

Usefulness of FMECA for improvement of productivity of TWR process



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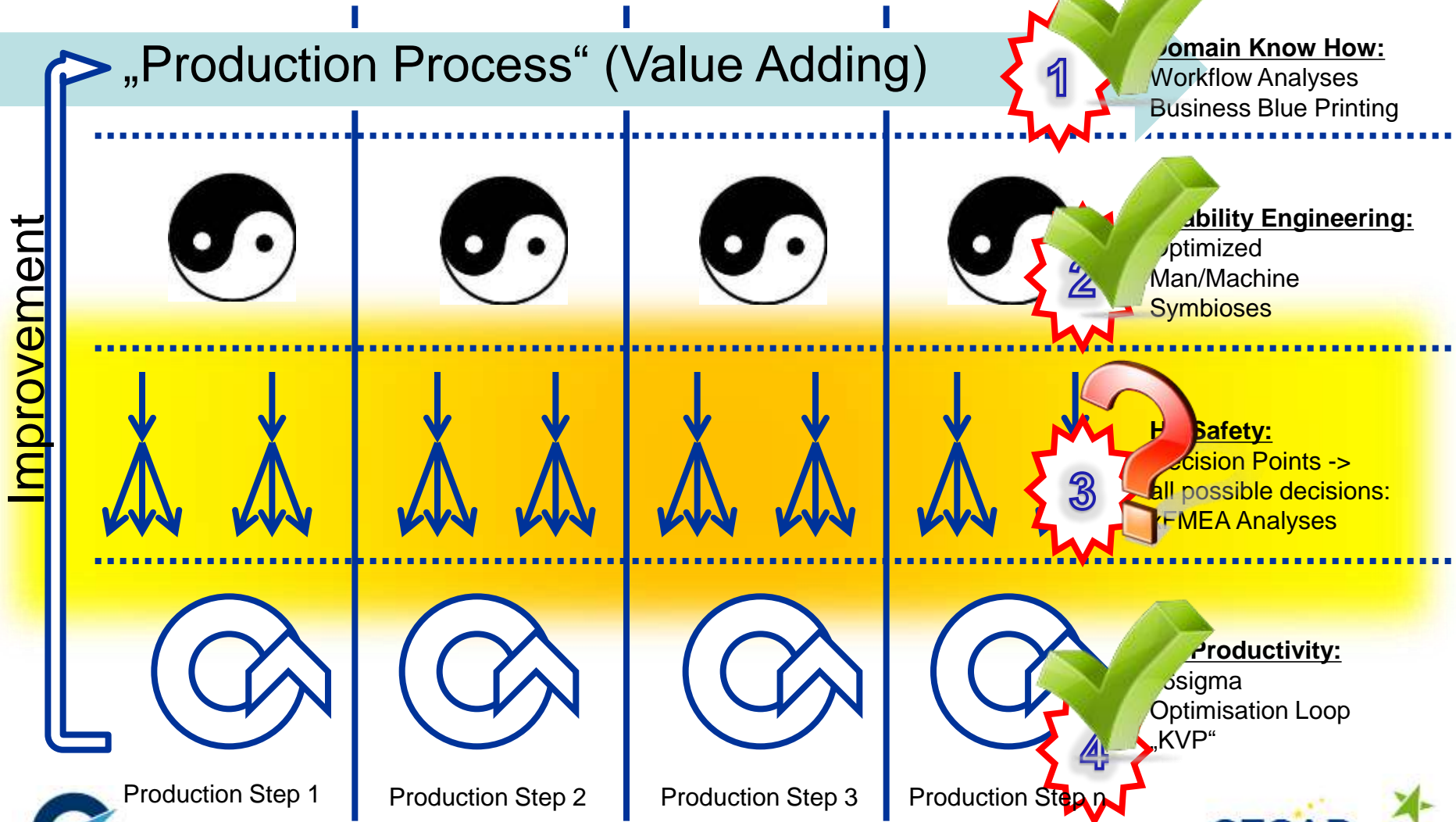


