ADVANCED PROJECT MANAGEMENT FRAMEWORK FOR PRODUCT DEVELOPMENT

Katsufumi Araki

iTiD Consulting, Ltd.

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1   INTRODUCTION

It is common that product development projects encounter difficult situations such as schedule delay, budget overrun and no attainment of target specifications. The main cause should be inadequate consideration on project risks in the early stages of product development and project plans are likely to be only target information based on the top management demand. The ideal project planning for product development should be to identify the gap between the top management demand and reasonable prospects and to plan proactive countermeasures to solve this gap. The challenge to realize the ideal condition is how to obtain reasonable prospects in a practical way by analyzing coupled risks: one is product risks (difficulties to achieve product targets) and another is process risks (difficulties to overcome schedule and budget constraints).

To meet the challenge, this paper proposes an advanced product management framework, integrated product and process management framework, by utilizing DSM and DMM related analysis capabilities.

2   INTEGRATED PRODUCT AND PROCESS MANAGEMENT FRAMEWORK

To obtain reasonable prospects in a practical way and identify the gap between target and prospect information, we need to establish an integrated product and process model based on a work breakdown structure (WBS) and a product breakdown structure (PBS). Fig.1 shows an overview of the integrated product and process model.
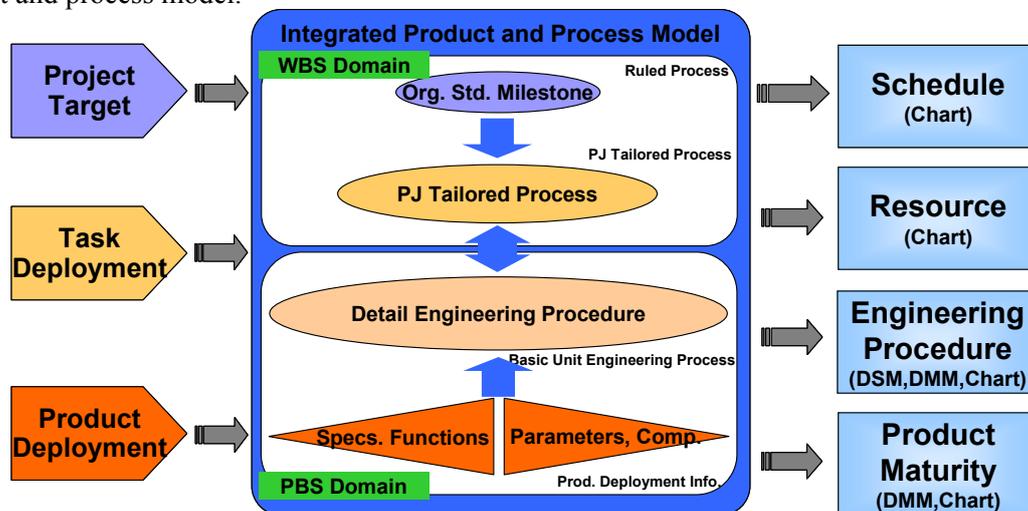

Fig. 1 Integrated Product and Process Model

The first step is user input acceptance. The model accepts basically three types of input. The first one is project target information for schedule, resources and product maturity at predefined organization standard milestones. The second one is task deployment information which is basically a project by project tailored work breakdown structure including duration and resource estimations for each task. The third one is product deployment information which is also a product by product tailored product breakdown structure including product risk assessment information for each requirement and design entity. The highest layer of the WBS contains link information to organization standard milestones. The lowest layer of the WBS contains link information to the product breakdown structure. Fig. 2 shows an example of user-defined task list with the link information to the PBS.
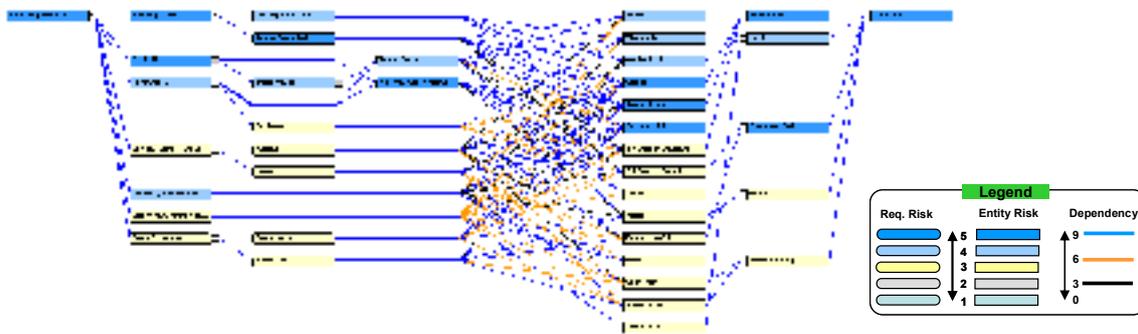
Fig. 2 User-Defined Task List Example

Once user input is set, the next step is to complement what is already defined and generate the integrated product and process model.

