Maturity Stage Management in New Product Development

- Objective, qualitative assessment of Maturity
- Implementation within Planisware

Your Product is our Passion!
Agenda

• Who should implement Maturity Stage Management?
• Introduction
  – Basic understanding of Maturity Stage Management
  – Simple example „Estimate my weight!“
• How to implement Maturity Stage Management
  – Definition of a method to calculate maturity
  – 7 steps for a successful implementation
• Example*: Function of Headlamp System (AFS)
  – Explanation and main results
  – Demo: Implementation within Planisware
• Summary
• Discussion

* Data used in examples do not represent real target values, functions or their definition
Who should implement Maturity Stage Management?

- Maturity stage management estimates the maturity of a (new) product during the development phase from project start to end (SOP)
- Maturity stage management supports the development of „complex“ products...
  - Mechanic, electronic and software components or
  - Intensive iterations between different disciplines and organisations/suppliers or
  - Long-term projects

- …in industries like
  - Automotive
  - Medical Engineering
  - HighTech & Electronics
  - Machine Engineering
„Internal logic“ of Engineering or „felt maturity“

Start of development

Series

Stage of maturity

100%

Start value e.g. 30%

M1 M2 M3 M4 M5

Maturity stage of actual product
Maturity stage ideal curve
Abnormal deviation or development risk
Simple example – „Estimate my weight!“

<table>
<thead>
<tr>
<th>Method</th>
<th>Forecast</th>
<th>Method</th>
<th>Reliability*</th>
<th>Effort/characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>91,5kg</td>
<td></td>
<td>70%</td>
<td>Reliability of the forecast?</td>
</tr>
<tr>
<td>Old mechanical scale</td>
<td>88,5 Kg</td>
<td></td>
<td>80%</td>
<td>Maybe direct accessible, very low invest</td>
</tr>
<tr>
<td>New electronic scale</td>
<td>89,9 Kg</td>
<td></td>
<td>85%</td>
<td>Invest, effort: Go to shopping center, buy scale</td>
</tr>
<tr>
<td>High precision medical scale</td>
<td>90,21Kg</td>
<td></td>
<td>97%</td>
<td>High invest for medical scale or go to hospital (effort and cost)</td>
</tr>
<tr>
<td>Physikalische technische Bundesanstalt</td>
<td>90,223 Kg</td>
<td></td>
<td>100%</td>
<td>Travelexpenses, PTB-Costs and effort - &gt;Maximum of precision</td>
</tr>
<tr>
<td>(national metrology institute)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The probability that this result is precise or real
Conclusions

- Reliability
  - Each method has its own degree of reliability
  - There is a natural “ordering” of using methods
    - “simple” methods can be used immediately
    - The more reliable the validation method, the more intensive (cost, effort) or complex preconditions have to be fulfilled
    - Preconditions often define the “ordering”, the sequence of methods

- Forecast of value
  - The more reliable the method, the more closer the forecast covers reality.

- Main Conclusion:
  - The ideal progress of maturity is mainly influenced by the reliability of used methods.
  - The “ordering” of methods relates to the milestones within a project
4 Goals to measure maturity progress in a project (Product Development)

1. Define the optimum of maturity progress
2. Calculate the progress of maturity
3. Estimate the „abnormal“ development risk or deviation
4. Support project management by providing reports/graphical analysis describing main reasons of deviation to identify actions for improvement
Constraints of Maturity Stage Management

- **Innovation Degree**
  Support the ability to adapt the maturity progress to the degree of innovation of a new product

- **Moving Targets**
  Support analysis and methods to deal with „Moving Target“ situation

- **Product Development Characteristic**
  Support analysis and methods to derive actions if basic characteristics have to be changed, i.e. process, milestones or used methods
(Mathematical) Maturity stage definition

The maturity stage method combines the deviation from the defined functional target value and combines it with the reliability of the validation method, which provides the actual forecast.

Conclusion

The product has reached 100% maturity if the targets have been reached and these targets have been proved by methods with maximum reliability.
3 phases and 7 steps to implement Maturity Stage Management

- Provide Basics
  1. Define **functional product model** and prioritize the functions
  2. Define a **classification scheme for the reliability of validation methods**
  3. Assign the **validation methods to the milestones** of the product development process
  4. Derive the „**optimal progress of maturity**“
  5. Define the Integration of the maturity stage assessment within **project management** (engineering reviews)

- Adopt to a project
  6. Define the actual the target values of the product functions and check priority and completeness of the functions.

