

How can CM support requirement management in a product line environment?

Scenario: Development project

With current generation wheel loaders still operating at several customer sites, a project is initiated to developing a new generation wheel loaders.

- Five different sizes are defined (6 ton, 10 ton, 15 ton, 20 ton, 30 ton)
- Each size will have 5-10 variants (e.g. different engines, different tyre sizes, different loaders etc)



Questions

1. In what way should the requirements be structured?
2. What should be considered from a CM point of view regarding:
 - a. updating current requirements?
 - b. adding new requirements?

1. In what way should the requirements be structured?

- *Ett antagande: Storlekarna är **varianter** och det 5-10 "varianterna" (motor, däck, skopa osv) är valbara konfigurationer*
- *Vi identifierar en **plattform**, som innehåller de gemensamma kraven nedbryten i en struktur utifrån arkitekturen (vi utgår ifrån finns).*
- *För varje variant inordnar vi de variant-specifika kraven i en lika dan struktur som plattformen (speglad).*

2. What should be considered from a CM point of view regarding

a) updating current requirements?

b) adding new requirements?

Vi identifierar varje variant som ett CI, vilket betyder att det blir föremål för formell ändringshantering.

Vid ändring av krav gäller att gamla kravversioner fortsätter gälla för den äldre generationen.

Wider system level

En högsta systemnivå
Övergripande krav som gäller alla maskiner
Lagkrav typ maskindirektiv
Även befintliga maskiner omfattas av denna nivå.
Operationella scenarier ("work steps")
Produktlinjearkitekturkrav

Top System level

Ett maskinslag (dvs den nya generationen)
Vilka krav föranleder att just 5 maskinstorlekar
är den optimala fördelningen.

System level

Maskinstorlek (Base variant)

System variant level

Maskinstorlek (variant)

- En matris visande vilka krav som är övergripande

What should be regarded from CM perspective?

- När slutade det gamla kravet att gälla?
- Change processen, hur förändras kraven?
- Systemperspektivet vs. Förvaltning av Krav?
- Change processen bör omfatta kravförändring över tid samt inom respektive produkt/projekt
- En matris visande vilka krav som är övergripande

1. In what way should the requirements be structured?

- *Vehicle electrical system*
 - *System overall requirements*
 - *ECU specific requirements*
 - *Variants*
 - *Software requirements*
 - *Hardware requirements*

2. What should be considered from a CM point of view regarding

a) updating current requirements?

- *Branching*
- *Baselining*
- *Change Control Board*
- *Parameter controlled configuration*

b) adding new requirements?

- CM should be part of the new development from beginning
- Same as a)

1. In what way should the requirements be structured?



Machine size

Generic reqs.
Independant of loading capacity

Variable reqs. As function of capacity

Equipments – generic (independant of Load cap.)

Engines – specific for Load cap. & Market

Drive Lines – specific for Load cap.

Hydraulic systems – specific for Load cap.

Equipments – specific for Load cap.

Buckets type X – specific for Load cap.

cap.
cap.

- *Add bullits and photos of sketches here ...*

1. Background for reasoning

- *Machine size is rated based on performance, in "Loading capacity" (pay load in bucket)*
- *There are global requirements, that are shared by all machines (Legal requirements, emissions & Safety, EU-compliance, etc.....)*
- *There are requirements that are closely connected to or a result of performance (Loading capacity), these are e.g. Derived requirements from performance on e.g. Engine performance, Hydraulic performance, Drive Line system performance, etc.).*

2. What should be considered from a CM point of view regarding

a) updating current requirements?

- *Within approved design space, defined by Form-, Fit-, Function, Performance of function and Characteristics of functions.*
- *Apply CM to evaluate and maintain status Q within allowable design space*

b) adding new requirements?

- *Add bullits and photos of sketches here ...*

1. In what way should the requirements be structured?

- *General high level requirements*
 - *In part inherited from the current product generation*
 - *New functions and features are specified in relation to the current generation*
 - *Efficiency, e.g. How fast can a certain amount of "stuff" be loaded / transported.*
 - *Improved user interfaces*
 - *Etc*
 - *Input not only from product planning/product marketing/sales but also from aftermarket and production.*
 - *Requirements from industry standards.*

Broken down into several levels:

- *Functional requirements*
- *Platform requirements*
- *Component Requirements*

2. What should be considered from a CM point of view regarding

a) updating current requirements?

