

# Contribution Matrix: a method to analyze the structure of technological contribution

An application on the case of the development of UPSat

**Paris Chrysos**

ISC Paris Business School, France

ECE NTUA, Greece

paris.chrysos@iscparis.com

**Kevin C. Desouza**

QUT Business School Queensland University of Technology, Australia

kev.desouza@gmail.com



The 17th International Conference

July 8-10, 2019, Utrecht

# Presentation Plan

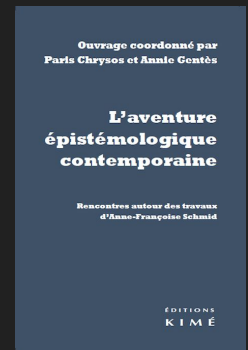
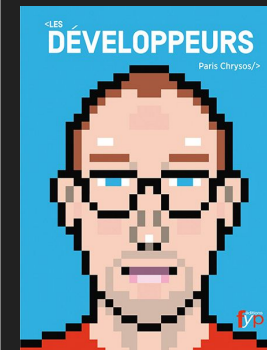
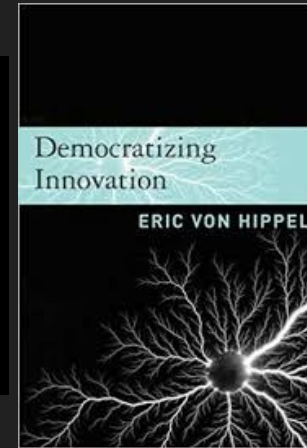
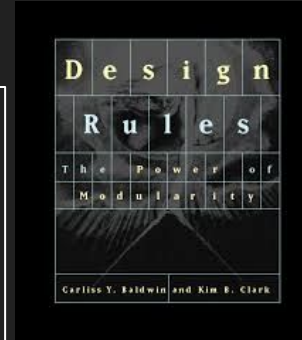
1. Overview of the challenges tackled
2. Methodological applications of Graph Theory
3. Employment of the Contribution Matrix (CM)

# Overview

Theoretical Challenges  
Technological Challenges  
A way to tackle them

# A two-fold theoretical challenge

1. The Design Matrix (Baldwin and Clark 2000; Steward 1981) is good for rationalized systems (Colfer and Baldwin 2016; Chrysos, 2013) **BUT** other methods are needed for **emerging technology analysis.**
2. The distinction between user and manufacturer (von Hippel, 1977; 1994) is good when there's a design division between use-related and technology-related innovation **BUT** in Developer Innovation (Chrysos, 2013; 2015) **technologies are developed in a personal manner.**



# Research Question And Context

Does the social structure of the development of technical systems correspond to the dependencies of the resulting systems ?

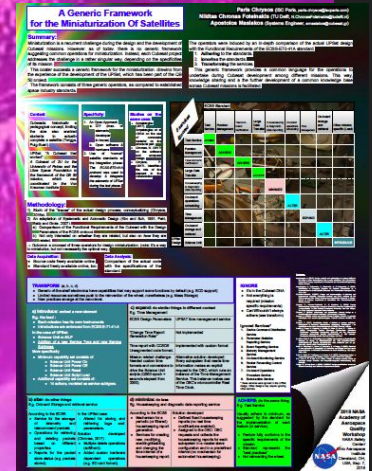
- History: Pioneering work of Bob Twiggs and Jordi Puig-Suari
- R.C. between
  - QB 50 (Von Krauman Institute, EU Commission)
  - University of Patras (UP) & the LSF

Objective:

- Measure the Thermosphere (RC for RC for R)

Useful particularities

- UP followed a DIY approach → “much” development (less consumption)
- LSF introduced an Open Source approach → no trade secret, greater access to knowledge as a third party.
- The team used GitHub → we can analyze the “monument” (Chrysos, 2016) of the RC.
- Had a delivery date



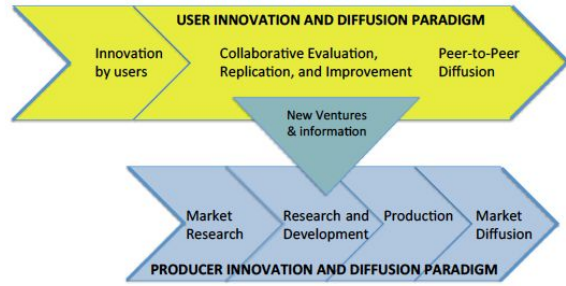
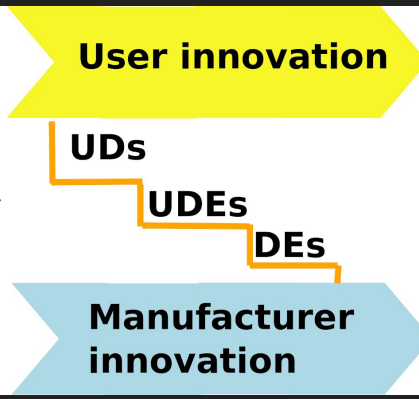