Regarding the PBS domain, a PBS itself is modeled based on multiple engineers' inputs as combinations of design structure matrix (DSM [1]) for intra-domain dependencies and domain mapping matrix (DMM [2]) for inter-domain dependencies. Dependencies among requirements or among design entities are model as DSM. Inter-domain dependencies between product requirements and design entities are modeled as DMM. Meanwhile, task dependencies of detail engineering procedures are automatically generated based on the PBS information as DSM [4]

Regarding the WBS domain, organization standard milestones are predefined ruled processes and project targets are set based on top management inputs. Meanwhile, dependencies of project tailored process are automatically generated based on the WBS and PBS link information as DSM by inheriting dependencies from upper level (ruled processes) and lower level (detail engineering procedures). Fig. 3 shows an example of generated dependencies of project tailored processes.

Fig. 3 Generated Dependencies of Project Tailored Processes

Note that one of major advantages of this integrated modeling approach is that dependencies between tasks for project tailored processes and detail engineering procedures are automatically generated and maintained to reduce user input workload.

Once the integrated model is generated, it can be analyzed to obtain schedule and resource estimations [3], and it can be also analyzed to obtain optimized detail engineering procedures [4]. In addition, a product maturity score can be obtained based on each risk assessment result on the PBS.

3   PROJECT PLANNING USAGE

3.1   Product Breakdown Structure Visualization

While the PBS information is kept as DSM and DMM format in the integrated model, a PBS tree view can be generated automatically for better understanding of a product structure and product risks. Fig. 4 shows an example of Product Breakdown Structure Visualization.

Fig. 4 Product Breakdown Structure Visualization Example

3.2 Schedule and Resource Estimation

Fig. 5 shows an example of schedule estimation as GanttChart showing the gap between target and analyzed prospect information. While the target information is simply shown as a blue bar based on user inputs, the analyzed prospect information is shown as a pink bar as the result of DSM sequencing and schedule simulation for project tailored processes.
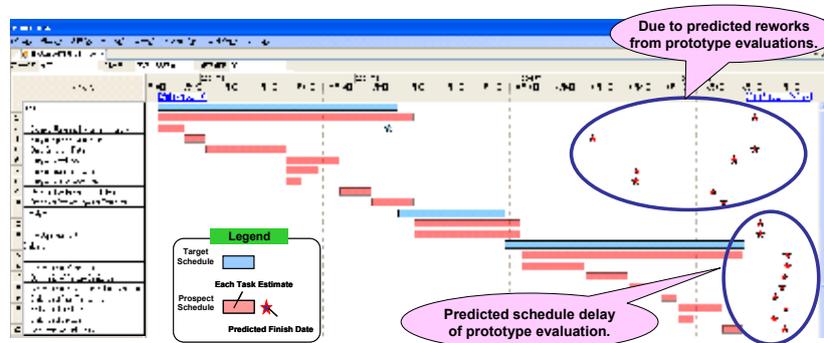

Fig. 5 Schedule Estimation Example

4 CONCLUSION AND FUTURE WORK

By utilizing this approach, we can obtain reasonable prospect information in a practical way and identify the gap between target and prospect information in the early development stage because it is easier for engineers to input product deployment information and a task list than to describe task dependencies as DSM.

We have just developed the beta version of commercial purpose software featuring this proposed management framework capability and plan to launch the commercial software next year. We will continue to increase cases and improve this capability based on clients' feedback.

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[1]   Donald V. Steward Systems Analysis and Management ISBN 0-89433-106-X 1981.
[2]   Danilovic M., Browing T. A formal approach for Domain Mapping Matrices (DMM) to complement Design Structure Matrices (DSM). In The Sixth Design Structure Matrix (DSM) International Workshop, September 12th-14th, 2004, University of Cambridge.
[3]   Tyson R. Browning and Steven D. Eppinger, Modeling Impacts of Process Architecture on Cost and Schedule Risk in Product Development IEEE Transactions on Engineering Management, Vol. 49, No. 4, November 2002
[4]   Katsufumi Araki DMM Partitioning Analysis For Design Study Procedure Optimization. In the 9th international Design Structure Matrix (DSM) Conference, October 16th-18th, 2007, Munich, Germany.

Contact: Katsufumi Araki
iTiD Consulting, Ltd. Research and Development Unit
2-17-1, Konan,Minato-ku, 108-0075, Tokyo, Japan
Phone: +81-3-6713-5735 Fax: +81-3-6713-5899
e-mail: arakatsu@itid.co.jp

