HSLU Hochschule Luzern

Technik & Architektur
Industrial Technologies
Master of Science in Engineering

Master-Thesis Engineering, Profile Industrial Technologies

Advanced Automation for Space Mechanism Production

Figure 1: Satellite with Solar Array Wings and an Antenna [Source: beyondgravity.com]

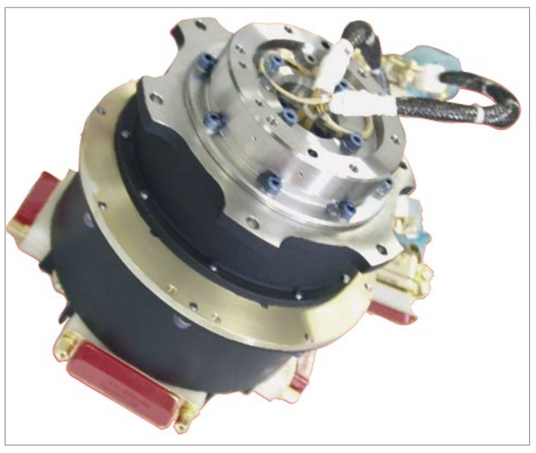

Figure 2: SEPTA 41; Solar Array Drive Mechanism [Source: oerlikon.com]

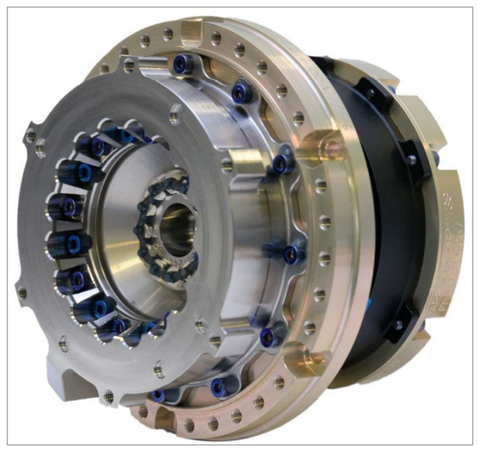

Figure 3: SARA 21; Rotary Actuator for Antenna Pointing [Source: ruag.com]