Figure 1: The user and producer innovation and diffusion paradigms

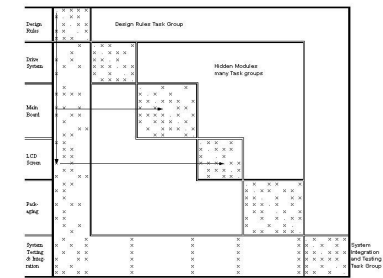
Von Hippel and Raasch, 2012



Chrysos, 2013

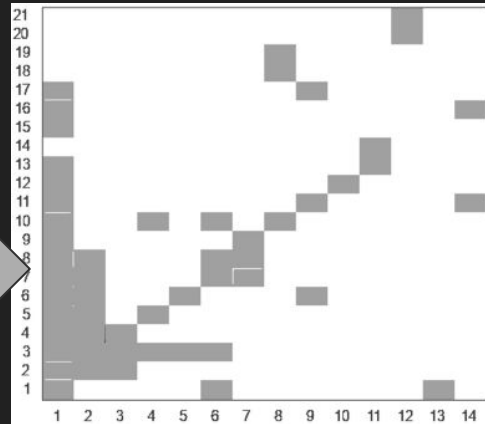


Design Structure Matrix Map of a Modular System



Slide 19

© Carlin Y. Baldwin and Kim B. Clark, 2003



# Methodological Applications of Graph Theory

NxN Graphs and DSM  
NxM Graphs and CM

# NxN matrices : Design Structure Matrix, Actor-Network Matrix

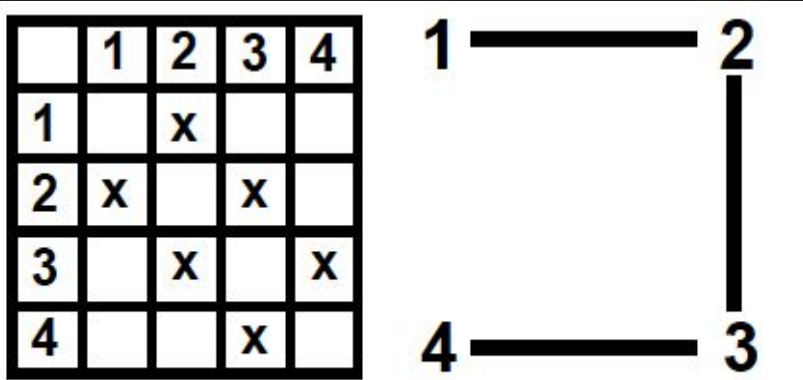
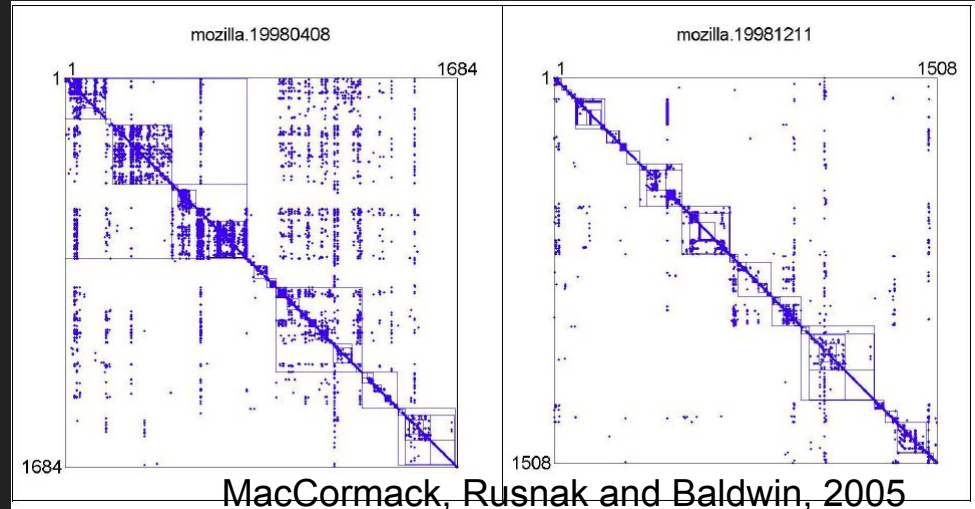


Figure 1. Two ways to represent the DSM. As an illustration, we suppose four elements in this example having three connections.



