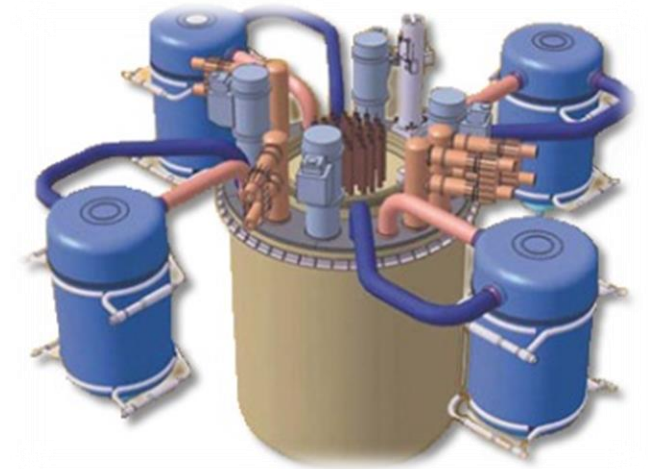


“Back to the future”: The importance of scales in the development of new nuclear infrastructure



Stéphanie Tillement, IMT Atlantique
Frédéric Garcias, Lille University



Empirical context

Le Monde
Nucléaire : la France abandonne la quatrième
génération de réacteurs
Un réacteur à neutrons rapides est mis à l'arrêt en catimini par le Com
un coup dur pour l'avenir de la filière.



- **2009**: decision of the French government (part of the “investissements d’avenir” national plan) to **restart the SFR program in France** with a project of ‘**industrial demonstrator**’ steered by CEA: **ASTRID**

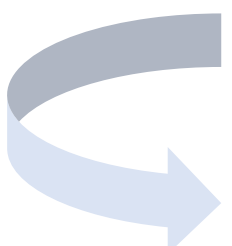


- **2010**: Launch of ASTRID project → A consortium with CEA, Framatome & EDF to design and develop ASTRID is settled




- **2019**: decision of the CEA & the French government to stop the ASTRID reactor project and to postpone decisions regarding ‘GEN IV’ technology

“Astrid is dead. We no longer devote resources or energy to it.” (internal source from the CEA)

- 
- ▶ **?** How can we explain, both theoretically and practically, the failure of ASTRID?
 - ▶ **?** What lessons can be drawn from the analysis of ASTRID trajectory regarding the ability of nuclear projects to meet expectations?

Theoretical background: which framework to study ASTRID trajectory and failure?

- Viewing the ASTRID reactor as an infrastructure under development... and focusing on the project infrastructure for developing ASTRID
 - A rich literature in STS on 'infrastructures'...
 - ... but a gap on the matter of 'scales': **a major challenge when developing a new infrastructure consists in bridging scales**
 - 3 dimensions of scales: large/small, global/local, long-term/short-term
 - *"bridging [these] three kind of scales present central challenges with which any effective practice and theory of infrastructure must come to terms"* (Edwards & al, 2009)
 - Research question: A need for 'scale alignment' when developing infrastructure? How to achieve scale alignment?
- ▶  the analysis of the ASTRID project can contribute to a better understanding of how a project can fail in meeting expectations

Collected data

- Main source of data:

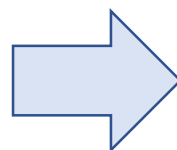
-AGORAS ANR program (2014-2019) on post-Fukushima impacts

