

The engagement of a Construction Manager (CM) offers another possibility for complex projects. It is a more professional dedicated approach and the A/Es finish their work after finalizing the detailed design and preparing the tender documents. The CM works as an extension of the owners' staff and with the primary objectives of cost, schedule and quality.

The Integrated Project Design and Management concept (IPD&M) provides an alternative approach with significant benefits. According to specific requirements, a dedicated, highly experienced IPD&M Core Team (Figure 3) is formed to design, coordinate and manage all efforts from the very start of the project to the final delivery of the completed facility. The Core Team (CT) begins to work in the project definition and design phase. Many key decisions are made during this early phase and cost-saving potential is at its highest. Changing key

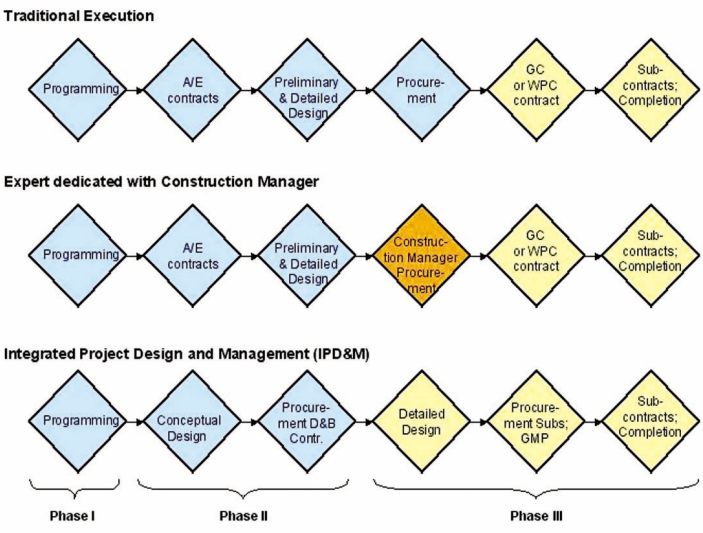

Figure 1. Project Key Elements.

decisions very often impairs costs, schedule or quality. The Project Programming is created with the client (Phase I, compare Figure 1) and the building program is the basis for the following Conceptual Design (Phase II). The comparison of the three project concepts shown in Figure 1 makes it clear that the typical A/E or CM functions are not needed in the IPD&M concept. The owner has to sign two contracts, one with the CT and one with the Design and Build contractor (D&BC), who is awarded a GMP contract in Phase III and guided by the CT through the entire project. The risk for the client is reduced and the strict and optimized planning phase saves valuable time and money.

The article describes the main tasks of each phase and gives an overview on how IPD&M works.

Phase I: The Project Programming (PP)

The Project Programming is the first step (Figure 2). Due to the complexity and size of the project, an intensive workshop is held with the owner, user and representatives of all relevant technical disciplines. The main target is to set up a qualified program for the entire building and infrastructure scope after defining the project purpose and goals. Special requirements and characteristics (eg site restrictions, Corporate Identity etc) are identified and discussed with external specialists (ESH, utility suppliers, local authorities) if required. The IPD&M-Project Manager leads the workshop, assisted by his experienced Core Team. The common approach secures the efficiency of the workshop and the commitment to the programming results.

The IPD&M-CT checks and verifies the input data on plausibility and defines the requirements with the help of reference data and benchmark figures. The following example ratios are compared:

- Gross Flat Area (GFA)/Net Wafer Processing Area (WPAN)
- Clean Support Area/WPAN
- GFA/Facility Support Area
- GFA/Office Area
- Wafer Starts per Week (WSPW)/WPAN
- Utility consumption/Manufacturing layer
- Utility consumption/WSPW

Functional area programs (production area, support areas, two or three level fab, etc) and technical demands are discussed and optimized in a direct dialog with the client. Deviations from best practice are recognized and corrected before they cause negative impact on the overall project. The generation of a Site Master Plan for a new 'green field' fab is particularly challenging for the team, and a real milestone. The programming ends after defining a cost budget and a milestone schedule.