Howison and Crowston, 2014: Single programmers working on one task

LIMITS: “when the underlying technologies are rapidly changing and becoming more complex, breaking away from the logic of strict mirroring can lead to better technical performance and competitive advantage” (Colfer and Baldwin, 2016)



# Contribution Matrix : NxM (Features x Contributors)

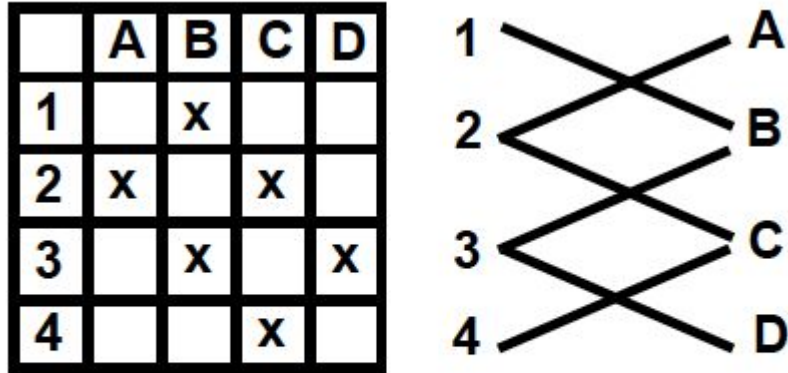
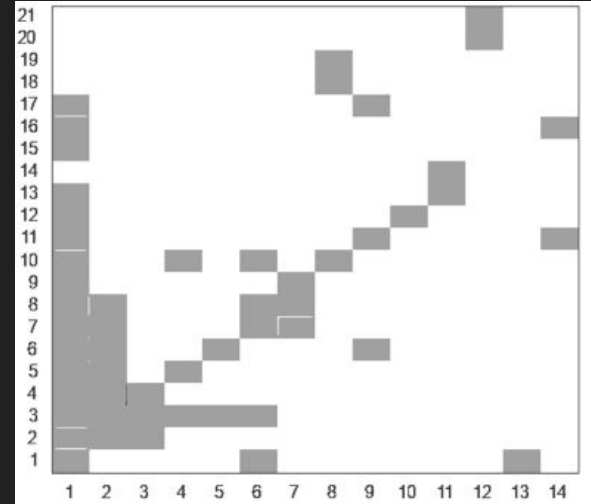


Figure 2. Two ways of representing the CM for 4 features (1..4) and four agents (A..B). In this example, we see two collaborations for contribution (A with C for the development of the feature 2 and B with D for the development of the feature 3).



Chrysos and Desouza, 2019

# Employment of the CM on the UPSat case

“Monuments of the Cyberspace” (Chrysos, 2016)  
Relating CM to other methods

# Studying the “monuments of cyberspace” (Chrysos, 2016)

The screenshot shows the GitHub repository page for 'librespacefoundation / upsat-obc-software'. The repository name is circled in blue and labeled 'Name of the feature'. Below the repository name, the text 'OBC software for UPSat' is circled in blue. The repository statistics show '369 commits' (circled in purple), '2 branches', '2 releases', '3 contributors' (circled in red), and 'GPL-3.0' license. The commit history is visible, with the first commit by 'mashua' (circled in red) and 'ppapadeas' (circled in red) titled 'IAC, Camera GPIO off by default. (#49)' (circled in red). The commit message 'finished functionality in time management' (circled in purple) is labeled 'Contribution' in purple. The commit date '2 years ago' (circled in purple) is also labeled 'Contribution' in purple. The commit by 'cubeMX' is dated 'a year ago'. The initial commit is dated '2 years ago'.