-Focus on new reactors development and sodium technology

-Interviews mainly with Framatome designers + IRSN regulators

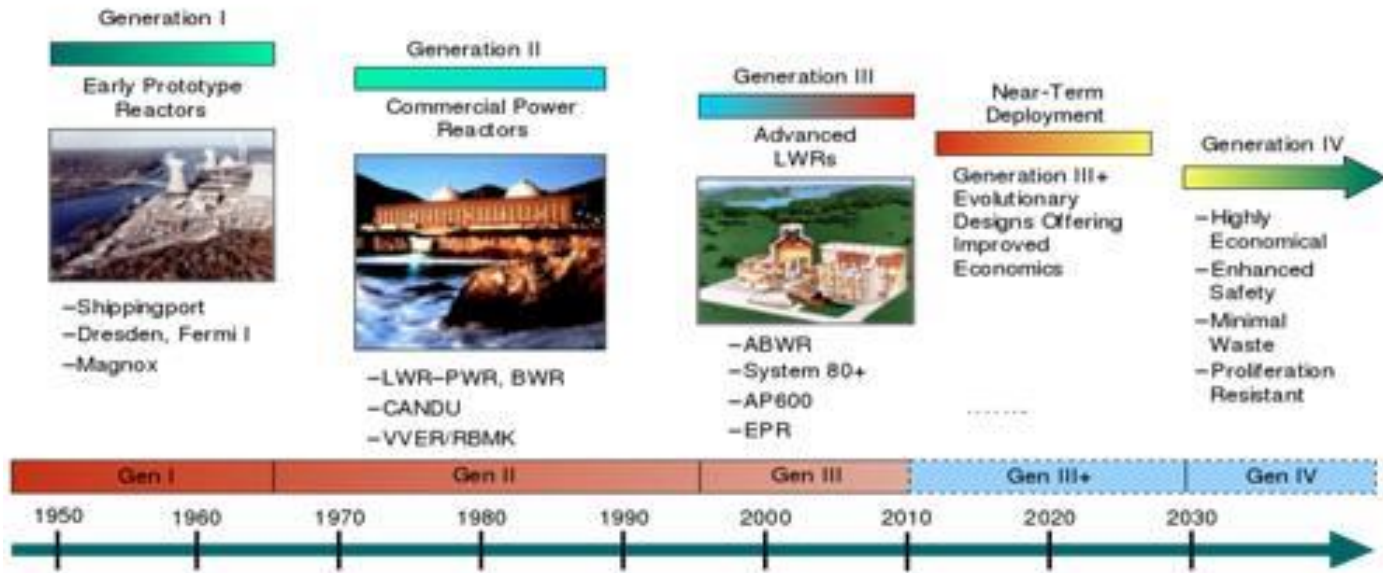
-No direct access to CEA

- Data collection



| | Data collected and Time of collection | Analysis and use in theory development |
|---|---------------------------------------|--|
| Interviews | | |
| Individual recorded interviews (90 to 150 min) | TOTAL: 28 interviews | Transcribed interviews coded: close examination of qualitative data to name and categorize phenomena. Continual and longitudinal review of data to categorize the “sensitizing concepts” and the relations between them, in order to identify shifts in the project year after year and possible “turning points” affecting the course of the project relations between local ASTRID infrastructure and global nuclear infrastructure narratives related to ASTRID, Gen IV and nuclear “of the future”, and their evolution in time, according to the organization of the interviewee |
| Ex-AREVA (ASTRID project team) | 20 interviews | |
| Project manager (PM) | 2015, 2016, 2017, 2019 | |
| Functional architect (FA) | 2015, 2016, 2017 | |
| Civil engineering techn. manager (CEM) | 2015, 2016, 2017 | |
| Nuclear core techn. manager (NCM) | 2016, 2017 | |
| Mechanical techn. manager (MTM) | 2017 | |
| Technical engineer (SCE) | 2017 | |
| Project safety engineer (PSE) | 2015, 2017 | |
| Safety engineer 1 (SE1) | 2015, 2017 | |
| Safety engineer 2 (SE2) | 2017 | |
| IRSN (safety experts) | 5 interviews | |
| I1,I2 | 2014 | |
| I3 | 2014, 2017 | |
| I4 | 2017 | |
| EDF (engineers) | 3 interviews | |
| E1,E2,E3 | 2014 | |
| Focus-groups (lasting from 3h30 to 7h) | | |
| “Politics”: 4 participants (P1, P2, P3, P4) | 4 meetings | Transcription of discussions. Understanding the history and trajectory of French nuclear sector Identifying, how each interviewee, according to its social world, accounts for nuclear of the future (Gen IV) and more precisely on ASTRID and its possible place in the French energy landscape |
| “Research & Development”: 5 participants (R1, R2, R3, R4, R5) | 15 participants in total | |
| “Academic”: 6 participants (A1, A2, A3, A4, A5, A6) | | |
| Collective final workshop (all previous participants) | | |
| | | |
| Documents | | |
| Legal reports (CEA reports of 2012 and 2015 related to the law of 2006) | 656 pages | Understanding structural and institutional context. Identifying formal roles, responsibilities and coordination mechanisms Analyzing “master narratives” associated with ASTRID and their evolution in time |
| Internal documents from project team | | |
| Scientific and technical publications | | |