The Hypothesis

- Applying processes from mass production improves productivity and safety in ATM Systems.
- Assumptions
 - *An ATM Control Room is a sociotechnical system*
 - *An ATM Control Room is producing “something”*
- Main Questions
 - *Can ATM be seen as production process?*
 - *Can the production be divided into value adding production steps?*
 - *Which process tools fit best?*



ZeFMaP - Safety Critical Mass Production



FMECA & FTA

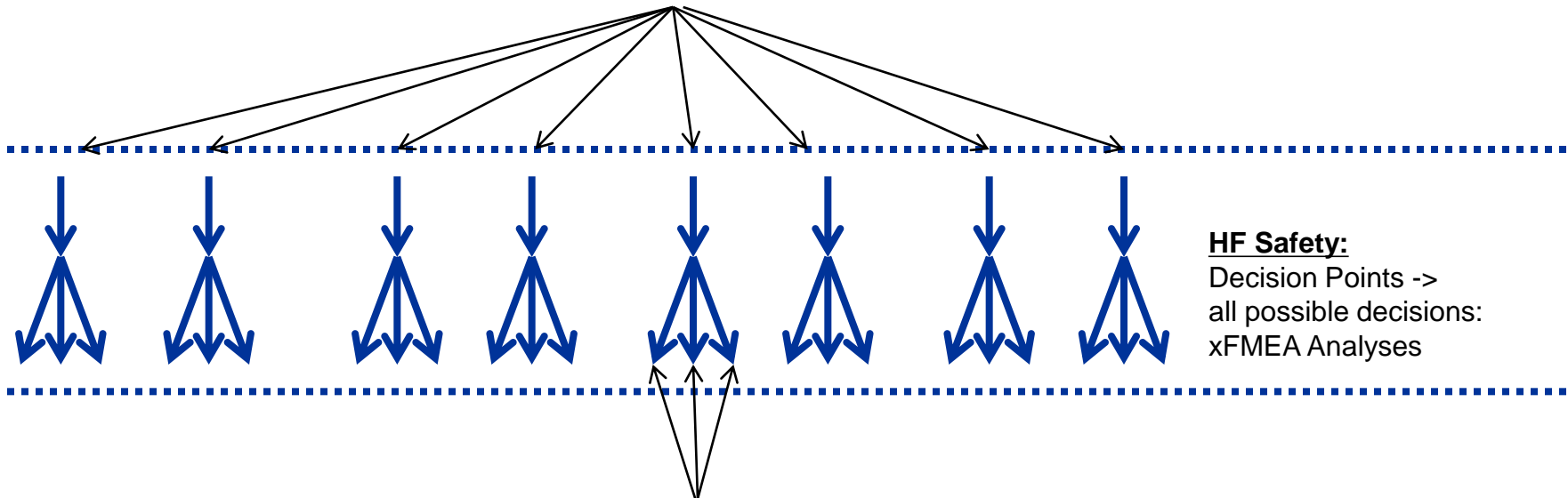
- **Failure Mode and Effects and Criticality Analyses**
 Simplified: (Product)FMECA shall detect and analyse failures of systems through analyses of possible malfunctioning of one ore more of its parts (**Fault Tree Analyses**). Every possible combination of malfunctioning parts are to be analysed.

We looked for something like:

- ***Decision Quality and System-wide Effect Analyses***
 would be the analogue method to gain system optimised decisions for every possible situation.