**Name of the feature**

OBC software for UPSat

**Number of contributors**

369 commits 2 branches 2 releases 3 contributors GPL-3.0

Branch: master New pull request Find file Clone or download

**Names of contributors**

mashua committed with ppapadeas IAC, Camera GPIO off by default. (#49) a year ago

cubeMX IAC, Camera GPIO off by default. (#49) a year ago

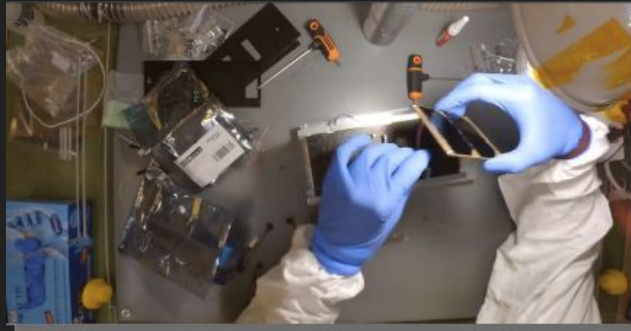
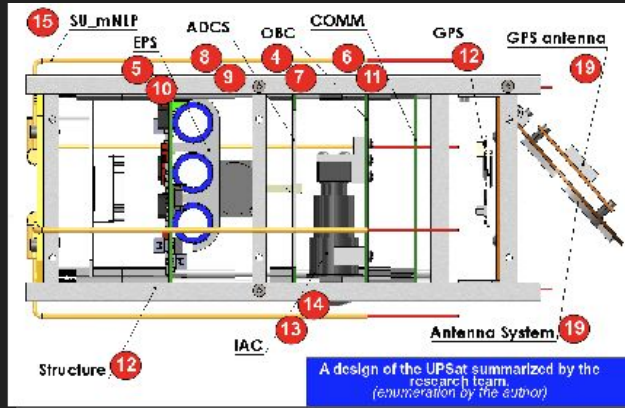
finished functionality in time management 2 years ago

fixed hk service and added tests 2 years ago

Initial commit 2 years ago

**Contribution**





Feature code name	Description	
1	lsf-kicad-libs	Auxiliary resources for the development of the satellite.
2	packetCraft	A setting to test the communication among the different parts of the satellite.
3	ecss-services	A way to implement normal card file standards to the LP-Sat.
4	upsat-obc-software	The software for the computer of the satellite.
5	upsat-eps-software	The software for the power system.
6	upsat-comms-software	The software for the communication with the Earth.
7	upsat-obc-hardware	The designs of the hardware of the computer.
8	upsat-adcs-software	The software for the navigation of the satellite in space.
9	upsat-adcs-hardware	The hardware for the navigation of the satellite in space.
10	upsat-eps-hardware	The hardware for the power system.
11	upsat-comms-hardware	The hardware for the communications system.
12	upsat-structura	The actual "box" of the satellite.
13	upsat-iac-software	The software for the camera.
14	upsat-iac-arsible	The software for the camera.
15	upsat-sa-breakout	The instrument to measure the Thermosphere.
16	upsat-plotter	A program to print the output of the satellite.
17	electores	A first attempt to develop a the communication system.
18	HeaterBoard	A system to regulate the temperature of the battery.
19	UPSatDeployTestBoard	A system to deploy the antennae once in orbit.
20	lsf-org	The website of the LSF.
21	upsat.org	The website dedicated to the project.

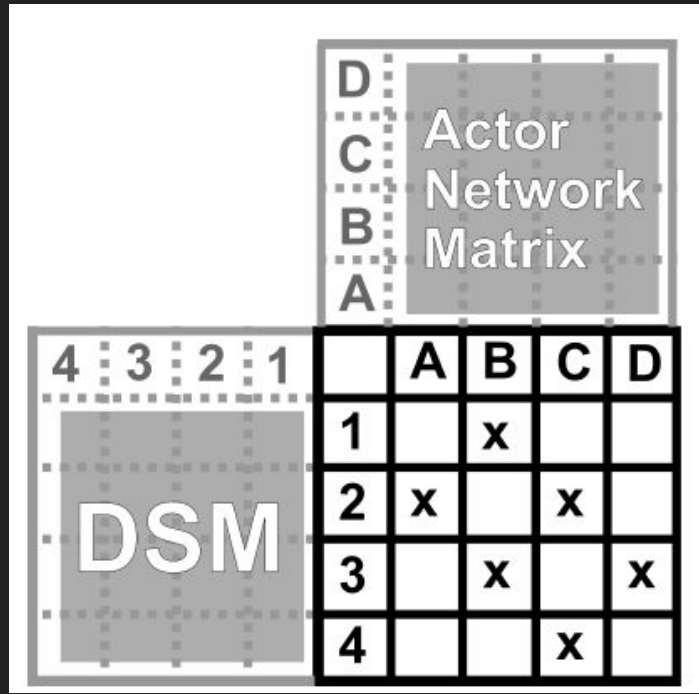
Table 1: The features of the UPSat and their description.

