Moving Toward Integrated Digital Design

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Bio

Kirk Nelson

- Lead Engineer, Design Technical Excellence, Boeing Commercial Airplanes
- 22 years at Boeing, mostly in Knowledge Based Engineering
- BS and MS in Mechanical Engineering from Michigan State University

Summary

Modern CAD/PLM systems are moving us closer to the panacea of design: integration across the product lifecycle, ease of morphability and change, and requirements that are captured and able to be validated within the system. This presentation explains the key drivers in achieving that goal and also some potential pitfalls.

Evolution of CAD and PLM

CAD as a drafting aid - Replacement for manual drawings

CAD as a modeling tool – physical simulation (surfacing, solid modeling)

Parametric Design – extension beyond pure geometry modeling (parameters, rules, automation)

PLM Platform – Full integration across value stream (loads/FEM, optimization, simulations, factory floor, etc.)

History

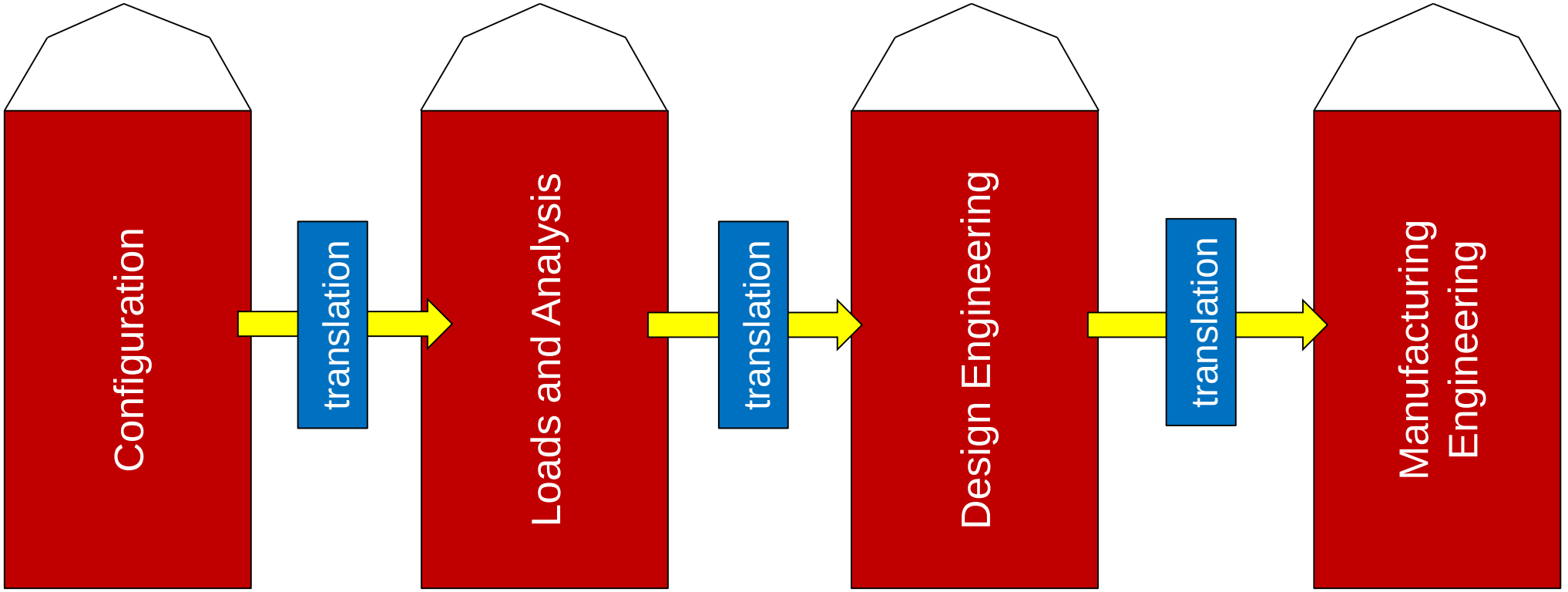
So where are we heading?

Modern CAD designs should go beyond merely satisfying form, fit and function. They must also be easily modified when requirements change, deliberately provide information for downstream use, and support automation.