- Tune maturity method and basics
  7. Adapt the method to other product classes, the degree of innovation and optimize validation methods and or milestones of the product development process

Who?
- Productmanager
- Manager Product Development
- Projectmanager
- Projectmanager
- Manager Product Development
Maturity Stage Management uses existing data

- Most of the necessary information already exists, but distributed
  - functions and functional structure
    - QFD incl. prioritization, FMEA
    - Product portfolio management
  - components and their structure
    - BOM (PDM/PLM)
  - target values
    - Requirements Management, Specification (VDI: „Lastenheft“)
  - milestones
    - Definition of product development process
- …and some might have to be collected and structured
  - Classification of validation methods
  - Assigning validation methods to milestones
Example – Functions (extract) Headlampsystem

1. Adapt front lighting to street (bend lighting, steering angle)
2. Adapt front lighting to acceleration and vehicle load
3. Adapt front lighting to velocity and street (townlight, country road, motorway)
4. Achieve product weight
5. Achieve target costs (manufacturing costs)
### Example – Definition of Functions in Planisware

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AFS: Fahrbahnanleuchtung optimieren (adopt frontlig)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autobahnlicht aktivieren (activate motorway light)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landstraßenlicht aktivieren (activate countryroad light)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lichtstreuung bei Schlechtwetter anpassen (adapt scattering)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>max. Anpassungsgeschwindigkeit (max. time to move)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>max. Schwankeung, Wälzenmotorgesch. (max. variation roller percent)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stelllicht aktivieren (activate tracklight)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AFS: Kurvenlicht verstärken (adopt dynamic frontlight)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>max. Anpressdruck, Schwenkmodul (max. pressure of actuator module)</td>
<td>N/mm²</td>
<td></td>
</tr>
<tr>
<td>maximale Geschwindigkeit (max. velocity of projection module velocity)</td>
<td>mm/s</td>
<td></td>
</tr>
<tr>
<td>minimale Geschwindigkeit (min. velocity of projection module velocity)</td>
<td>mm/s</td>
<td></td>
</tr>
<tr>
<td>Relation Gesch. Fahrzeug/Frankenmodul (relation vehicle-relation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zähmunspiegel, Dämpfung (max. time for damping)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>max. Anpassungsgeschwindigkeit, Schwenkmodul (max. time to move projection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AFS: Lichthöhe dynamisch anp. (adopt frontlighting)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leuchtwerte an Beleuchtung anpassen (adopt range of lighting)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leuchtwerte an Brems-/Frischlicht anpassen (adopt range of light)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximale Geschwindigkeit, (max. velocity of projection module velocity)</td>
<td>mm/s</td>
<td></td>
</tr>
<tr>
<td>minimale Geschwindigkeit (min. velocity of projection module velocity)</td>
<td>mm/s</td>
<td></td>
</tr>
<tr>
<td>Zähmunspiegel, Dämpfung (max. time for damping)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>max. Anpassungsgeschwindigkeit, Schwenkmodul (max. time to move projection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Kosten (manufacturing costs)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herstellungskosten (manufacturing costs)</td>
<td>Kosten</td>
<td></td>
</tr>
<tr>
<td><strong>Produktgewicht (weight)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gesamtgewicht (weight)</td>
<td>Gewicht</td>
<td>kg</td>
</tr>
</tbody>
</table>
Example – Functions and product components

Functions relate to specific product components, i.e.

- Sensor for identifying steering angle
- Electric motor to move projection module
- Software to steer motor of projection module
- Sensor to check new position of projection module
- …..
Example – Functions and product components in Planisware

Product structure

Functions, components & relationship
Example – Functions and target values

All functions can be described by a set of target values

Max. time to move projection module from neutral position
Max. time for damping
Min velocity of moving projection module
Max. velocity of moving projection module
Relation velocity car/projection module
……

Adapt front lighting to street (steering angle)
Example – functional target values in Planisware