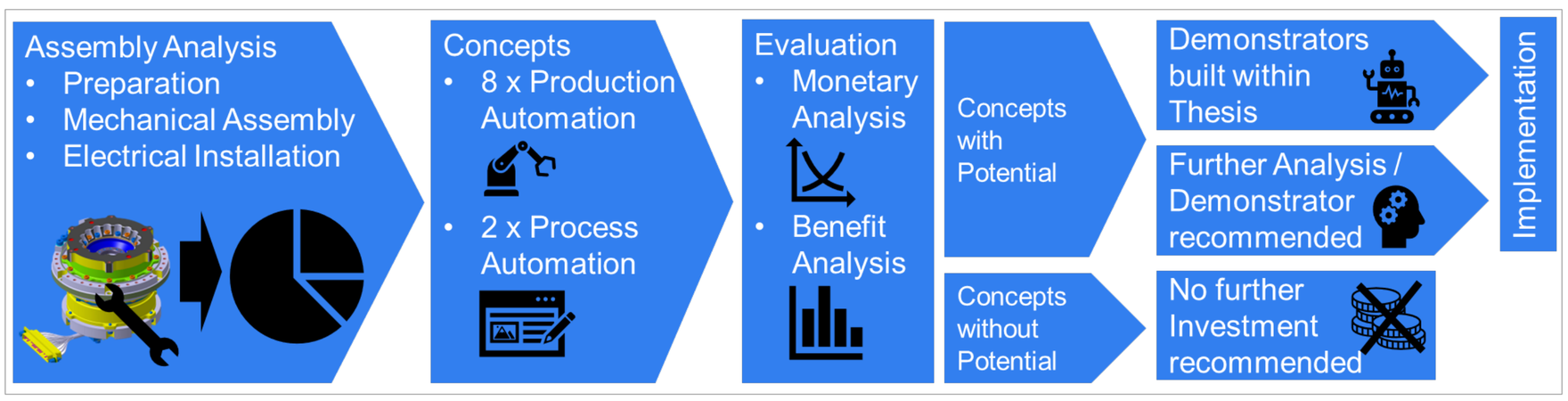

Figure 4: Process Overview Master Thesis

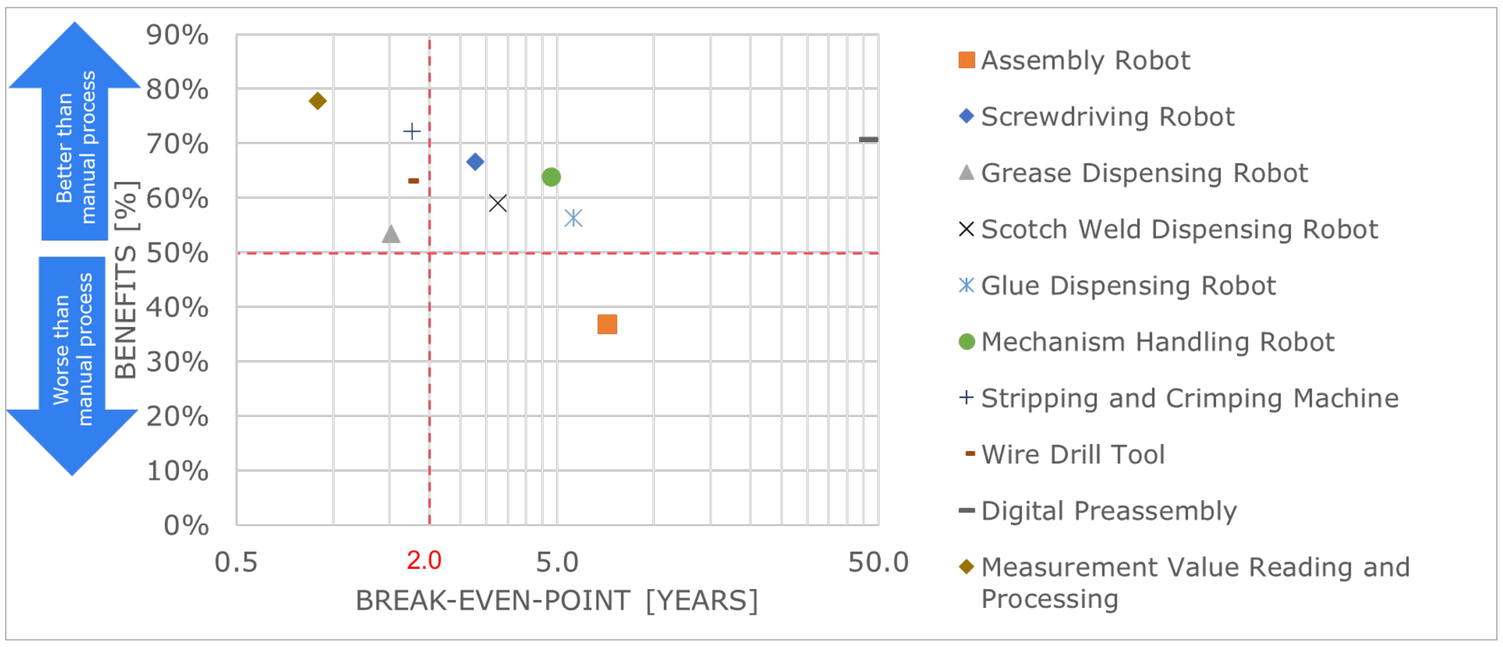

Figure 5: Results of Financial and non-Financial (Benefit) Evaluation

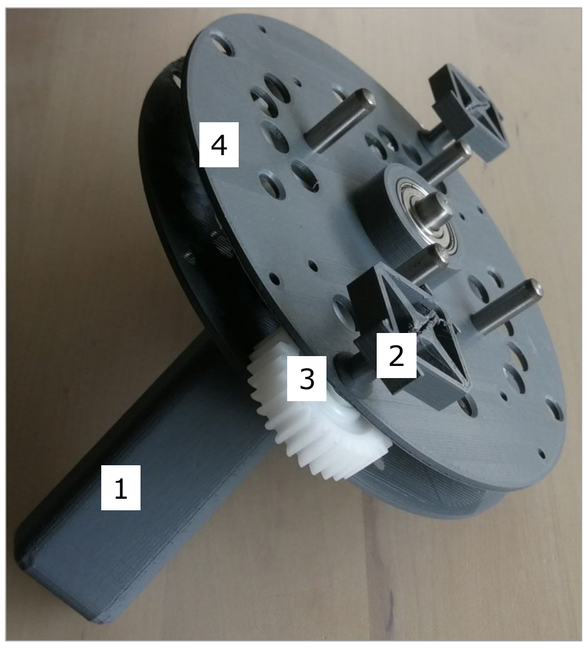

Figure 6: Wire Drill Tool Prototype; 1: Handle; 2: Wire Clamp; 3: Gears; 4: Rotating Disc

Problem Definition
Satellite mechanisms are typically used to move and orientate equipment which is attached to a spacecraft (see Figure 1). Currently, these complex mechanisms (see Figure 2 & 3) are assembled mostly in manual working steps. In the new space era, large satellite constellation are launched. Therefore, efficient and repeatable automation methods must be found to realize significantly higher mechanism production quantities.

Approach
The steps performed within the master thesis are shown in Figure 4. To understand the details and the difficulties of the current assembly processes, a complete mechanism assembly was attended in the cleanroom. Basically, the assembly can be structured into the parts preparation, mechanical assembly and electrical installation. The highest automation potential was detected in the areas mechanical assembly and electrical installation.

Based on the assembly analysis, automation concepts were developed, typically for repeating assembly steps.

The proposed concepts include 8 production automation solutions and 2 process automation approaches.

The evaluation is based on a financial calculation of the Break-Even-Point and a benefit analysis with criteria like failure rate, accuracy and quality assurance. In areas where the automation concepts can use their advantages in accuracy and repeatability, potentials can be obtained with for example a Break-Even-Point of 1.5 years for a grease dispensing robot (see Figure 5).

Results
Based on the evaluation, four concepts without automation potential were determined. Six concepts do have automation potential and for three of them, prototypes were already developed and built. This includes two process automation approaches, programmed in MATLAB and the 3D printed wire drill tool (see Figure 6) which aims to replace the manual drilling process. The requirement to not twist the individual wires during the drilling process made this tool complex.

By realizing the six proposed flexible automation solutions for the SARA 21 production, the assembly time could be decreased by 11.3 % and the production quality increased.

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