10TH INTERNATIONAL DSM CONFERENCE

Advanced Project Management Framework For Develoment

Katsufumi Araki

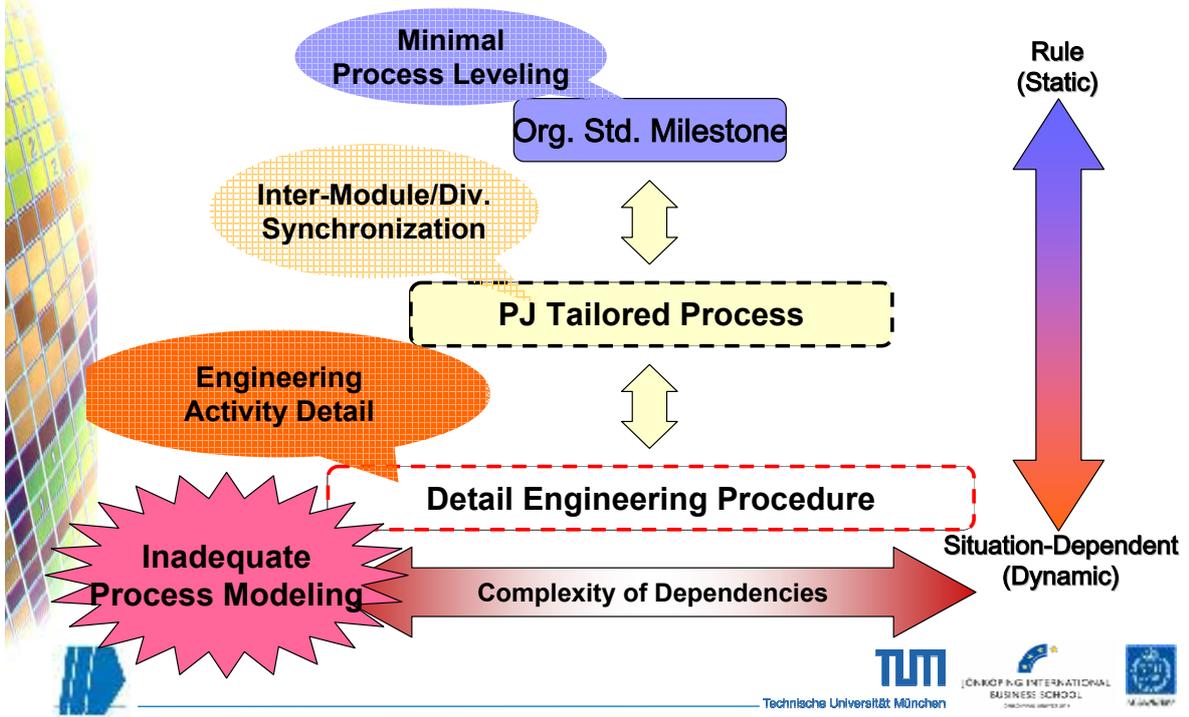iTiD Consulting, Ltd.
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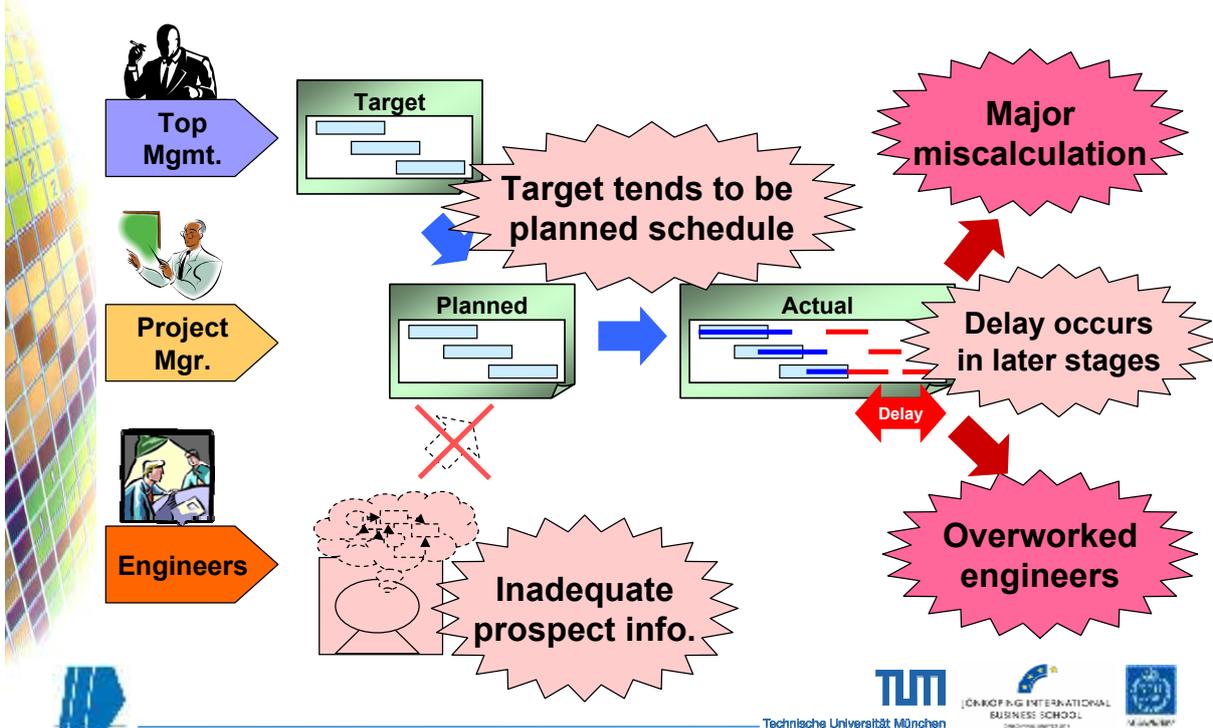JÖNKOPING INTERNATIONAL BUSINESS SCHOOL

