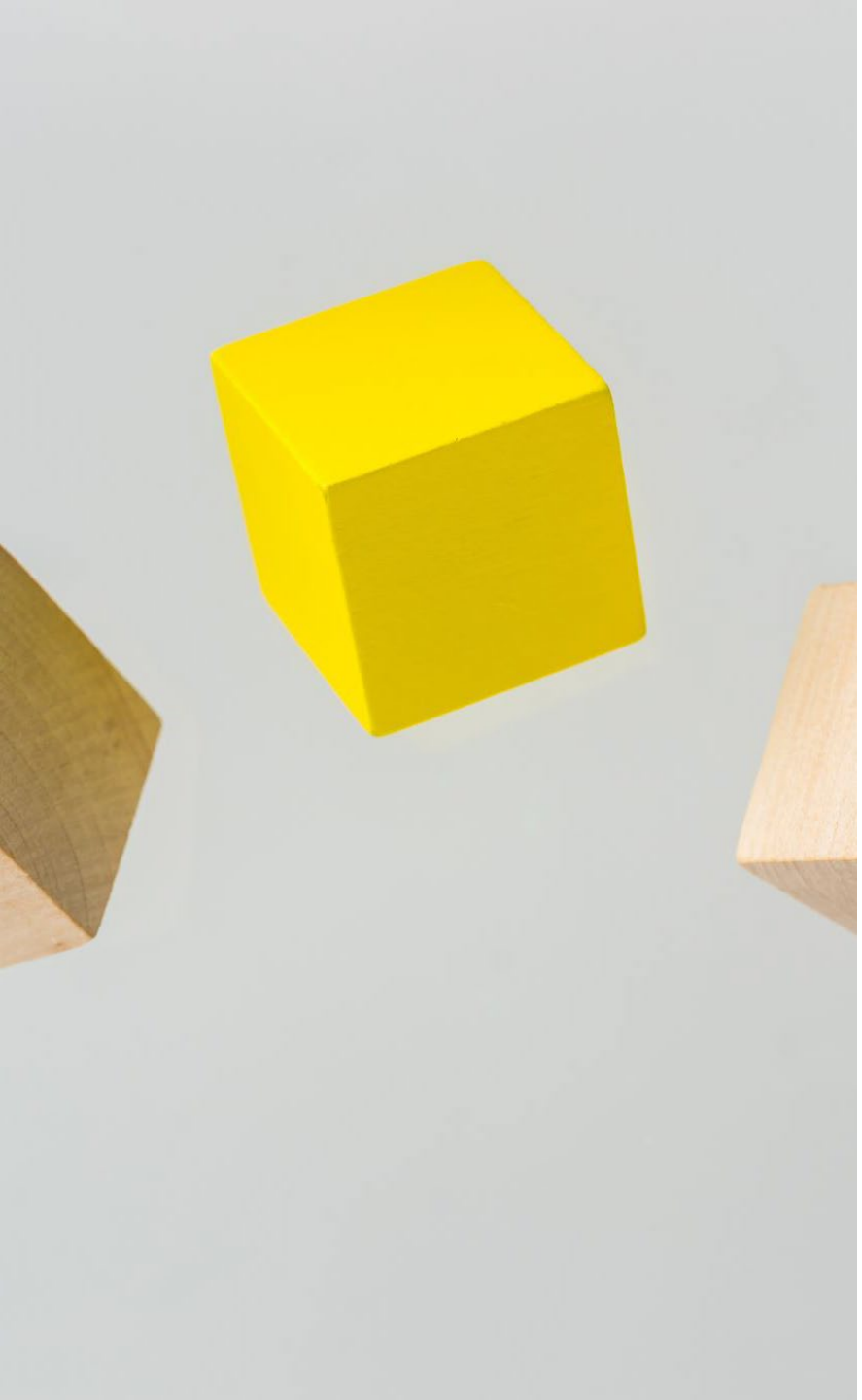

Cubesat development: enthusiasm, clock reset and collective intimacy for innovation

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- Cubesat development in universities seen from the perspective of Science and Industry
- Interviews with developers from 6 countries (Greece, UK, France, Belgium, China, USA).
- A potential disruption of the industry and a paradigm shift in scientific projects

Three learnings from cubesat development

Enthusiasm for contributing to a potential paradigm shift

Developing **a place for collective intimacy** to host a living process for technological development

“**Clock reset**” of the spacecraft development history through selective knowledge reuse and innovation

The limits of standard technological management

Project Management

- initially conceived for “routine workers” not “experts” like “artists, designers, engineers, investigators, and inventors”, (Gantt Chart, Gantt, 1919, p. 289)
- Issue with original missions: defining the tasks as the projects advances (exploration)

Modular architecture of technologies

- “The designers of modular systems must know a great deal about the inner workings of the overall product or process” (Baldwin and Clark, 1997, p. 86)

Interviews

for those who expect a standard process:

- An “anathema” for the space industry
- An “error of youth”

or those who embrace the exploration:

- “you were getting to see the overall product fully built and building it was quite nice”
- Teams enjoy a great autonomy in the development process, as one cannot expect that industrial standards will apply as usual.