Key Tasks Phase I

- Understanding of the project purpose and goals.
- Definition of the project target.
- Understanding of client Corporate Identities.
- Determination of relevant requirements (Administration, Production, Labors, Logistics, etc).
- Set up Site Master Plan, building concepts, internal and external Infrastructure concepts.
- Definition of the flexibility range.
- Determination of all restricting elements.
- Integration of the Top Management of all disciplines, the architects and engineers (goal: 'jointly invented').
- Continuous visualization of the work results.
- Determine requirements between the functional areas.
- Milestone Time Schedule (planning phase, Groundbreaking, construction phase, Ready for Equipment, equipment hook-up, process ramp-up).

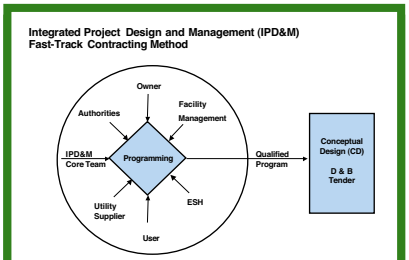

Figure 2. IPD&M-Project Programming.

Phase II: The Conceptual Design (CD)

After the Project Programming, the IPD&M-CT starts to develop a Conceptual Design (CD) based on the qualified project program. The Conceptual Design includes all necessary solutions for building and infrastructure and is used to select a Design and Build Contractor (D&BC) on competitive bids.

The external and internal supply and discharge concepts are determined based on the Site Master Plan and a generic equipment layout. The required facility

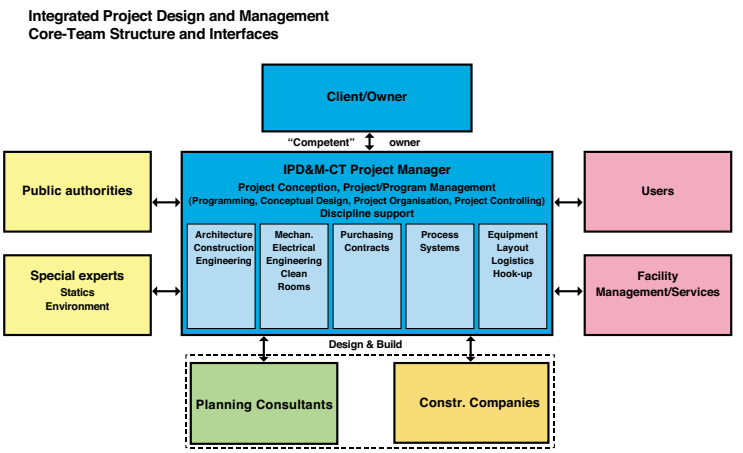

Figure 3. IPD&M-Core Team Structure.

capacities are defined either on real consumption figures or reference data and a room program is derived. The resulting building layouts and logistic concepts are evaluated and optimized with the client. In critical cases (eg building height, building distances, radar compatibility in the vicinity of airports, emissions, fire protection) additional confidential discussions with authorities or experts are held to secure the compliance with local codes and regulations. In the next step the cost budget is split up into single cost packages according to the well known SEMATECH fab cost model. Target costing is a key element of the Conceptual Design and the main guideline for design, aesthetics and function. Discrepancies between the client requirements and financial possibilities are solved in detailed discussions. Appropriate technical requirements for system redundancies, quality and material specifications can help to achieve the goal 1).

The concept for each package consists of a detailed functional description, specifications and process diagrams for technical systems. Check lists are used to test and determine scope interfaces. The Conceptual Design represents a comprehensive description of the whole project and enables the D&BC to place a precise and solid request for proposal. The target cost structure is used during the competition phase for negotiation purposes and an excellent basis for fixing a Guaranteed Maximum Price (GMP). With a GMP, the owner is in a 'win-win' situation. If the total construction cost is less than the GMP, only that amount is payable. If the construction cost is higher, only the GMP is paid. A 'share in savings' approach is used as an incentive for the D&BC to reduce costs.