# Applying the method

```
{
  "sha": "a04902fc894e9c22d39a4b5e92af9874f256e941",
  "commit": {
    "author": {
      "name": "Apostolos D. Masiakos",
      "email": "amasiakos@gmail.com",
      "date": "2016-08-11T22:36:24Z"
    },
    "committer": {
      "name": "Pierros Papadeas",
      "email": "ppapadeas@gmail.com",
      "date": "2016-08-11T22:36:24Z"
    },
    "message": "IAC, Camera GPIO off by def",
    "tree": {
      "sha": "52eb81a27809c99e1043f81f528cb",
      "url": "https://api.github.com/repos/trees/52eb81a27809c99e1043f81f528cbfd200d13f8"
    },
    "url": "https://api.github.com/repos/commits/a04902fc894e9c22d39a4b5e92af9874f256e941",
    "comment_count": 0
  },
  "url": "https://api.github.com/repos/liba04902fc894e9c22d39a4b5e92af9874f256e941",
  "html_url": "https://github.com/Librespac"
}
```

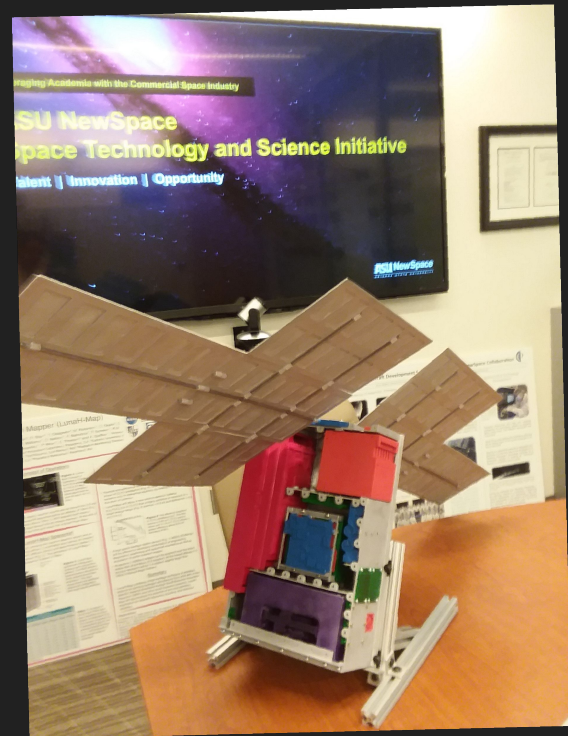
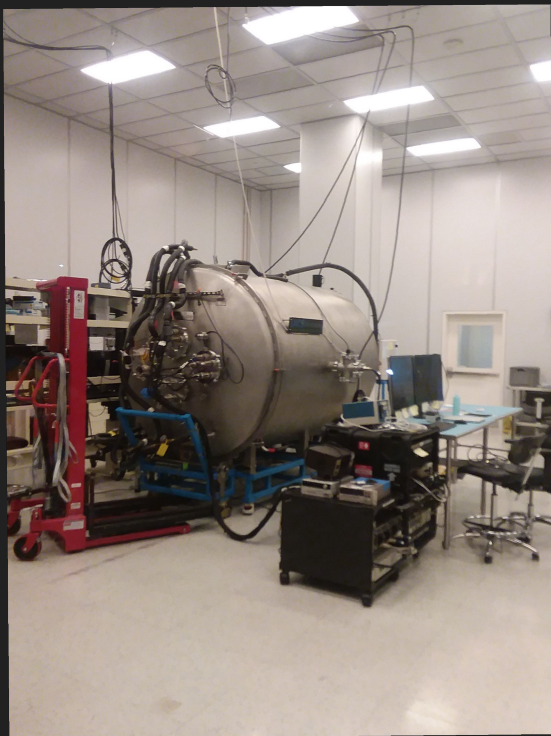
Project	diactoros	gms-services	gms00-geduchield	HeaterBoard	librespacefoundation.org	lib-kicad-lits	tsf-org	packerCraft	gmsan-source	upsat-adsb-software	upsat-commis-software	upsat-commis-software	upsat-obs-software	upsat-iac-software	upsat-iac-software	upsat-obs-hardware	upsat-obs-software	upsat-org	upsat-pioneer	upsat-structural	upsat-su-breakout	UPSatDeploymentBoard	upsat-ocswrt
diactoros	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
gms-services	0	0	0	0	0	0	0	0	0	56	227	0	4	0	8	44	0	0	0	0	0	0	0
gms00-geduchield	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
HeaterBoard	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
librespacefoundation.org	0	0	0	0	9	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
lib-kicad-lits	0	0	5	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	1	0
tsf-org	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
packerCraft	0	0	0	0	0	0	69	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
gmsan-source	0	0	10	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
upsat-adsb-software	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0
upsat-commis-software	0	0	0	0	0	0	0	0	0	9	0	1	0	0	0	7	83	0	0	0	0	0	0
upsat-commis-software	0	0	0	0	0	0	0	0	0	12	0	6	15	0	0	0	0	0	0	0	0	0	0
upsat-obs-software	0	0	0	0	0	0	0	0	0	8	0	18	0	3	0	101	0	0	0	0	0	0	0
upsat-iac-software	0	0	0	0	0	0	0	0	0	0	2	0	1	0	50	0	0	0	0	0	0	0	0
upsat-iac-software	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
upsat-iac-software	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
upsat-obs-hardware	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	1	17	0	0	0	0	0
upsat-obs-software	0	0	0	0	0	0	0	0	0	0	97	269	0	3	0	0	0	0	0	0	0	0	0
upsat-org	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
upsat-pioneer	0	0	0	0	0	0	0	0	0	0	0	1	6	0	0	0	0	0	0	0	0	0	0
upsat-structural	22	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
upsat-su-breakout	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
UPSatDeploymentBoard	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
upsat-ocswrt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