Index

- Motivation

- Integrated Product and Process Model

- Project Planning Usage

- Conclusion and Future work

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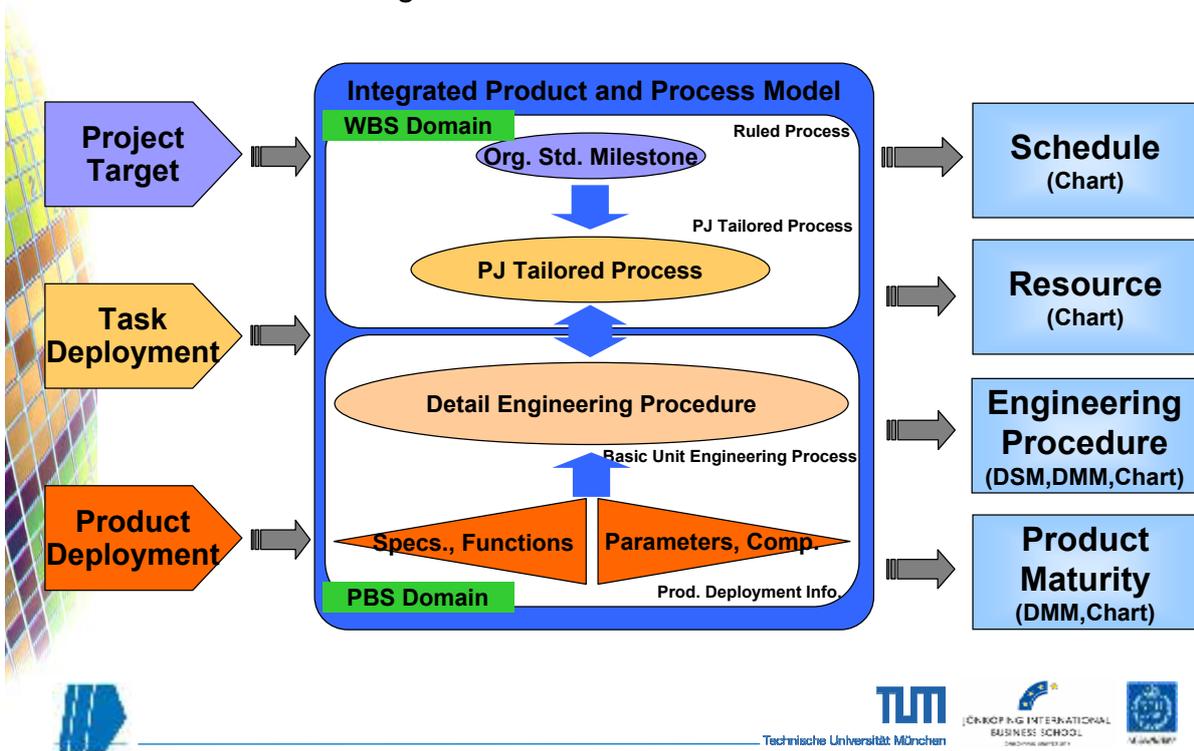
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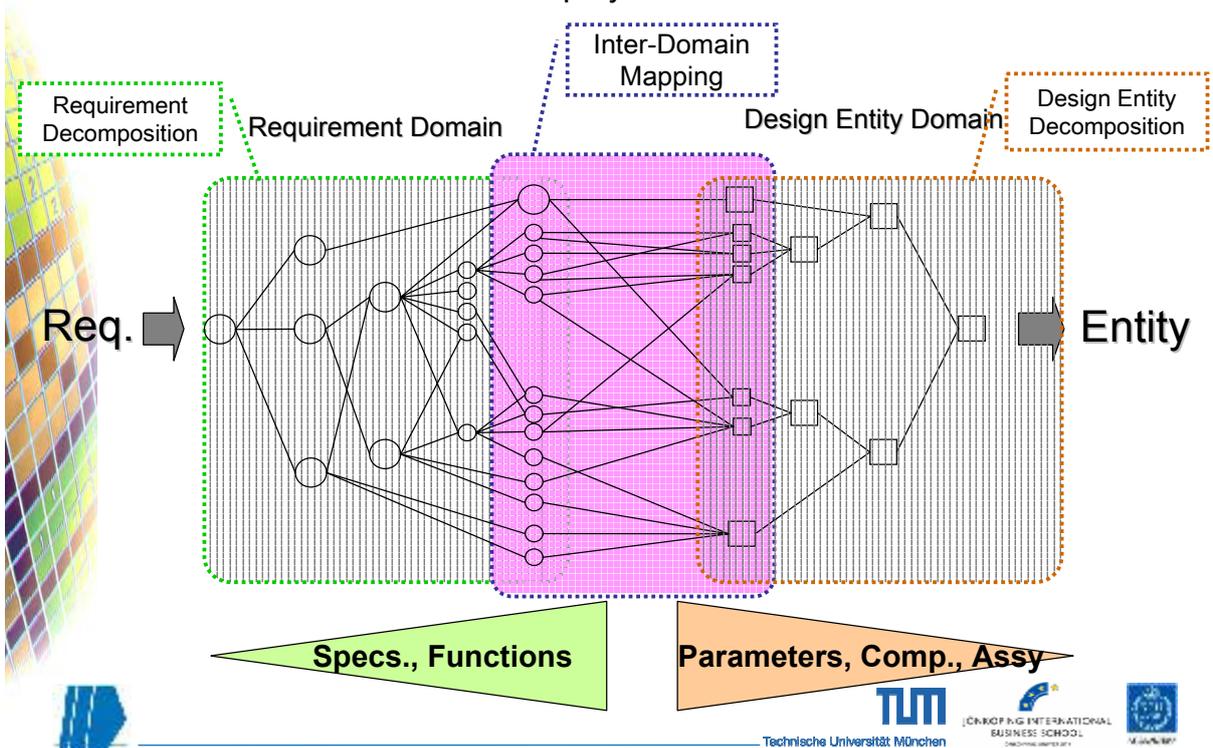
Product Development Process Overview

Why does the schedule delay occur?