→ **Standard management norms just provide some structure**

An example from UPSat development

Source: Chrysos and Desouza, 2019

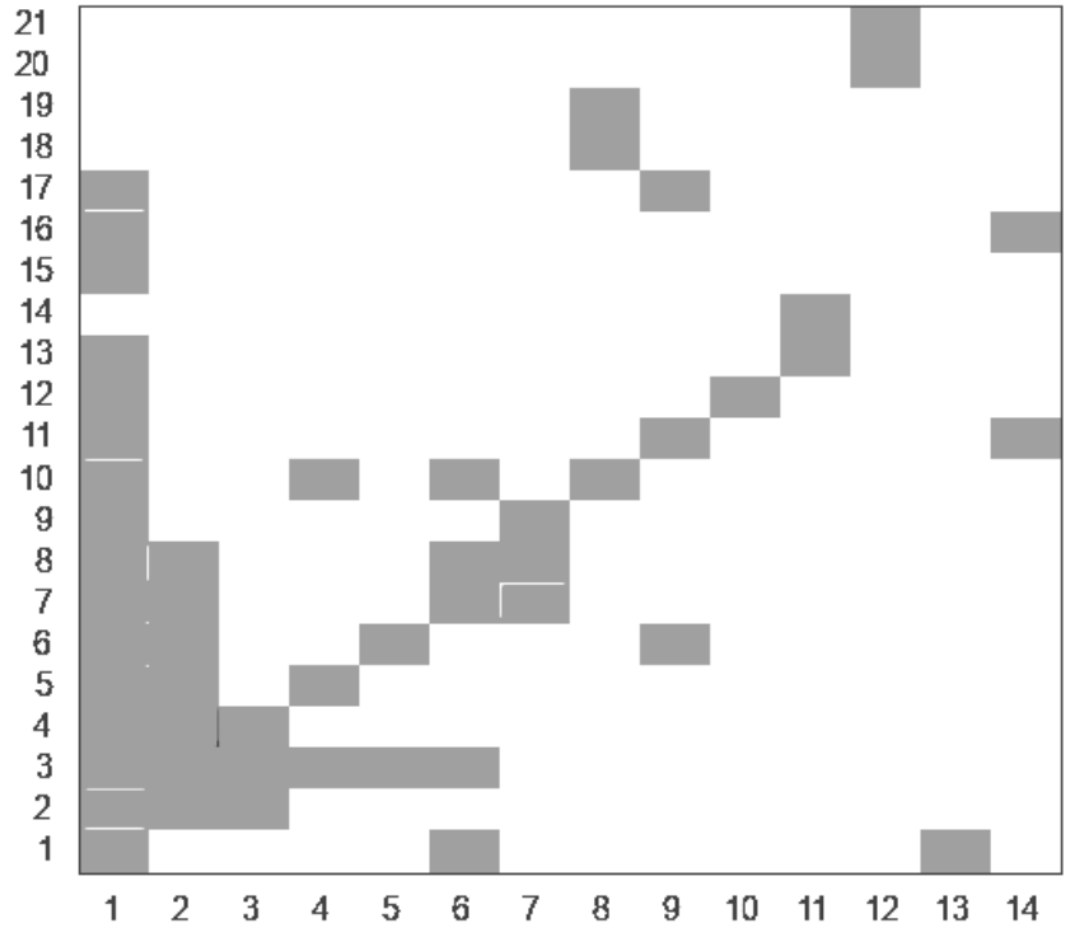


Figure 3. Employment of the Contribution Matrix to the UPSat development. During the last development phase, the UPSat system was composed by 21 elements, which required the collaboration of 14 contributors.

Enthusiasm fuels space exploration with Cubesats from Universities

"It started as an educational project. And that's part of why the innovation kind of worked" (Prof. Puig-Suari)

"Believe it or not, it all started by our students" (UPSat PI)

"Be the first to…"

Cubesat development is a living process:

a challenge for "outsiders"	a dream for personal fulfillment and accomplishment	the "magic" of developing something that will go to the sky	an opportunity to put one's skills in action and expand them (not a routine project)	Pride to participate, especially when development "the first satellite to…' (original missions

Issue

while the project inspires **pride**, how to deal with **egos**?

Example

an engineer wanted to make the On-Board Computer **perfect**, **delaying** the integration and testing of the overall cubesat.