<table>
<thead>
<tr>
<th>Performance feature</th>
<th>Planned value</th>
<th>Target values</th>
<th>Prioritization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scheinwerfersystem (headlamp system)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AFS: Fahrbahnausleuchtung optimieren (adopt frontlight to velocity and street)</td>
<td>Autobahnlicht aktivieren (activate motorway light): Zeit</td>
<td>0.500</td>
<td>0.500</td>
</tr>
<tr>
<td>Landstraßenlicht aktivieren (activate countryroad light): Zeit</td>
<td>0.500</td>
<td>0.500</td>
<td>0.10</td>
</tr>
<tr>
<td>Lichtsteuerung bei Schlechtwetter: Vorausrechnen (calculate for bad weather): Zeit</td>
<td>0.250</td>
<td>0.250</td>
<td>0.20</td>
</tr>
<tr>
<td>max. Anpassungskonstanten (max. time to move modular)</td>
<td>10.000</td>
<td>10.000</td>
<td>0.20</td>
</tr>
<tr>
<td>max. Schneeräumung auf der Fahrbahn (max. time to remove snow)</td>
<td>1.000</td>
<td>1.000</td>
<td>0.30</td>
</tr>
<tr>
<td>Stadtlicht: aktivieren (activate town light): Zeit</td>
<td>0.500</td>
<td>0.500</td>
<td>0.10</td>
</tr>
<tr>
<td>AFS: Kurvenlicht versetzen (adopt dynamic frontlighting)</td>
<td>max. Anpassung Schaumstoff (max. pressure at and position)</td>
<td>0.870</td>
<td>0.670</td>
</tr>
<tr>
<td>maximale Geschwindigkeit (max. velocity of projection module): v</td>
<td>5.200</td>
<td>5.200</td>
<td>0.30</td>
</tr>
<tr>
<td>min. Geschwindigkeit (min. velocity of projection module): v</td>
<td>4.500</td>
<td>4.500</td>
<td>0.30</td>
</tr>
<tr>
<td>Relation Gesch. Fahrzeug/Projektschaum (relation velocity v)</td>
<td>0.546</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>Verzögerungszeit Dämpfung (max time for damping): Zeit</td>
<td>0.500</td>
<td>0.500</td>
<td>0.05</td>
</tr>
<tr>
<td>max. Anpassungskonstante Schornstein (max time to move smoke)</td>
<td>2.100</td>
<td>2.100</td>
<td>0.10</td>
</tr>
<tr>
<td>AFS: Leuchtwerte dynamisch anpassen (adopt frontlighting to acceleration and loading)</td>
<td>Leuchtwerte an Anpassung anpassen (adopt range of lighting): v</td>
<td>2.000</td>
<td>2.000</td>
</tr>
<tr>
<td>Leuchtwerte an Brems/Netzfall anpassen (adopt range of lighting): v</td>
<td>0.500</td>
<td>0.500</td>
<td>0.25</td>
</tr>
<tr>
<td>maximale Geschwindigkeit (max. velocity of projection module): v</td>
<td>2.500</td>
<td>2.500</td>
<td>0.10</td>
</tr>
<tr>
<td>min. Geschwindigkeit (min. velocity of projection module): v</td>
<td>1.000</td>
<td>1.000</td>
<td>0.10</td>
</tr>
<tr>
<td>Verzögerungszeit Dämpfung (max time for damping): Zeit</td>
<td>0.250</td>
<td>0.250</td>
<td>0.10</td>
</tr>
<tr>
<td>max. Anpassungskonstante Schornstein (max time to move smoke)</td>
<td>0.500</td>
<td>0.500</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>Kosten (manufacturing costs)</strong></td>
<td>Herstellungskosten (manufacturing costs): Kosten</td>
<td>12.250</td>
<td>22.250</td>
</tr>
<tr>
<td><strong>Produktgewicht (weight)</strong></td>
<td>Gesamtgewicht (weight): Gewicht</td>
<td>0.450</td>
<td>0.400</td>
</tr>
</tbody>
</table>

Functional Target values and their prioritization
Example – Functions and validation methods

To derive forecasts, different methods during product development are used and relate to a class of reliability and milestones.

Adapt front lighting to street (steering angle)

<table>
<thead>
<tr>
<th>Method</th>
<th>Method-class</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts / analogy to products</td>
<td>Estimation</td>
<td>30%</td>
</tr>
<tr>
<td>Rough CAD based simulation</td>
<td>Rough calculation</td>
<td>40%</td>
</tr>
<tr>
<td>CAD based simulation</td>
<td>Calculation</td>
<td>60%</td>
</tr>
<tr>
<td>Detailed CAD based simulation</td>
<td>Detailed Calculation</td>
<td>70%</td>
</tr>
<tr>
<td>Detailed Simulation with specific simulation software</td>
<td>Simulation</td>
<td>80%</td>
</tr>
<tr>
<td>Virtual Reality</td>
<td>Tested/Prooved</td>
<td>95%</td>
</tr>
<tr>
<td>Test Lab</td>
<td>Series validation</td>
<td>100%</td>
</tr>
</tbody>
</table>
Example – Functions, Implementation in Planisware