# Integrating the different methods



# References

- Baldwin, C. Y., & Clark, K. B. (2000). *Design Rules, Vol. 1: The Power of Modularity (First)*. Cambridge, MA: The MIT Press.
- Chrysos, P. (2013). *When users create industries: the case of Web-based applications*. Mines-ParisTech.
- Chrysos, P. (2015). *Les développeurs*. Paris: FYP.
- Chrysos, P. (2016). *Monuments of cyberspace: Designing the Internet beyond the network framework*. *First Monday*, 21(12). <https://doi.org/10.5210/fm.v21i12.7112>
- Chrysos, P. (2017). *Contribution Matrix: A Method to Analyze Individual Participation in Research Collaborations Developing Technologies - An Application on the Case of the Development of UPSat*. Phoenix, Arizona.
- Chrysos, P., & Gentes, A. (2016). *L'aventure épistémologique contemporaine*. (P. Chrysos & A. Gentes, Eds.). Paris: Presse des Mines.
- Colfer, L. J., & Baldwin, C. Y. (2016). The mirroring hypothesis: theory, evidence, and exceptions. *Industrial and Corporate Change*, 25(5), 709–738.
- Howison, J., & Crowston, K. (2014). *Collaboration Through Open Superposition: A Theory of the Open Source Way*. *MIS Quarterly*, 38(1), 29–50.
- MacCormack, A., Rusnak, J., & Baldwin, C. Y. (2006). Exploring the structure of complex software designs: An empirical study of open source and proprietary code. *Management Science*, 52(7), 1015-1030.
- Steward, D. V. (1981). The design structure system: A method for managing the design of complex systems. *IEEE Transactions on Engineering Management*, EM-28(3), 71–74. <https://doi.org/10.1109/TEM.1981.6448589>
- Von Hippel, E. (1977). The dominant role of the user in semiconductor and electronic subassembly process innovation. *IEEE Transactions on Engineering Management*, (2), 60-71.
- von Hippel, E. (1994). "Sticky Information" and the Locus of Problem Solving: Implications for Innovation. *Management Science*, 40(4), 429–439. Retrieved from <http://www.jstor.org/stable/2632751>
- von Hippel, E. (2005). *Democratizing innovation*. Cambridge, MA: The MIT Press.
- Von Hippel, E. (2016). *Free innovation*. MIT press.



# Acknowledgements

Many thanks to the participants the seminar at COD, School of Public Affairs, ASU (November 2017) for their comments and suggestions and to the developers of the UPSat for sharing their knowledge.



# Thank you!

Paris Chrysos

<http://parisx.me>

@xparis

[paris.chrysos@iscparis.com](mailto:paris.chrysos@iscparis.com)