The CAD platforms provide the tools, we must provide the know-how. As designers we need to collect data from many sources and produce a safe and efficient design.

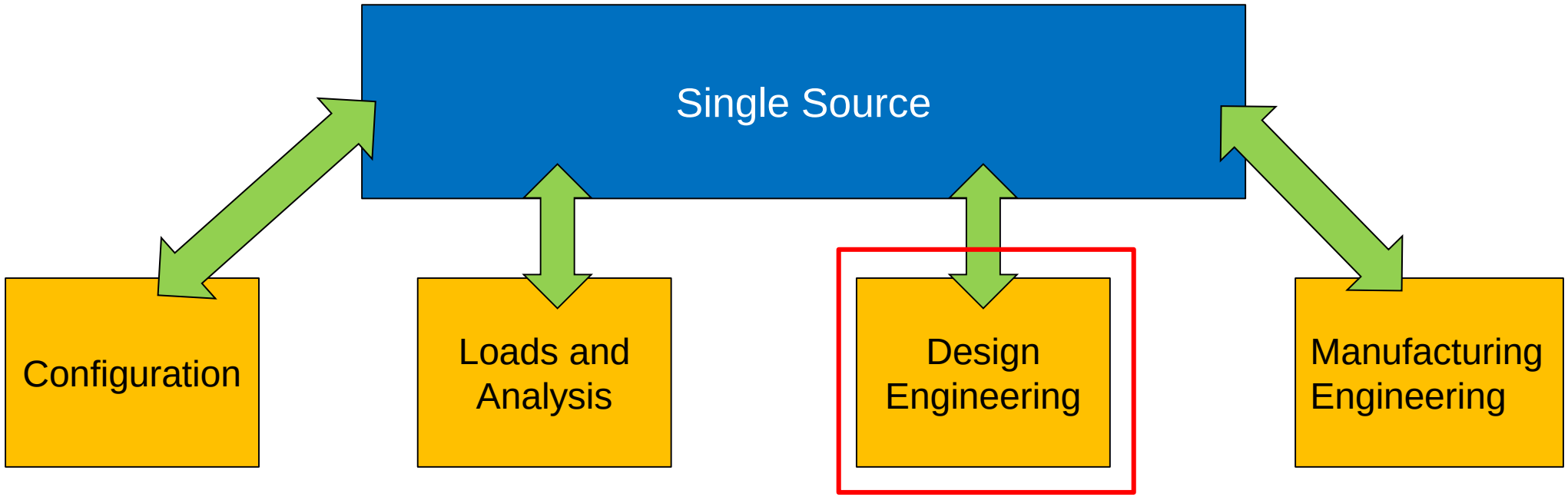
The Problem…

Siloed data by function, not much integration…
Lots of data translation, data loss or replication