- *Start with a baseline with definitions of the different variants. Work with Change Requests and configuration control to maintain traceability and dependencies between requirements. If possible in the requirement tool for increased CM efficiency.*

b) adding new requirements?

- *See applicable parts of 2a.*
- *Identify what old requirements are impacted / obsolete due to the new requirements? Maintain consistency with the complete requirement set.*

How can CM support requirement management in a product line environment?

Scenario: In operation accident

Five years into operation, an engine on one of the new generation wheel loaders breaks down. The cause is unknown, but a design fault in the engine is suspected (could be HW or SW). The specific engine variant is installed in several products and variants.



Questions

3. What is required from a CM point of view to be able to identify all the individuals with the particular engine variant?
4. What is required from a CM point of view to ensure that this does not happen again?

3. What is required from a CM point of view to be able to identify all the individuals with the particular engine variant?

- *En tillräckligt nedbryten CI-struktur*
- *Baselines kopplade till relevanta steg i livscykeln (as req, as designed, as delivered ...)*
- *Fysisk märkning*
- *Individuppföljning*
- *ändringshistorik under driftperiod*
- *Avtala CM med kunderna (vem har vilket ansvar)*

4. What is required from a CM point of view to ensure that this does not happen again?

- *Koll på historiken mha baselines genom utvecklingsprocessen.*
- *Ändringshanteringen måste inbegripa alla steg i livscykeln*
- *CM för root cause (tex för att kunna återskapa testmiljöer)*

3. What is required from a CM point of view to be able to identify all the individuals with the particular engine variant?

- A database including all information (all part numbers) for each individual vehicle, where it's possible to search for a specific part number that has a problem.

4. What is required from a CM point of view to ensure that this does not happen again?

- *Focus on test & verification*
- *Maintain information about compatibility between HW and SW*
- *Feedback to development organisation*

3. What is required from a CM point of view to be able to identify all the individuals with the particular engine variant?

- *To connect system data (e.g. Engine variant and SW-version) through engine unique serial number, connected to Product/Machine serial number as part of assembly sequence (System architecture, connected to assembly sequence through systems serial numbers / SW-versions).*
- *The Product/Machine serial number, shall contain a connection to machine configuration as part of assembly sequence, shall be a delivery from assembly line to Product Maintenance, After Market and Sales Support (for connection to customer).*
- *System/Machine configuration changes have to be systematically retrieved and recorded/processed by After Market / Service function. "Vehicle history Information Data base"*
- *Extract vital reliability and claims data history from FRACA's system, for preventive actions. (FRACAs=Failure Reporting and Corrective Actions systems).*

4. What is required from a CM point of view to ensure that this does not happen again?

- *System/Machine configuration changes have to be systematically retrieved and recorded/processed by After Market / Service function.
"Vehicle history Information Data base"*
- *Extract vital reliability and claims data history from FRACA's system (Field Failure report, Non conformity report, etc.), for preventive actions.
(FRACAs=Failure Reporting and Corrective Actions systems).*
- *Based on performed systematic Problem solving (Root Cause Analysis => Challenge requirements & design => trigger re-design & corrective actions (Document generation and evaluation of design concept, update FMEAs & risk Mgmt docs.)=> verify solution – right problem solved with right quality => document solution in TDM couple/connect to System-of-Interests & Product (update Engineering documentation and Legal & Regulatory Compliance docs)=> Communicate to all stake holders, including "Lessons learnt to R&D".*

CM responsibility is to manage large amount of data in a systematic and product/system structured way, making information available for key stakeholders, in a comprehensive way – supporting analysis and decision making!

3. What is required from a CM point of view to be able to identify all the individuals with the particular engine variant?

- *A CM system with production baselines for each individual including part numbers and versions for all components.*
- *A customer register where all individuals are matched towards customers.*
- *A PLM system with*
 - *traceability from the faulty engine type and version to all vehicle types and variants it has been included in.*
 - *traceability of the faulty component version to all engine types it has been included in.*

4. What is required from a CM point of view to minimize the risk that this happens again?

- *Check that the problem has been solved using the issue management system. All affected individuals need to be corrected.*