Key Tasks Phase II

- Support client during definition of the production and utility layouts, logistic concepts, hook-up concepts.
- Definition of the industrial engineering starting points for architecture, facilities and utilities.
- Development of an integrated design.
- Definition of the redundancies and spare capacities for each system.

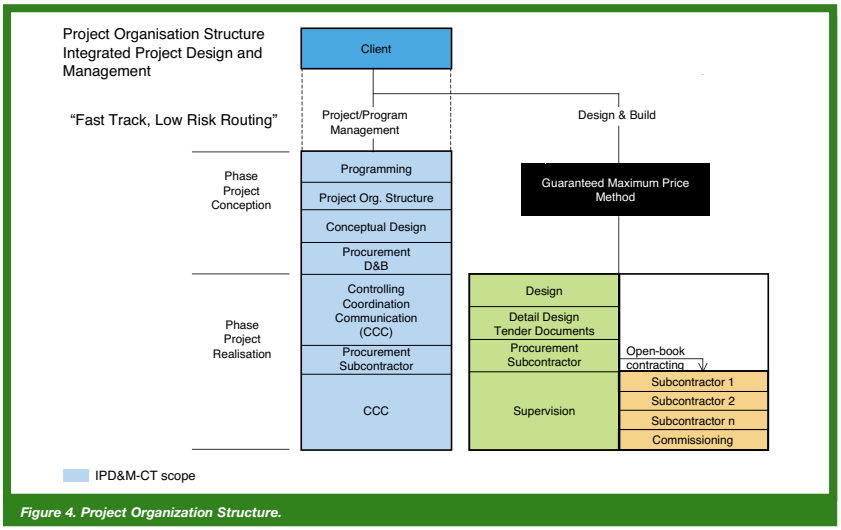

Figure 4. Project Organization Structure.

- Verification that the acceptance for approval is guaranteed (with authorities).
- Evaluation of the insurance requirements.
- Evaluation of the disposition and the costs of supply and discharge.
- Definition of standards.
- Definition of the cost budget (nomination of 'non included' items) on the basis of target costing.
- Preparation of a Milestone time schedule.
- Management of the D&BC with GMP tender.

Phase III: The Project Controlling and Coordination

After awarding the D&BC the IPD&M-CT slips into the role of a project controller (compare Figure 4; project realization phase). The D&BC has to transfer the Conceptual Design into a detailed design and prepares tender documents for the subcontractor selection. The IPD&M-CT as the client representative is a "single point competence" and the team handles and clarifies open items relating to the tender documents. The CT approves the bidder's list and participates in all vendor meetings, which are led by the D&BC. The final vendor selection is a collective decision of the client, the IPD&M-CT and the D&BC. Relevant decision criteria apart from costs are aspects such as local support for an ongoing After Sales Service, and technical competence, as well as references and experiences gained during previous projects. Another important cost criteria is a well-balanced ratio between invest and operational costs, especially for packages like Ultra-Pure Water, Waste Water Treatment or toxic abatement systems. The subcontractors are enabled to challenge the concepts and room is given to reduce the costs and to increase the project quality.

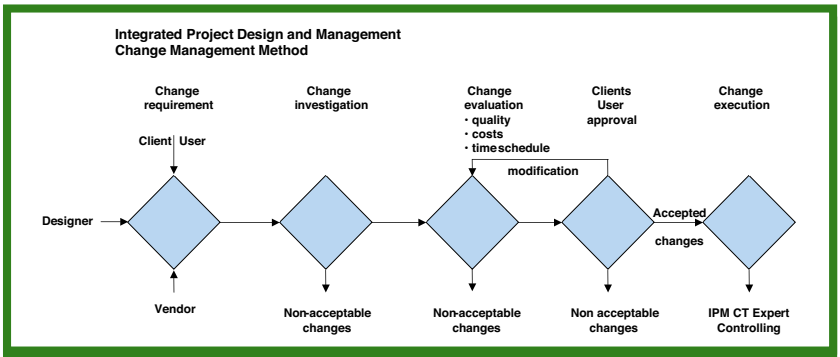

Figure 5. Active Change Management.