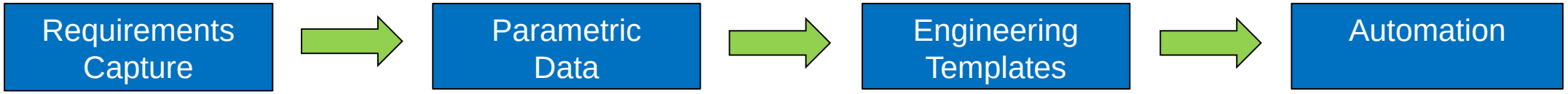
The Solution…

Single source of data
Data **objects**
Relational links



Four Key Drivers

The path to integrated design…

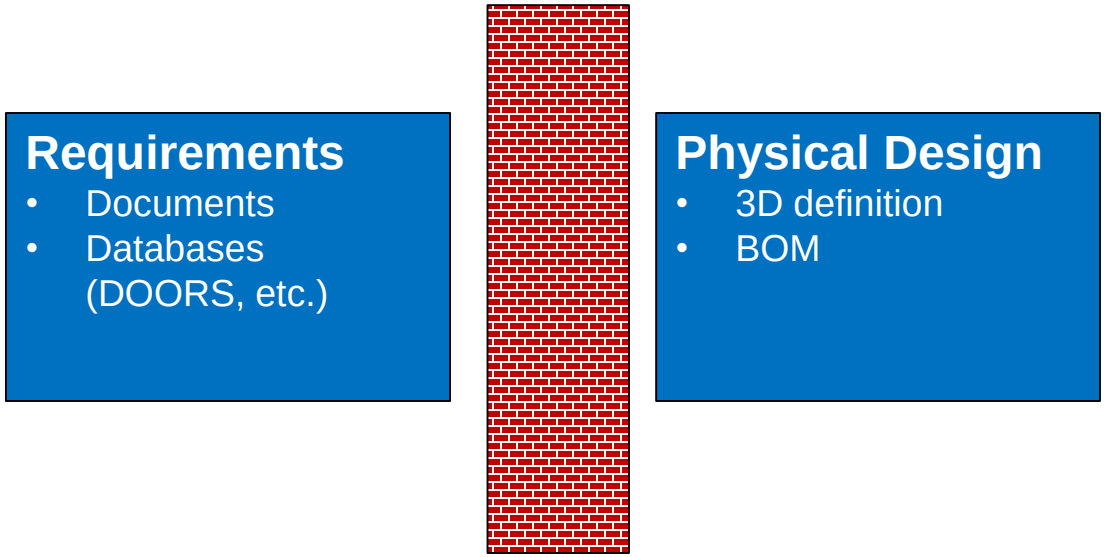


* My perspective is “acreage” design. May differ for more specialized designs.

Requirements

Traditional Approach:

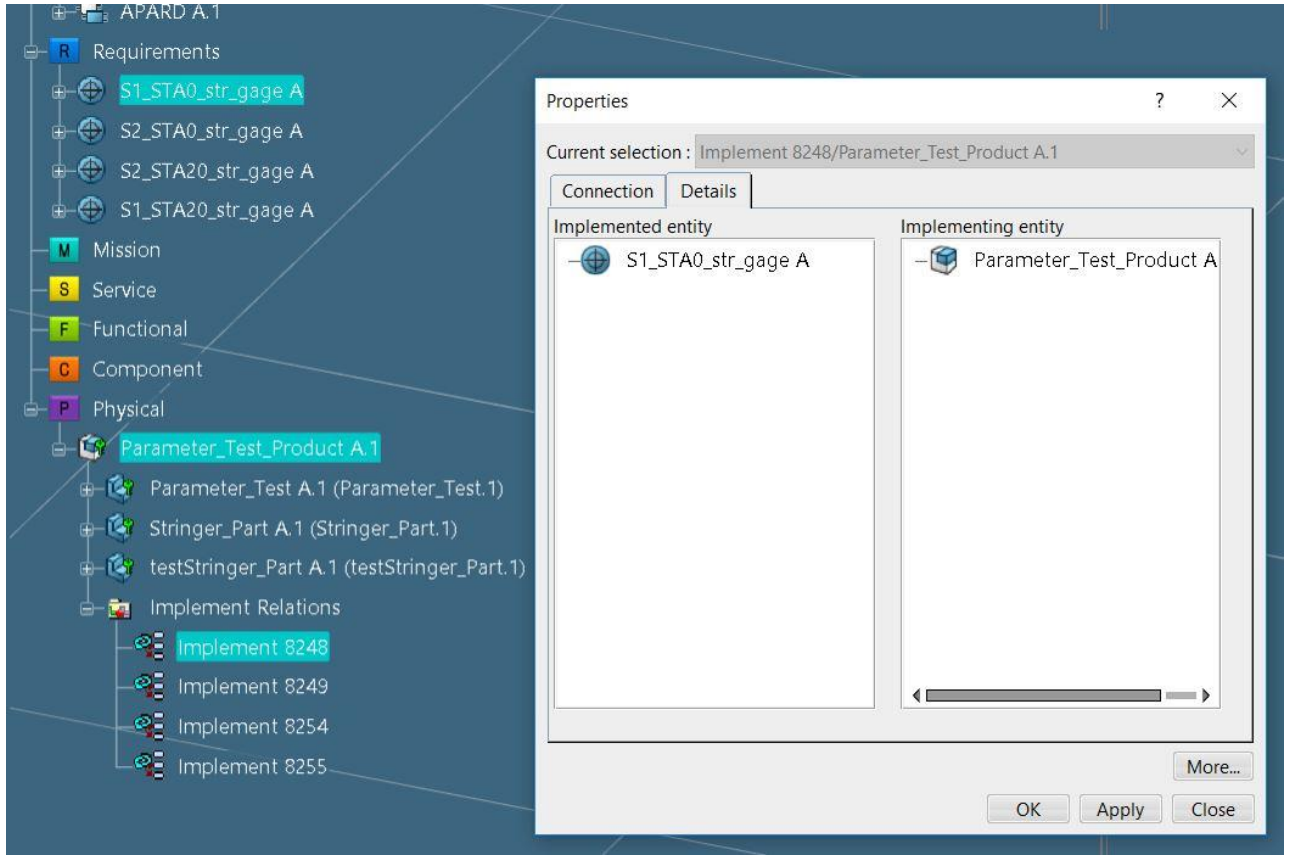
- Designs must meet all requirements, but these requirements are stored independently from the physical design.
- No digital linkage between the requirements authority and the physical design authority.
- Leads to delays and rework if requirements are missed.