147

## Integrated Product and Process Model

Product Deployment Scheme

148

Product Deployment (Tree View)

Product deployment tree view can be exploded for user input / output.
Product maturity level can be also visualized on the deployment structure.

Product Deployment (Tree)

simplified example
of copier fuser unit

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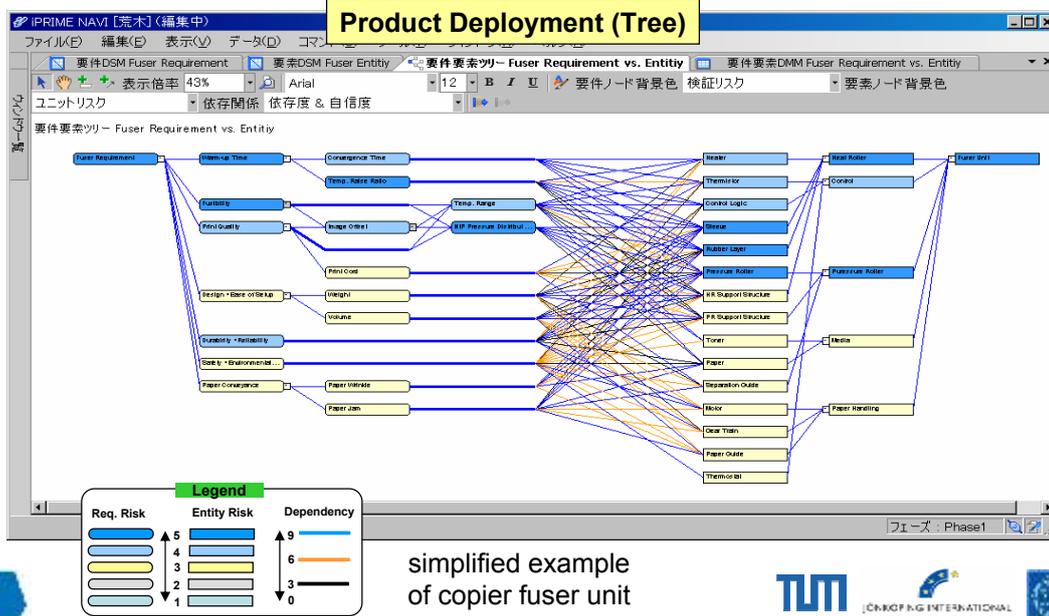
Product Deployment (DMM View)

DMM view can be also created based on the same data
for complicated requirements vs. entities dependencies.

Product Deployment (DMM)

要件要素DMM Fuser Requirement v		Heater	Sleeve	Rubber Layer	HR Support Structure	Pressure Roller	Separation Guide	PR Support Structure	Thermistor	Thermostat	Control Logic	Motor	Gear Train	Paper Guide	Paper	Toner
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Temp. Range	1	9	9	9	3	6		3	9		9				9	9
NIP Pressure Distribution	2		9	9	9	9		9							3	9
Temp. Raise Ratio	3	9	9	9	3	9		3	6		9					
Convergence Time	4	9	9	9		9			9		9					
Print Cord	6		6	6	6	3	9	6	9							
Paper Wrinkle	7		9	9	6	9		6						6	9	
Paper Jam	8		9	9		9	9				3	6	6	9	9	
Weight	9	3	9	3	9	9	3	9				6	3	6		
Volume	10		9	3	9	9	6	9				6	6	9		
Durabiirity・Reliability	15	6	9	9	3	9		3	6		3	9	9		3	
Safety・Environmental Burden	17	6	6	6	6	6	6	6	3	9	6	9	6	6	3	6

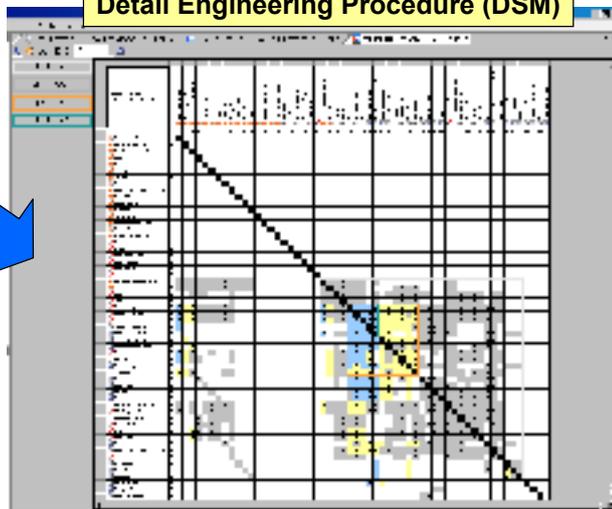10th International DSM Conference 2008- 8

149

Detail Engineering Procedure Generation

Generate detail engineering procedure from product deployment information.
(the DSM is partitioned to suggest optimum procedure)

Product Deployment (Tree)
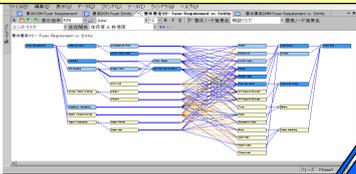
Detail Engineering Procedure (DSM)

Please see "DMM Partitioning Analysis For Design Study Procedure Optimization", DSM'07 for more details.

