

# Development and Evaluation of a Complexity Measure for the Work of Assembly Teams

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## 1. Research Question, Aim and Simulation Approach

### Research Question and Aim

- Products and Processes have become more complex
- Research Question: How can the complexity of the work of assembly teams be measured?
- Aim: Development of a complexity measure of the work of assembly teams that considers the overall assembly process with all tasks during a whole shift
- Simulation studies for evaluating the measure

### Simulation Model for Evaluation

- One-Piece-Flow assembly line model as study object



## 2. Development and Evaluation of the Complexity Measure

### Existing Complexity Measures

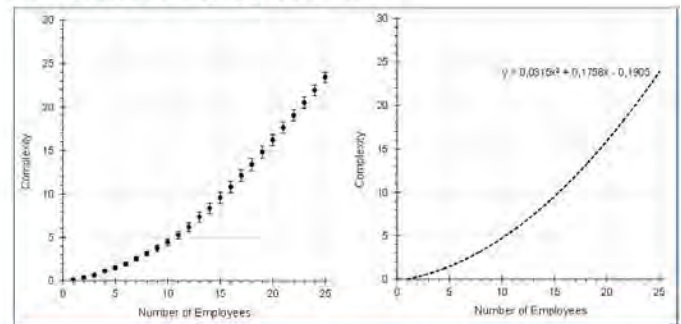
- Entropic-information approaches
- Hybrid metrics / heuristics
- Computational metrics / heuristics
- Axiomatic Design
- No measure captures the work of assembly teams

### Adapted Measure (Shannon Entropy)

$$C_{\mu} = - \sum_{e=1}^E \sum_{j=1}^J p_{ej} \log_2 (p_{ej})$$

- $C_{\mu}$  = statistical complexity [in bits as unit]
- $j$  = state (task)  $j, j \in J$
- $e$  = employee  $e$  of the assembly team;  $e \in E$
- $p_{ej}$  = probability of employee  $e$  being in state  $j$

### Simulation Study Results

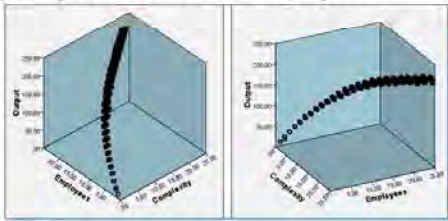


- Complexity measure for the work of assembly teams with respect to the number of employees (process with overtaking)
- 651 shifts simulated per scenario ( $d=0.02$ ,  $\alpha=0.05$ )
- Adequate data fit with 2<sup>nd</sup> order polynomial ( $R^2 = .99$ ;  $p < .001$ )

## 3. Practical Implications

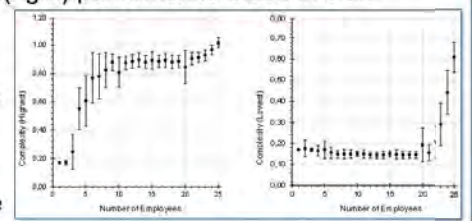
### Complexity-Output-Relation

- Output vs. Complexity vs. Number of Employees
- Assembly process with overtaking
- 3D plots from two perspectives



### Employee Considerations

- Individual complexity levels of the employee with the highest (left) and the lowest (right) performance index in shift
- Assembly process without overtaking
- Different complexity curves observable
- Complexity level adjustment possible



## 4. Discussion and Digital Twin Implementation

### Discussion

- Further statistical analyses are necessary to evaluate the measure
- Development of descriptions and interpretation guidelines for practitioners
- Implementation into Digital Twin of assembly line

### Digital Twin

- Linking of physical line to Digital Twin
- Control of the system's complexity level via Digital Twin using algorithms



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