System-wide Decision Analyses

Deterministic points for a decision



HF Safety:
Decision Points ->
all possible decisions:
xFMEA Analyses

Decision Variables

Setup

- Simulated Environment: Hamburg Airport (EDDH)
- 5 Roles: Clearance Delivery, Ground, Apron 1, Apron 2, Tower



- Two days; training and measured runs (37 flights in 37,5 minutes)
- Defined Workflows & Separation Rules

Tools

- 4D Aerospace: Radar & Auxiliary Display
- Communication: Verbal



- FREQUENTIS:
Electronic Flight Strips
- Clearances: CPDLC on
flight strips



The goals of the first experiment

Evaluating the experimental design, tools and measurements -> *limited scenario*

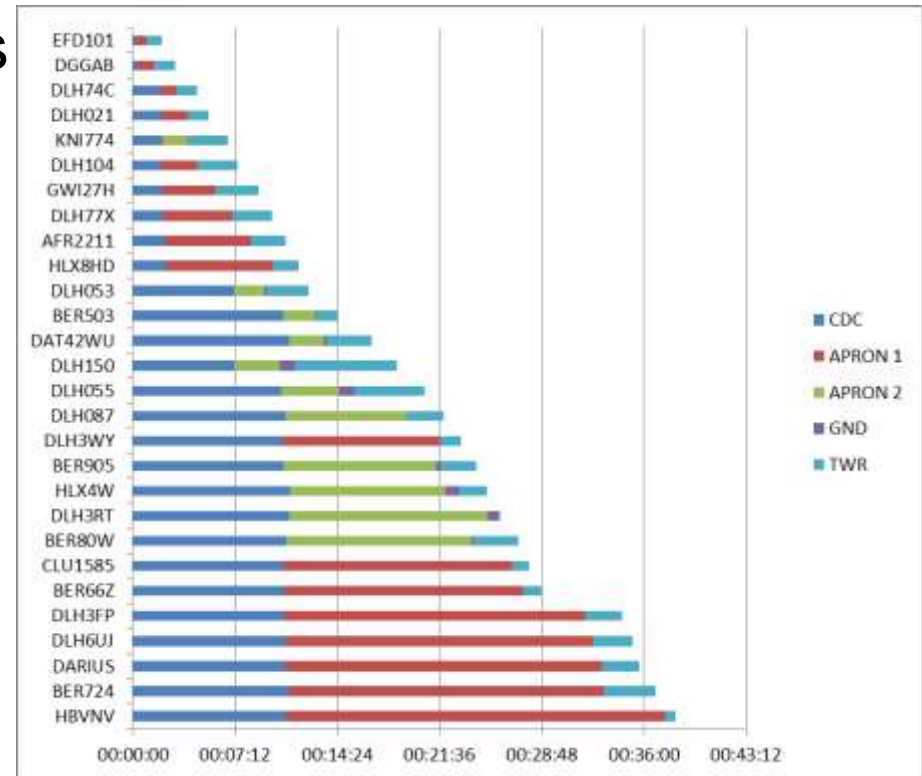


Collecting the data for FMECA analysis

- Is FMECA useful?
- What is the quality of the decisions?

Preparing the data

- Synchronizing data sources
- Coding handovers
- Semi-automatic adaptations
- Visual representations



FMECA analysis

- **System** – effect of the five controllers' decisions (37,5 minutes, 27 departures, 10 arrivals)
- **Item** – each of the role
- **Failure modes** – list of possible non-optimal decisions for each position (expert walkthrough)

