Top-Down Component Requirements with Guaranteed Assembly Accuracy

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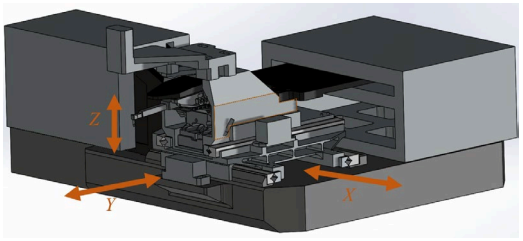


Figure 1. *ASMPT Industrial Wirebonder Model*

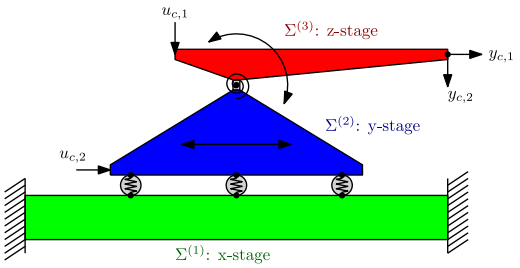


Figure 2. *(Simplified) 2D-Wirebonder model*

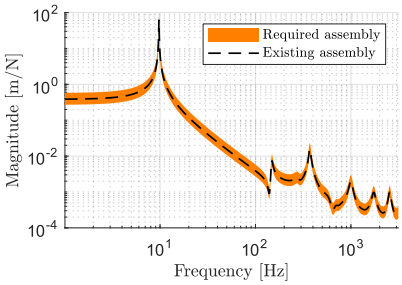


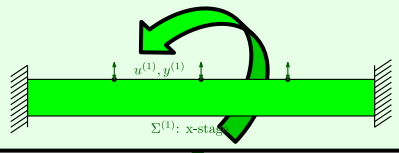
Figure 3. *Example of assembly requirements*

User-Defined Assembly Requirements

Complex mechatronic systems often involve assemblies of multiple components. To achieve high performance and precision, system engineers usually establish **design specifications at the assembly level**. We propose a top-down approach that **automatically determines requirements for each component** based on specifications for the overall assembly. This approach enables **modular redesign** to improve the system's performance, precision, reliability and reduce costs.

Assuming the availability of models for the system and its components, assembly requirements are defined in the frequency domain. From these, component requirements are derived, based on a **maximum allowed change in the dynamics** of the existing models. The component requirements are allocated in such a way that more freedom is available to redesign components with less impact on the overall assembly specifications.

Derived Requirements x-stage → **Verify** → **Modular Redesign**



Example: Mass Reduction

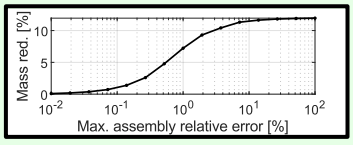
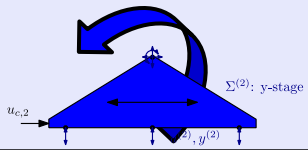


Figure 4. *Given required assembly accuracy, possible allowed mass reduction x-stage*

Derived Requirements y-stage → **Verify** → **Modular Redesign**



Example: Addition of Encoder Ruler

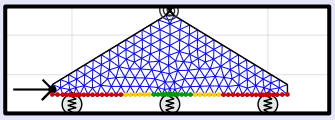
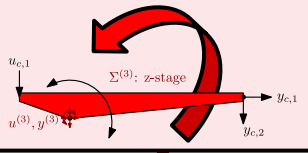


Figure 5. *Allowed locations of:*
- *Ruler 80 g,* *Ruler 40 g and,*
- *Neither ruler possible*

Derived Requirements z-stage → **Verify** → **Modular Redesign**



Example: Addition of Accelerometer

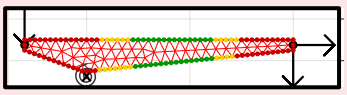


Figure 6. *Allowed locations of:*
- Accelerometer (ACC) *50 g,*
- *ACC 25 g and,* *Neither ACC possible*

Guaranteed Satisfaction of Assembly Requirements

The top-down approach is based on previous work [1], where a model reduction problem was reformulated into a **robust performance analysis framework.** This framework enables the application of robust control tools, such as ***μ*-analysis**. By treating assembly specifications as robust performance criteria, the approach allows for determining maximum design modifications at the component level that satisfy the assembly criteria. Summarizing, if individual components meet their requirements, this approach **guarantees that the overall assembly specifications are also satisfied.**

References

[1] Janssen, Lars A.L., Besselink, Bart, Fey, Rob H.B., & van de Wouw, Nathan. "Modular Model Reduction of Interconnected Systems: A Top-Down Approach." *IFAC World Congress 2023, Yokohama*. 9-14 July 2023.