Requirements

Best Approach:

- Systems engineering capabilities, such as RFLP (Requirements: Functional, Logical, Physical) in 3DExperience, allow the design requirements to be stored with and linked to the physical (CAD) design.
- Automation of requirements allocation and validation of requirements.



Evolution of Parametric Data in CAD

Basic control of geometric parameters (e.g. circle radius) in CAD model

- **Formulas and Rules**
- **Non-geometric parameters (metadata)**

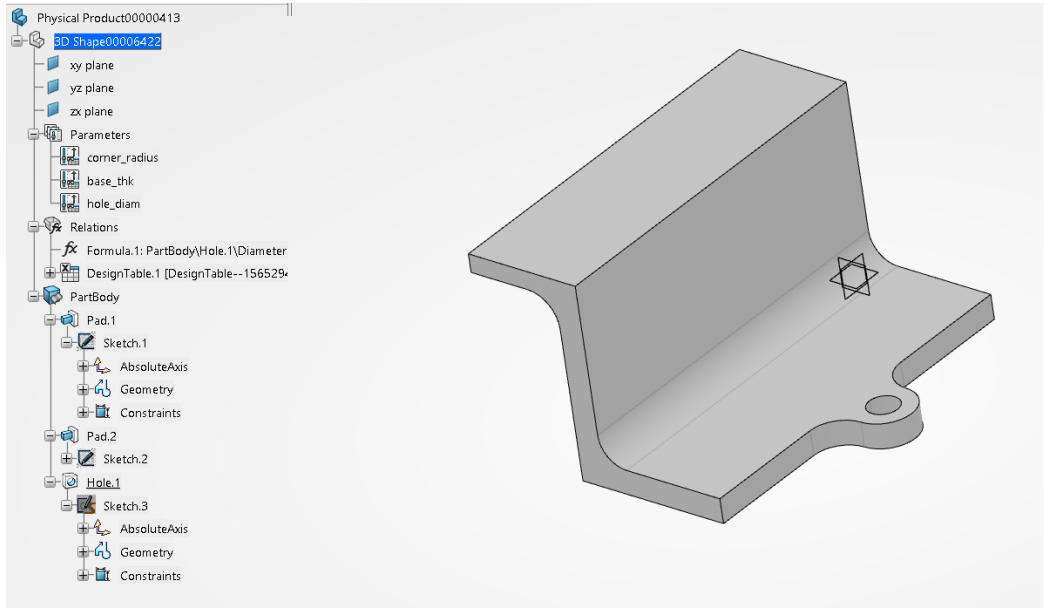
Parameters fed from external sources (e.g. spreadsheet based design tables)

- **Parameters as objects stored within the system**
- **Parameters linked to requirements**

Templates

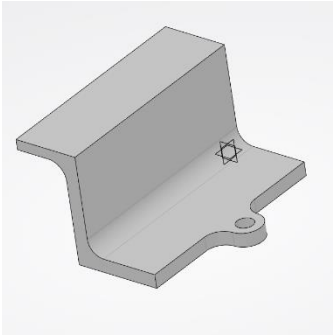
- Creation of part families using reusable, parameterized templates
- Embedded rules
- Requirements captured in templates as parameters and rules, with linkage to the requirements definition
- Can range from simple to complex