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Engineering Procedure Suggestion

Detail engineering procedures can be also suggested by DMM

ファイル(F) 編集(E) 表示(V) データ(D) コマンド(C) ツール(T) ウィンドウ(W) ヘルプ(H)

要件要素ツリー Fuser Requirement vs. Entitiy

表示倍率 100%   MS UI Gothic

Design Procedure

要件要素DMM Fuser Requirement vs

Engineering Procedure Suggestion (DMM)

Evaluation Procedure

		Paper	Toner	Rubber Layer	Pressure Roller	Sleeve	Heater	Control Logic	Thermistor	PR Support Structure	HR Support Structure	Separation Guide	Paper Guide	Motor	Gear Train	Thermostat
		14	15	3	5	2	1	10	8	7	4	6	13	11	12	9
Temp. Raise Ratio	3			9	9	9	9	9	6	3	3					
NIP Pressure Distribution	2	3	9	9	9	9				9	9					
Convergence Time	4			9	9	9	9		9							
Durabirity・Reliability	15	3		9	9	9	6	3						9	9	
Temp. Range	1	9	9	9	6	9	9	9	9							
Paper Jam	8	9		9	9	9		9	9					6	6	
Paper Wrinkle	7			9	9	9				6						
Weight	9			3	9	9	3			9	9					
Volume	10			3	9	9				9	9	6				
Print Cord	6			6	3	6										
Safety・Environmental Burden	17	3	6	6	6											

Design and Evaluation Cycle Prediction

150

Task Deployment

Engineering Procedure Suggestion (DMM)

User defined task list is created and linked to product deployment information with referring engineering procedure suggestion to obtain valid task list.

Task Deployment (Task List)

PJ Tailored Process Generation

Task dependencies among PJ Tailored Process can be automatically generated by inheriting dependencies both from organization standard process and detail engineering procedure. User can identify which information dependency could be a bottleneck in the process.

PJ Tailored Process (DSM)

Unexpected Information dependency from prototype evaluations to design.

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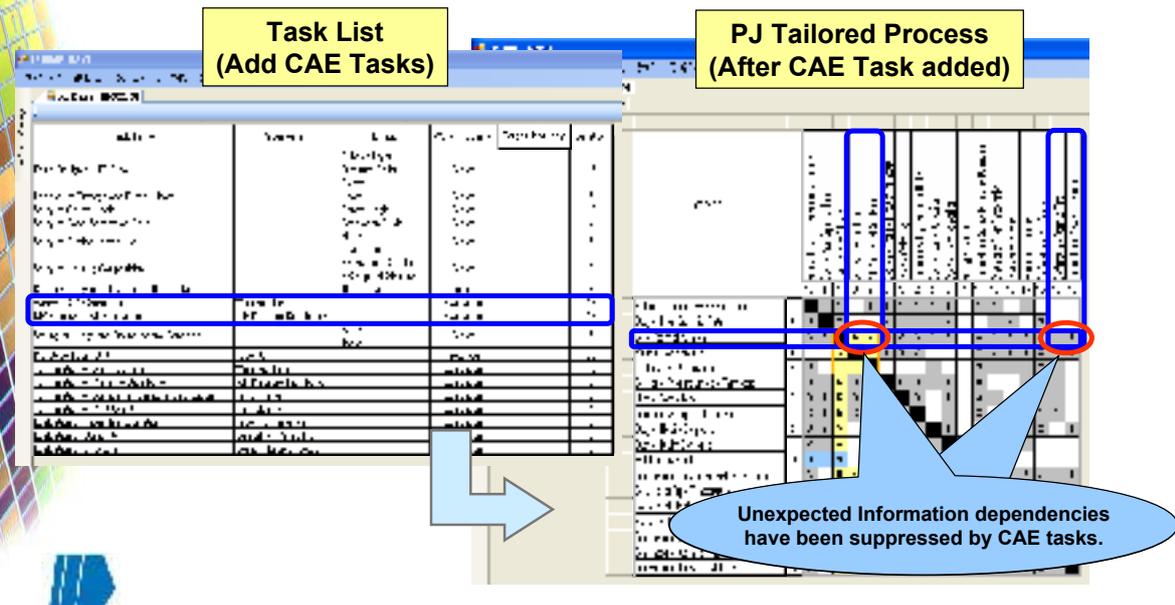## Target vs. Prospect Schedule Visualization

Prospect schedule of PJ Tailored Process is obtained through below analysis.

Sequence : Re-sequence to reduce rework risk.
Overlap   : Optimum task overlap conditions considering dependencies.
Schedule : Predict schedule considering remaining rework risk.