<table>
<thead>
<tr>
<th>Method</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geschätzt (estimation)</td>
<td>30 %</td>
</tr>
<tr>
<td>Auslegungsberechnung (rough calculation)</td>
<td>40 %</td>
</tr>
<tr>
<td>Berechnung (calculation)</td>
<td>60 %</td>
</tr>
<tr>
<td>Berechnungsnaehweis (detailed calculation)</td>
<td>70 %</td>
</tr>
<tr>
<td>Simuliert (simulation)</td>
<td>80 %</td>
</tr>
<tr>
<td>Getestet/Gemessen (tested/measured)</td>
<td>95 %</td>
</tr>
<tr>
<td>Serienbewertung (series)</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Reliability classes of validation methods

Methods adapted to functions and milestone
Example – Optimum of maturity progress

The optimum of maturity progress can be defined.

- **ER Start-Up**: Experts / analogy to existing functions or project modules
- **ER Functional Proof**: Test Lab / functional modell
- **ER Technology Proof**: Rough CAD based simulation
- **ER Pre-Series**: Detailed Simulation with specific simulation software
- **ER Completion**: Series validation

**Stage of maturity**

**Start value e.g. 30%**

**Series**
Example – Optimum of maturity progress

Ideal progress of maturity

- Ideal reliability

Maturity stage

1 - ER Start Up
2 - ER Functional Proof
3 - ER Technology Proof
4 - ER Pre-series
5 - ER Completion

100 %
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
0 %
Example – Adopt to Project

Define target values and prioritize the functions
Maturity stage Progress – deviation to ideal progress

Abnormal deviation, development risk
Example – Integrate in Project Management (Engineering Review)

Maturity stage*: Reports and Analysis

Discussion of necessary changes with DMU

- Design-Freeze
- Cross-functional team evaluation
- Traceable changes: maturity stage <-> function <-> part/component
- Definition and tracking of activities to increase the maturity progress

*early version
Example – Identification and analysis of deviation

1. Analyze the maturity stage of each function to identify areas of deviation

2. Identify deviation in achieving target values per function

3. Detailed look at target values and forecast at specific milestone

What causes the actual deviation?
Example – Identification and analysis of deviation

What causes the actual deviation?

4. Identify deviation in used methods as a possible reason for deviation in maturity/target achievement

5. Detailed look at used methods and reliability
Example – Verifying activities for maturity improvement

1. Main Discussion
Which activities could be derived?
Which components should be changed?

2. Analyze importance of components concerning possible changes

3. Define new forecast and analyze change in maturity

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Constraints of Maturity Stage Management

- **Innovation Degree**
  Support the ability to adapt the maturity progress to the degree of innovation of a new product

- **Moving Targets**
  Support analysis and methods to deal with „Moving Target“ situation

- **Product Development Characteristic**
  Support analysis and methods to derive actions if basic characteristics have to be changed, i.e. process, milestones or used methods
Constraints of Maturity Management: Adaption to degree of innovation

Developing a new variant/version, based on existing product
Constraints of Maturity Management: Moving Targets (1)

Change in target value for costs -20%
Constraints of Maturity Management: Moving Targets (2)

Moving targets, i.e. the change of priority of functions

Function target costs

Change priority

Cost sensitive to functional priority

Ideal progress of maturity
Actual maturity

Product maturity stage

Function prioritization
Moving targets, i.e. the change of priority of functions implies changes concerning importance of components
Constraints of Maturity Management: Characteristics of product development

- If this deviation happens often, i.e. in several projects
  - Qualification Skills of project teams?
  - Cross-project availability of resources for high-end, intensive simulation methods?
  - Reliability of methods?
  - Definition and/or amount of milestones?
Maturity Stage Management - Summary

- **Direct measuring** of maturity vs. existence of result types or release of documents
- **Precision** because of the combination of forecast and the reliability of methods that provide the actual forecast
- Coping with the **innovation level** of the project, product and its technologies
- Direct identification of the **development risk/deviation**
- **Differentiated control** of the maturity of each function
- Direct analysis of consequences of **moving targets**
- **Simulation** of the maturity stage progress
- Derivation of activities to **increase the maturity stage**
- Integration in the **project management**
Maturity Stage Management – Integration within Planisware

- **Link to Project Management** for example Dashboard
- **Link to Product portfolio management** for example list of products

Maturity stage management
Link to other Planisware modules via milestones and functions

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