A place for “collective intimacy”

- “Collective intimacy”: **in-between** the public and the private spheres (like a coffee shop).
- A place where **new identities** can be explored, both personal and technological – a place of becoming… (Chrysos, 2019)
- “***there can’t be any ego****, everyone is learning and teaching from each other*” - “*We have a couch, chairs, and a place where people can come in and listen to music … I’m trying to make it more …* ***a place where you want to be***” (LunaH-Map PM)
- Code reviews: “*The guys were like, ‘I’ll get naked in front of the others*’ (UPSat PM)

→Mission accomplishment and personal fulfillment go hand-by-hand

→Functional value: unexpected issues can be shared as they appear in the process.

Resetting the clock

- “Is this a real satellite”? (Open and user innovation conference, 2019)
- Not everything fits into the box
- “Transposing” elements of a standard satellite at the nano level
- It’s like “making a fresh start”.

Resetting the clock : A slow disruption ?

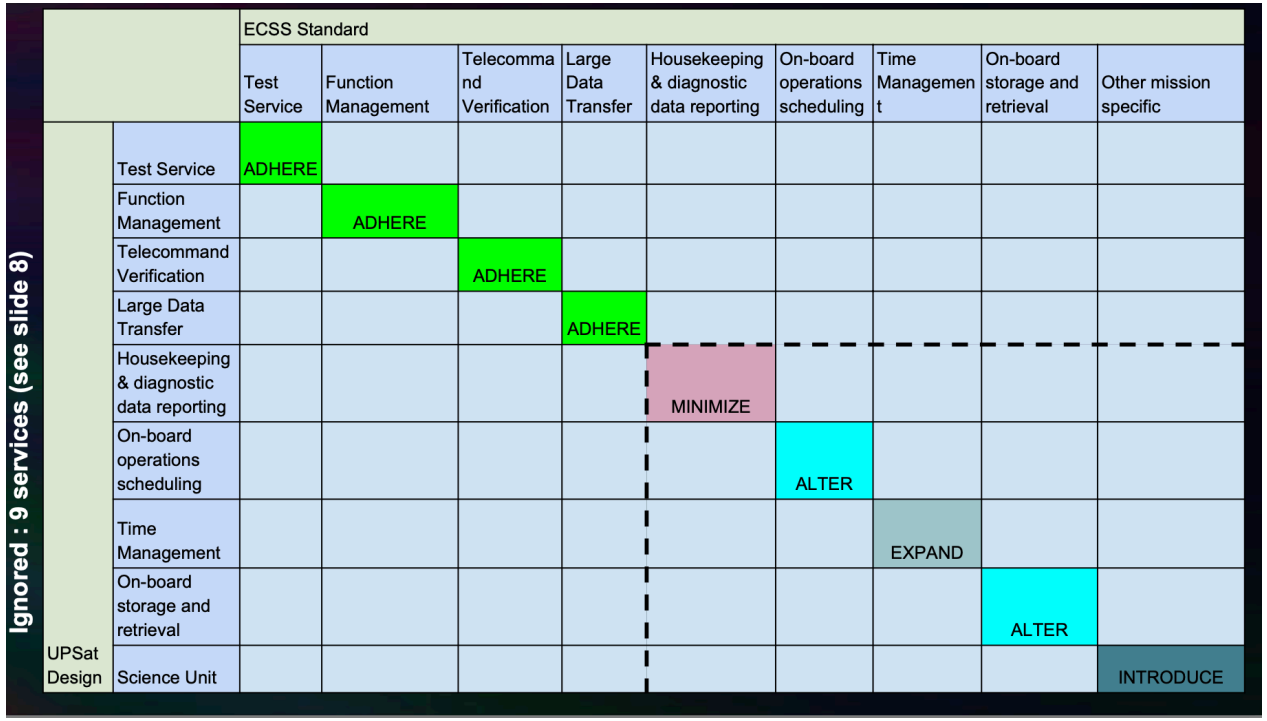
By using off-the-self chips, Cubesat development:

- follows Moore's Law, doubling chips capabilities every 18 months
- costs a fraction of the standard satellites' costs
- development is much faster

*"If you're going to build **very large expensive satellites**, from the time you decide to build them until the time you're getting it built you're using **old technologies**. but the turnaround time with the **CubeSats** is so short you can use **current technologies**"*
(Prof. Twiggs).

Resetting the clock: a paradigm shift?

- "*How an individual invents (or finds he has invented)* ***a new way of giving order to data now all assembled*** *– must remain inscrutable and may be permanently so. Let us here note only one thing about it. Almost always the men who achieve these fundamental inventions of a new paradigm have been* ***either very young or very new to the field*** *whose paradigm they change.*" (Kuhn, 1970, p. 90)



Source: Chrysos, Chronas-Fotakis and Masiakos, 2018

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