Cubesat Subsystems Preliminary Design: One Software Suite to Bind Them All?

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Teaching support

- Space Mechanics
- Mission Analysis
- Thermal Architecture
- Space Telecom
- Power system
- AOCS
- Launchers
- Project Management
- ...

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ISAE-SUPAERO: Doing Space Stuff

Research & Support
- Engineering Projects
- Research Projects

Facilities
- UHF/VHF antenna/station
- S-Band antenna/station
- Control Center
- Clean Rooms ...
1. Short feedback on Our Nanosats
   - Some examples
   - Should not seen as a big student project
   - A wide variety of tools and experts

2. Tools for a pre-design Analysis
   - Theorie: Concurrent Design Engineering
   - Many Existing Tools
   - Practice: Concurrent Design Engineering?

3. Nanostar CDF Software
   - Yet another CDF software...Emphasizing Standard Interfaces
   - Nanostar
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2 Tools for a pre-design Analysis

3 Nanostar CDF Software
3U Nanosats projects on the way (not only!)

- Entriesat
  - Phase D
- Eyesat
  - Phase D
- Nimph
  - Phase B1
3U Nanosats projects on the way (not only!)

- Entrysat
  - Phase D
- Eyesat
  - Phase D
- Nimph
  - Phase B1

- ~ 30 students/year
- ~ 5 engineers full-time
3U Nanosats projects on the way (not only!)

- Entriesat
  - Phase D
- Eyesat
  - Phase D
- Nimph
  - Phase B1

- ~30 students/year ~ 15 students/6 month
- ~4 engineers full-time ~ 2-3 engineers full-time
- Many engineers/teachers not full time at all
Some Feedbacks

Context of Academic Nanosats

- Student Projects
- Overbooked supervisors
- Experts on highly complex satellites
Some Feedbacks

Context of Academic Nanosats
- Student Projects
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- Experts on highly complex satellites

Lack of efficiency
- Lot of re-done work
- Communication issues
- Lack of team methodology
- Not adapted to bureaucracy
Mission Analysis

- GMAT
- Orekit
- Astropy
- RTK
- Celestlab
- Satorb
- SimuCIC
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ACDS

- Simulink
- Basile
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- Excel
- IDM-CIC

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### Radiation
- Fastrad
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### Structure
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### Link Budget
- AmsatXLS
- Satorb
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Visualisation
- Celestia
- VTS
- IDM view
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Requirements for a Preliminary Design
Many Existing Tools

[Di Domizio and Gaudenzi, 2008]
Many Existing Tools

- IDM-CIC
- IDM-View
- Simu-CIC
- Open format
Many Existing Tools

A-Team
- Trade Space Tools (Phoenix ModelCenter)
- Cost estimation tools (Excel)

Team X
(Concurrent Engineering Team)
- NExSys / Fredrik
- (Linked Excel workbooks)

Team Xc
(Concurrent Engineering Team)
- Phoenix ModelCenter
- (Linked Excel workbooks)

Study Management
- Fredrik

NASA
- Team-X
Many Existing Tools

C²ERES at Paris Observatory

- DOCKS
- Open format

In practice

Limits

- see The Dark Side [Braukhane and Bieler, 2014]
- Excel based
- “Friendly license” is not Open Source

Concrete usage (IDM-CIC and OCDT)

- Still redoing things
  - Versions management (Catia VS Sketchup VS Thermica)
  - Seen as supplementary work
- Interface with existings tools
- Heavy installation process
- Progress: STD, ergonomics, common base
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- Open Source
- Standards (CCSDS, ECSS, EDS...)

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Nanosat Preliminary Design - OSCW 2018
14 / 17
Nanostar SUDOE Project: http://nanostarproject.eu

NANOSTAR Consortium

- 7 Partners (Portugal, Spain, France)
- 2 aerospace clusters
- 2018-2020, 2 millions € budget
NANOSTAR Goal

- Provide relevant training on nanosat technology
- To provide a formation tool for students... and also engineers
- To support the emergence of nanosat environment
NANOSTAR work plan

- Setup a **collaborative platform**, with adapted software tools
- Setup geographically distant **Concurrent Design Facilities**
- Propose **student challenges** relevant for nanosats missions

Nanostar SUDOE Project: [http://nanostarproject.eu](http://nanostarproject.eu)
NANOSTAR project engaged

Software suite should be:
- Open-Source
- Cross-platform
- Standardized

Validated on student challenges

Next steps

Required software suite for a whole nanosatellite project
- Mission analysis
- Simulation
- Operation

Pragmatic approach. Compromise: massive re-using

Focus on data exchange interface & standards

Any advice is welcome
Thank you for your attention!

Any question?

Special thank to Lucien Senaneuch!
The dark side of concurrent design: A story of improvisations, workarounds, nonsense and success.
In 6th International Conference on Systems and Concurrent Engineering for Space Applications, Stuttgart, Germany, pages 8–10.

A model for preliminary design procedures of satellite systems.
Concurrent Engineering, 16(2):149–159.