Figure 6. First 300 mm Production Facility, Infineon Technologies Dresden (Germany).

It is a fact in the semiconductor business that the contractors have to deal with many changes, predominantly in the technical infrastructure. The changes are caused by revised tool layouts or new manufacturing processes which need to be implemented in the detailed design of the D&BC or the scope of work of the subcontractors. The IPD&M-CT controls and steers the necessary modifications in a proactive manner and ensures that the technical solution is optimized and integrated with the lowest possible implication on cost and schedule. A GMP with an open-book approach makes it possible to realize changes with a high transparency and without time-consuming negotiations.

The performance and the quality of the D&B subcontractors are monitored, together with the D&BC project managers throughout the whole project construction phase, and compliance with technical regulations and standards is verified.

The client is informed about project progress, cost and time schedules on a continuous basis and a project forecast is given. Deviations are reported and possibilities to recapture delays or to save costs are proposed.

The continuity in the client relationship from the first idea until the final project acceptance makes the IPD&M concept unique and valuable for the owner, who is actively involved in the team atmosphere.

Key Tasks Phase III

- Verification of the planning steps on conformity with the requirements and targets of the Conceptual Design (CD).
- Value Engineering during all project phases.
- Evaluation of possible synergy effects.
- Continuous control of construction progress and schedule planning. Proactive measures if differences occur.
- Prepare and monitor the project procurement plan.
- Active participation during the procurement procedure (tender documents, bidder's list, bid evaluation, tender recommendation).
- Quality checks according to technical regulations and standards.
- Continuous comprehensive reporting to Top Management with project result forecast (function, quality, costs, time schedule). Draw up action items, if differences occur.
- Continuous, methodical cost tracking.
- Active change management (minimization of impacts on function, quality, costs, time schedule).

Figure 7. New 200mm Production Facility, Austria Micro Systems International AG (Unterpremstätten, Austria).

Integrated Project and Design Management – Examples

The IPD&M concept was used to build the world's first 300mm semiconductor fab for Infineon Technologies AG (Dresden, Germany). The highly innovative and highly integrated building was completed within a 12-month construction period together with Meissner & Wurst Zander (Stuttgart, Germany), the Design and Build contractor. The target cost, based on the IPD&M Conceptual Design, as well as the scheduled Ready for Equipment date were both achieved. Permanent communication, control and coordination were essential for this success.

A second example showing how efficiently IPD&M works is the new 200mm fab for Austria Micro Systems International AG (Unterpremstätten, Austria). The Conceptual Design was completed only six weeks after the Programming workshop. Together with Siegle & Epple/ATP (Stuttgart, Germany/Innsbruck, Austria) as Design and Build contractors, breaking ground took place three weeks later. AMS will soon have one of the most economical fabs worldwide, built within less than 12 months.

Reference

[1] Dr Martin Weltzer, Technical Conference Ultra-Pure Media, 2-3 November 1999, Dresden, Germany.

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Biographies

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Dr 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 IPD&M-CT in Dresden (Infineon Technologies SC300) and Unterpremstätten (AMS 2000), he was responsible for Process Systems.

Heinz Gräber

Heinz Gräber holds a degree in General Mechanical Engineering. He led various Technology projects for Siemens worldwide and has over 25 years of semiconductor experience. As former head of the Department Real Estate Management, Projects and Architecture, he became the CEO of the recently formed Siemens Industrial Building Consultants (Siemens IBC), Munich, and invented new strategies to realize fast track projects.