Modern Collaboration Tools for Cost Effective Design of Small Satellites

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Summary

This poster presents the results of a study comparing design and collaboration tools which are currently used in the satellite industry, along with their problems and possible improvements. The study shows that new engineering tools need to be user-friendly and intuitive, handle automatic changes with notifications, include a version control system and have interfaces to other tools. The results from the study are used to:
(1) validate the development of a new, web-based data storage and collaboration tool that integrates in the current engineering work flow
(2) illustrate the potential of a tool chain of modern engineering tools connected through web standards

I. Background

Small satellites are becoming increasingly popular because of the low costs and fast development times, but the complexity of small satellite design projects is not to be neglected.

Challenges

- Low budget and fast development schedule
- Complexity
- Many stakeholders
- Highly competitive market

Efficient inter-team and interdisciplinary collaboration is needed to manage the complexity in order for small satellite missions to stay competitive.

Systems engineering approach

- Managing complexity with Excel has reached its limits
- Many teams are looking into Model Based Systems Engineering approaches, but this often requires too much time and effort spent on training and understanding of a specific modelling language
- The current model based tools are not flexible enough and add little practical benefit

Current opportunities

A new approach is necessary, breaking with classical processes and tools, which have grown as a patchwork in most companies over decades. Instead, new tools with good interactions and interfaces are needed for efficient hardware development.
Specific needs include:
- Web-based tools
- Tool interoperability

II. Results

(a) Collaboration tool study

A non-scientific study was conducted with 36 respondents across multiple engineering disciplines. The objective was to learn about percieved problems and possible improvements of engineering collaboration tools currently used in industry.

Simulation and calculation tools used in industry

Tools (top to bottom): Excel, MATLAB, Simulink, Other, Google Sheets, SolidWorks, Custom, None, Fluent, GNU Octave, Mathematica, Python
% of respondents using tool (0–80)

Data management tools used in industry

Tools (top to bottom): Excel, Word, PowerPoint, Google Docs, Rational DOORS, Other, Confluence, None
% of respondents using tool (0–80)

Problems identified with current engineering tools include:
- inconsistencies in the engineering data
- inefficient data management
- difficulties with getting an overview of the project data

Desired features of an engineering tool

Features (top to bottom): User friendly, Automatic change notifications, Connection to other tools, Offline/remote working, Version control, Connected data, Collaboration in large teams, Data visualisation, Flexibility, Requirements tracking, Calculation capability, Simulation capability
% of respondents wanting this feature (0–80)

To the question whether the respondents thought that their engineering work could be more efficient, 97.2% answered yes.

(b) New, web-based engineering tool

The findings from the study (a) were used to validate the development of a new engineering tool, Valispace, with the following properties:

1) Easy-to-use web interface

The complexity of the underlying model is hidden from the user.

2) Consistent database

A consistent database is the foundation of the tool. Often, detecting inconsistencies in the late phases of a project costs enormous amounts of time, money and re-work.

3) Connected data

Data is connected through formulas. When one value is updated, all dependent values are re-calculated and updated in all documentation automatically. This allows for:
- tracking and visualization of parameter dependencies
- clear views on how design changes affect the whole system
- consistent project data within and between engineering teams
- version control to allow for easy iteration and comparison, and to ensure traceability.

4) Connection to other tools

The data in the database can be accessed from external tools which makes it very flexible. Data can be exported and imported in standard formats or accessed directly from other tools through dedicated plugins.

5) Notifications

As changes propagate through the system, it is communicated directly to the appropriate engineers through an automatic notification system. The user always gets informed about a change in the project data and can take necessary actions.

(c) Modern tools & interfaces

The identified landscape of functionalities needed for the design of small satellites is presented together with relationships and interfaces between them. In the center of the tool chain lies a consistent engineering database which interfaces to other tools.

The web-based tools shown in the figure are considered the best fit for a modern hardware engineering tool chain, because data exchange can be done with existing web standards and APIs, which allows for seamless tool interoperability.

III. Conclusions

Within the space industry in general, systems engineering work is still largely document-based which often leads to inconsistencies in the engineering data.

What new tools are needed?

The study (a) shows that new engineering tools need to be user-friendly and intuitive, handle automatic changes with notifications, include a version control system and have interfaces to other tools for efficient hardware development.

A new engineering tool

A web-based tool which serves as a consistent engineering database with powerful visualization capabilities has been developed to meet the demands of the industry. The benefits of the developed engineering collaboration tool include:
- fast setup
- flexible and easy user interface
- little time spent on training
- consistent data
- interoperability

Web-based tool chain

The presented tool chain (c) consisting of web-based collaboration tools has the potential to provide significant improvements in the design, development and execution processes of small satellite missions.

For engineers to collaborate on complex projects and keep a low budget and fast development schedule, a web-based software environment that ensures consistent data throughout the whole project is needed.

For more information

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