Schedule Plan (Initial)

Due to predicted reworks from prototype evaluations.

Legend

Target Schedule

Each Task Estimate

Prospect Schedule

Predicted Finish Date

Evaluation schedule doesn't meet the target.
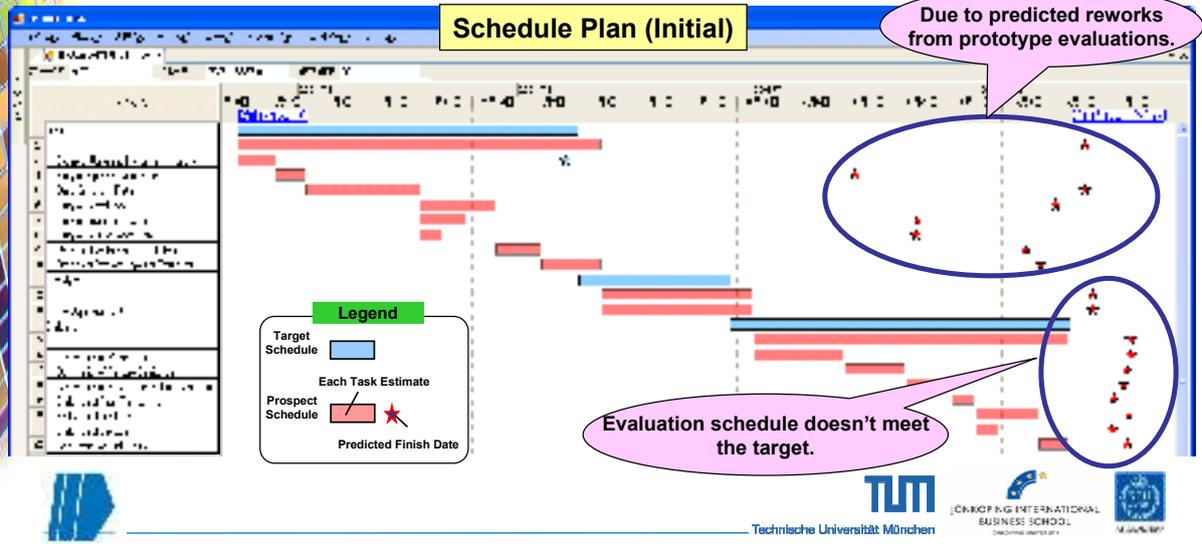
Add Countermeasures into Task list

**Consider countermeasures and update task list.
In this case, 2 CAE tasks are additionally planned.**

**Task List
(Add CAE Tasks)**

**PJ Tailored Process
(After CAE Task added)**

Unexpected Information dependencies have been suppressed by CAE tasks.

152

Schedule Agreement

**Total duration of prospect schedule meets the target while design and prototype schedule overrun the target, but it's acceptable.
In this case, the revised project plan is agreed among the team.**

Schedule Plan (Revised)

Legend

Cons. Schedule	
Each Task Estimate	
Pred. Schedule	★
Predicted Finish Date	
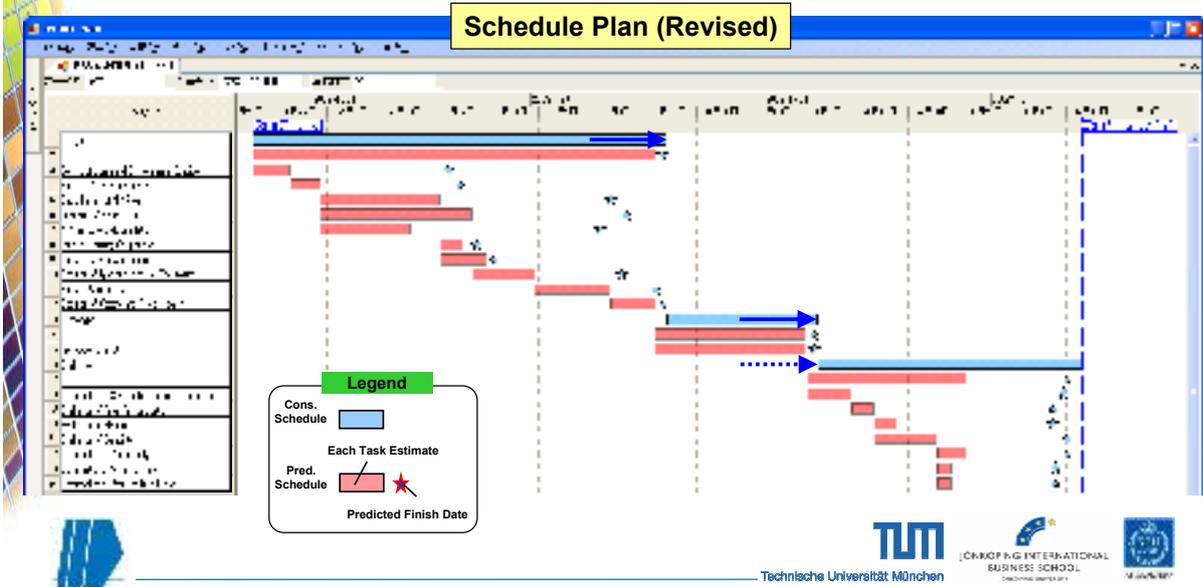
Adaptive Schedule Planning

Project plan should be updated according to unexpected situation changes.