A “master narrative” at the genesis of ASTRID




- **Sodium Fast Reactor, the reference option : [ASTRID, the technology demonstrator]**

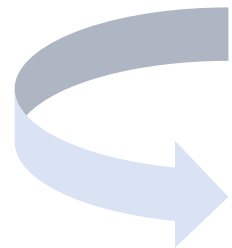
- *maturity, possible further improvements (safety, operability, economics)*

A timeline of reactor projects from 1967 to 2030. It shows RAPSODIE (1967-1983), PHENIX (1973-2010), SUPERPHENIX (1985-1998), EPR (1988-1998), ASTRID, and a Commercial reactor. The timeline is represented by a grey arrow pointing right.

- A linear succession of reactors’ “generations” with a gradual improvement of technology
- **ASTRID**: an “industrial demonstrator” aimed at accelerating the realisation of the promises of Generation IV reactors ► *less waste, less fuel consumption, the promise of a closed cycle, a nuclear technology that plays a key role in the fight against global warming.*

Departing from the master narrative: a gradual drift towards ambiguity at all scales of the project infrastructure

- From the beginning of the project: a ‘floating’ identity
 - ▶  exploratory prototype or industrial reactor? (cf. Tillement & al, 2019, PMJ)
- A drift from master narrative to ambiguity embodied in all scales of ASTRID project infrastructure
 - “What is Astrid for ?”(CEM, 2016)
 - Temporal dimension: schedules, deadlines, temporal structure
 - Social organization: Network of actors and organizations
 - “There is something paradoxical about an industrial-scale project managed by a research institution. There is a kind of anomaly somewhere. But the anomaly made it possible to do the project” (PM, 2019)
 - Practices: design strategies, engineering methods
- Ambiguity reflected in, and reinforced by, technical choices
 - a turning point in ASTRID trajectory, the decision of CEA to explore the ‘gas-PCS solution’ in 2017



“We have difficulty knowing how we should organize our studies in a very concrete way, what path we should give them, that is our role today. [...] We do a lot of prospective studies, very high-flying studies and at the same time we are still trapped in a work program that was initially called the basic design phase 2016-2019, it was anchored as a study phase where we start a detailed design in 2018-2019. Today, when we see what state we are in, it is clearly not a detailed design that we can make at the beginning of 2018... in terms of technical maturity, especially on gas, but not only, we are still asking ourselves real questions about the economic viability of the project, there would undoubtedly still be work to be done on reducing costs, on reallocating certain requirements, we are there today, at the point of redoing the value analysis. [...] We are not starting a basic design, unlike what we still see sometimes on some CEA presentations that overshoot the notions of “basic design” that would be completed by the end of 2019. That is absolutely out of reach. It’s hard sometimes to know where we’re taking our studies.” (CEM, 2017)

Discussion (1/2)

Theoretical
interpretation
of results

- Interpretation of the gradual drift and final failure of ASTRID: a **collective inability to achieve 'scale alignment'**
- A decoupling between ASTRID local project infrastructure and global French nuclear infrastructure regarding
 - **Time scales:** agenda of ASTRID vs agenda of nuclear organizations (not the *momentum* for GEN IV)
 - **Organizational actors:** CEA steering an 'industrial project', with the support of EDF & Framatome : a project not aligned with the organizational structure of 'normal' French nuclear infrastructure
 - **Design practices and technological choices:** ASTRID as chimeric project between 'new SPX' and something new
- This misalignment explains the increasing instability of the ASTRID project, the troubles experienced by designers in making sense of it, and therefore, probably, its final failure.

Discussion (2/2)

Managerial & societal implications

- Implications for practice:
 - Aligning the project infrastructure with the project identity: the key role of steering committees and consortium regulation in achieving scale alignment?
- Socio-political implications: how to engage vis-à-vis an industry that is both **intermittent and contested?**
 - The importance of scenarios in bridging the various dimensions of scales (temporal, local/global, political/industrial)
 - The current limitations of electronuclear scenarios (unable to make visible crucial stakes - such as socio-organizational dimensions –, interdependencies and impacts of (non)-decisions)

Thanks for your attention!!

“Back to the future”: The importance of scales in the development of new nuclear infrastructure



Stéphanie Tillement, IMT Atlantique
Stephanie.tillement@imt-atlantique.fr
Frédéric Garcias, Lille University