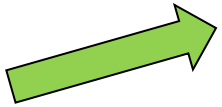
Parametric Data (from spreadsheets, database…)

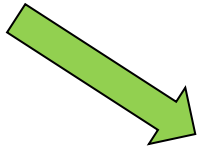


Automation

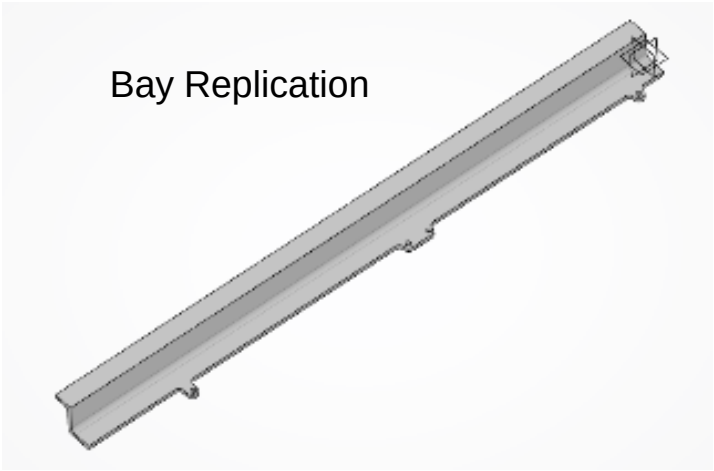
Template Model



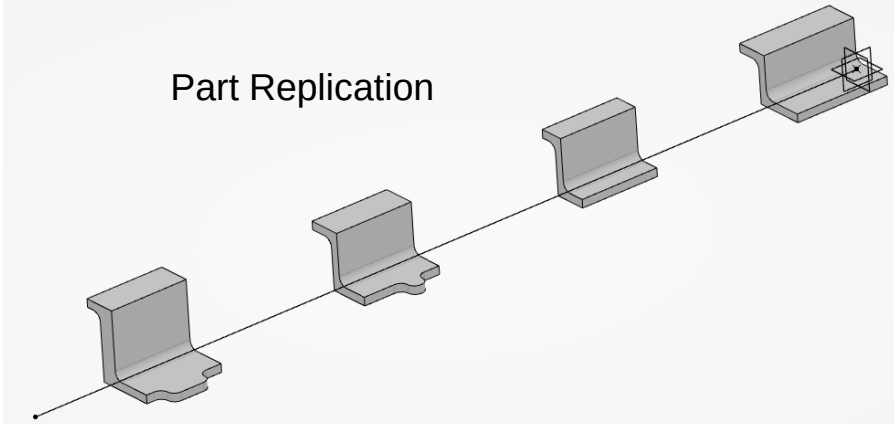




Bay Replication



Part Replication



- Modern CAD systems make it easy to morph a template into a multitude of similar parts
- Scripting and automation make this quick and error free

Automation

Automation Opportunities

- Translation and conversion
- Checking tools
- Data extraction and analytics
- Fastening
- Product definition data creation: drawings, layouts

Pitfalls

So what can go wrong?

1. Lack of an up-front commitment and buy-in from all stakeholders
2. There's a lot of data, and a lot of data connections. Gets complex fast!
3. Poorly organized data
4. Multiple CAD systems and legacy data

Pitfalls

1. Up-Front Commitment and Buy-In

- The key to this approach is the connection between the data and the flow of that data. Much of the benefit is lost when not fully realized.
- Projects need to plan for this and put all the pieces in place before the execution
- Extra effort early will pay off later

2. Data Complexity

- There's a lot of data, and a lot of data connections. Gets complex fast.
- There's a significant learning curve. The days of design engineers as "CAD jockeys" are over.
- Engineers need to adjust to this new mindset.

3. Data Organization

- As the CAD datasets get more complex data organization is more critical.
- Things like naming conventions need to be followed rigorously.
- Automation may be required to ensure the data standards are adhered to.

4. Multiple Data Sources

- Not always worth the expense to convert legacy data.
- Reality is we have to work with data in various formats.
- Automation can help!

Conclusion

- **Seamless flow of data throughout the product lifecycle should be the goal**
- **The best design process is one that leverages the data**