153
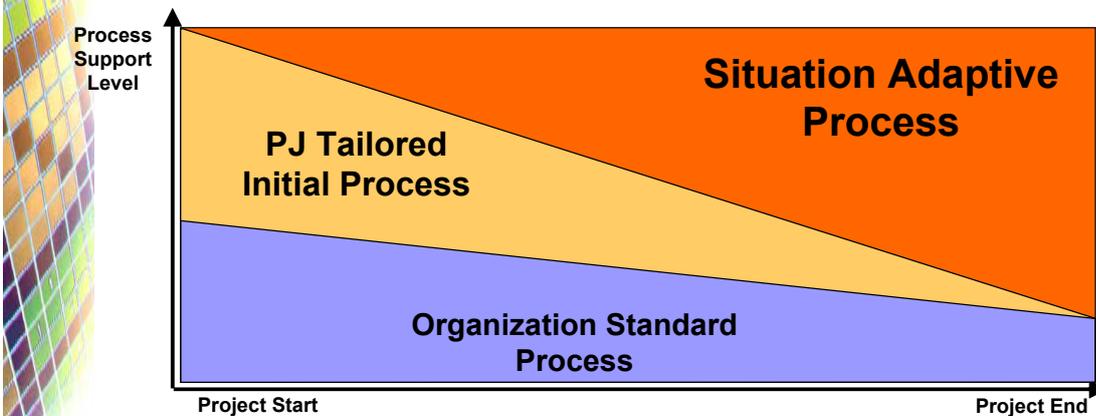
Unexpected Situation Example

**Task List
(as of durability test finished)**

**DMM
(as of NG reported)**

product risk info. was updated according to NG status report by task list.

Test was done but recognize design defect.
Some design and evaluation rework are required

Trouble Shooting Planning

**DMM
(as of NG reported)**

Add trouble shooting tasks into task list.

Design Change

Re-Test against NG

Regression Test

Task note started

**Task List
(revised for trouble shooting)**

154

Schedule Update

Schedule plan is adaptively updated even if some unexpected situation happens.

Schedule Plan (Revised for trouble shooting)

Legend

Target Schedule

Each Task Estimate

Prospect Schedule

Predicted Finish Date

Actual Schedule
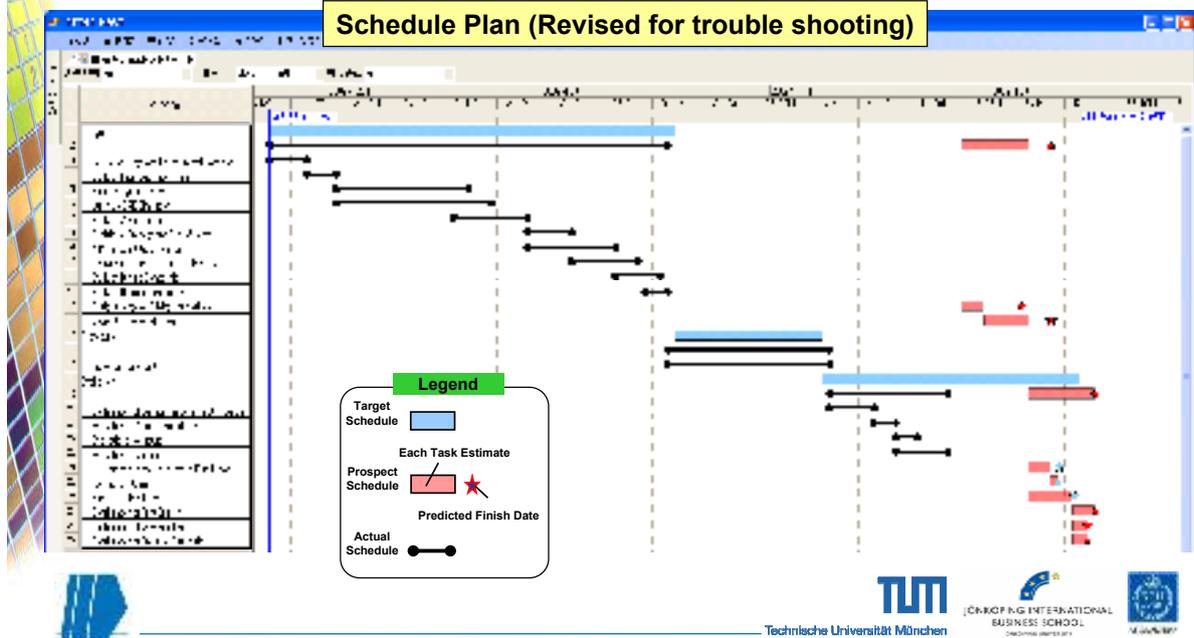
Conclusion and Future Work

- The concept of the integrated product and process management framework have been valued by Japanese clients especially in automobile industries.

- The product deployment scheme and the detail engineering procedure suggestion algorithm have been well validated with lots of practical industrial cases, so we are about to release a new commercial software featuring these capabilities.

- Analysis algorithm for PJ tailored process generation have been developed and implemented into the software for in-house test version. We need some additional works to make it capable of meeting commercial use.