CDR/APRON

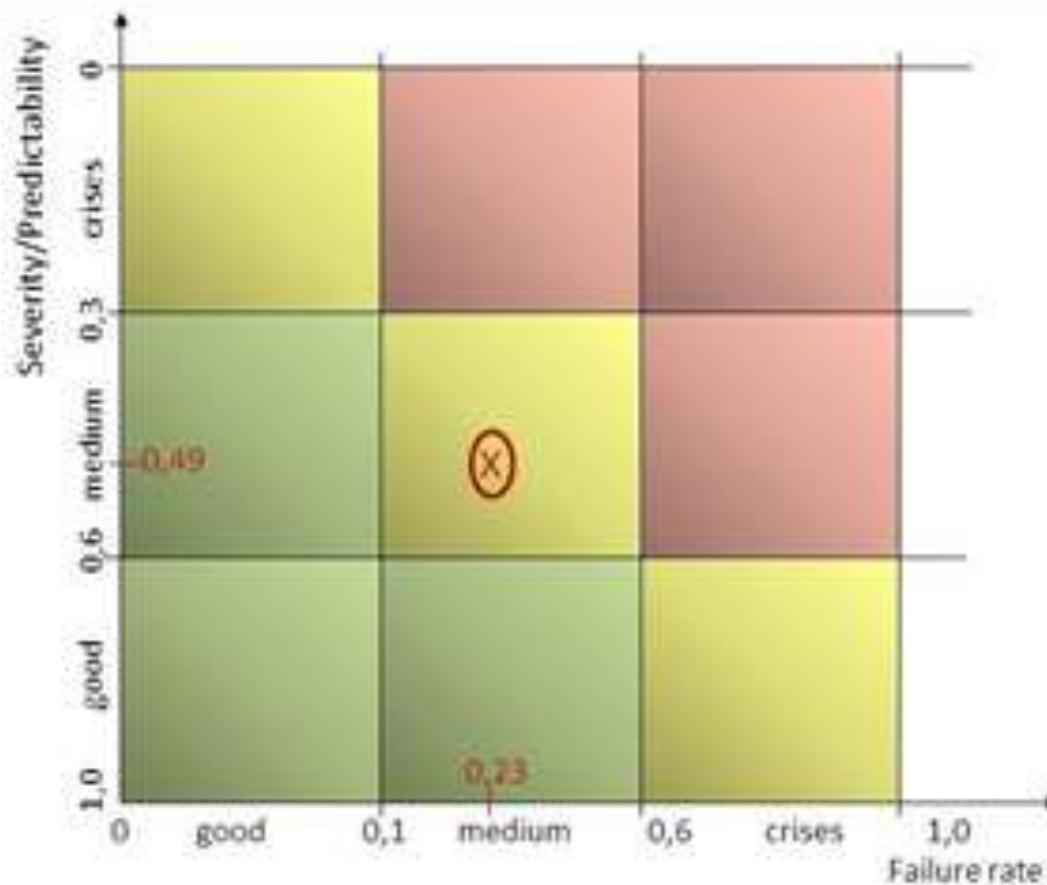
- Delay in strip take over
- Delay in push back clearance
- Rejected push back clearance (CTOC not valid)
-

- **Basic failure rate** – number of decisions (with failure or success) per total number of decisions for each role
- **Severity** – expert judgement for our KPIs (efficiency, flexibility, predictability, safety)
 - *Crisis: 0*
 - *Bad: 0.3*
 - *Medium: 0.6*
 - *Good :1*

Results

- No arrivals that can be improved
- Non-optimum decisions for departures were related to 'Departure clearance to invalid CTOT'
 - *Failure ratio - 0.23*
 - *CDC criticality number – 0.23 (failure mode ratio 1)*
 - *Severity codes for predictability averaged to 0.49*

Severity/predictability graph



Validity

- Limited scenario – too easy for the controllers
 - *More challenging scenario in the second experiment*
- Relatively small number of optimal decisions for closer investigation (225 optimal decisions; 19 non-optimal)
 - *Collect all the decisions over a longer period and under different conditions*
- Grading and scales – expert judgement
 - *Need validation*

Conclusions and future work

- Experiment 1 showed that the overall ZeFMaP process is probably useful.
- Particularly the process analyses (step 1) worked well.
- Simplifications through CPDLC could have affected the result.
- FMECA could be useful on larger data sets and with more challenging scenarios (Experiment 2) but probably not in real-time settings
- Next level of productivity improvement can be expected through real-time tools supporting system optimised decision
- Follow up projects concentrating on this step could be useful.

Thank you for your attention!

Questions? Suggestions?



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