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Reassembling an ecology of digital platforms: From interoperability towards convergence

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Reassembling an ecology of digital platforms: From interoperability towards convergence[1]

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The sociological analysis of digital platforms and infrastructures has almost always been carried out through methodological atomism. They have been observed as unconnected and isolated objects and the issue of their interconnection has been largely neglected. Yet, the topic of interoperability is very relevant today and calls for sociological contribution, especially in the wake of the challenges posed by the Covid-19 pandemic.

This preliminary paper aims at experimenting with an ecological gaze on digital platforms and infrastructures. An attempt has thus been made to move the focus from the microscope slide isolating each platform to the wider interconnected ecological tangle they chorally perform. To observe reassemble the ecology, the technical concept of 'interoperability' has been followed and three stories of interoperability have been described. These stories have been collected at a large university in central Italy.

The research shows that the interconnection between platforms happens as an intertwining of technical and social aspects. In the stories collected, interoperability is inscribed with values, hidden cultures, beliefs that express normative ideas and orders of value. Also, it is practically accomplished through collaborative processes, articulation of work and ruses. Digital platforms are thus performative not only as isolated entities: the convergence between platforms – i.e., the ecological 'coming together' of platforms – does work on the world too and is endowed with its own agency. Such convergence is dense with values, never detached from social processes, and happens around more or less opaque seams.

1. DATA, INFRASTRUCTURES, PLATFORMS, STANDARDS AND THEIR INVISIBLE WORK

Scientific research is today engaged in complex challenges: it is increasingly global, transnational and digital. *Data and metadata*[2] are deluging and positioning as crucial objects on the boundary between communities of practitioners and contexts. They are a crucial resource for e-Sciences, i.e. computationally-intensive sciences that draw on big data, and for researchers using metadata for bibliographical purposes; they are exploited by policy-makers for evidence-based decisions; they are deemed useful for assessment, evaluation and funding purposes; they rearrange organisational tissues and give rise to new professional forms (e.g., 'data management', 'data governance', 'data stewardship'); etc.

Data is increasingly stored and arranged into *information infrastructures* such as databases or the internet of things. Infrastructures can be considered as complex and sociotechnically imbricated assemblages (Landri 2018):

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[2] Metadata can be broadly considered as 'data about data' (Kitchin 2014).

modular, multi-layered, (…) not systems, in the sense of fully coherent, deliberately engineered, end–to–end processes. Rather, [they] consist of numerous systems, each with unique origins and goals, which are made to interoperate by means of standards, socket layers, social practices, norms, and individual behaviors that smooth out the connections among them. (Edwards et al. 2013:5)

Science and Technology Studies (STS) scholars traced some dimensions configuring most *infrastructures* (Star and Ruhleder 1996; Mongili and Pellegrino 2014; Karasti and Blomberg 2018). First, they emerge in relation to situated practices – they cannot be intended «as a thing stripped of use» (Star and Ruhleder 1996:113). They thus are embedded inside other sociomaterial arrangements, imbricated in the conventions and learning paths of communities of practitioners, constantly accreting on installed bases. Moreover, infrastructures are intrinsically invisible, unless in case of breakdowns. Connectedness is another dimension which configures infrastructures. They are «pervasive enabling resources in network form (...) that allow knotted work to be executed» (Bowker et al. 2010:98).

Digital *platforms* are very pervasive today. Also, they are frequently taken for granted and invisible. According to Jose van Dijk and colleagues, they can be considered as programmable digital architectures designed to order interaction among users and aimed at the systematic collection, algorithmic processing, circulation, and monetisation of user data (Van Dijck, Poell, and De Waal 2018). However, they are not to be thought of as extra-social phenomena, but rather as «a set of relations that constantly needs to be performed» (van Dijck 2013:26), inscribed with hidden cultures and normative values (Gillespie, Boczkowski, and Foot 2014). Being sociotechnical devices, they possess agency and shape the everyday life of their users (Williamson 2017; Decuypere 2018).

Also, infrastructures embed *standards*. Standards can be considered as agreed-upon rules «to establish uniformities across time and space, achieving coordination and control of activities at a distance (...) by which to order and perform realities» (Landri 2018:8; see also Busch 2011). Standards are immersed in and reshape social life: they are unevenly distributed across the sociocultural landscape and they codify, embody, prescribe ethics and values (Star and Lampard 2009:5). They can thereby exert a 'soft governance' and depoliticising power, as in the case of the Europeanisation of education and research (Normand 2016). Standards – benchmarks, indicators, etc. – are thus looked upon and offered in 'governing at a distance' efforts as assurances of objectivity, transparency and trustworthiness (Lawn and Grek 2012).

However, (meta)data and its elaborations are never neutral (Kitchin 2014; Williamson and Piattoeva 2019). Data encapsulate and perform values, thus keeping the *status quo* or bringing about change in every aspect of work and everyday life (Lupton 2018). Power/knowledge is e.g. enacted in database ontologies (Ruppert 2012), which define «exactly the kinds of things that exist in the application domain» (Sowa 2000:42). Database infrastructures are performative, as they «create silences (...), as much as they reveal relationships between data (...); they constrain and facilitate through their ontology, producing various presences and absences of relations» (Kitchin 2014:51).

2. INTEROPERABILITY: INFORMATION STUDIES AND SCIENCE AND TECHNOLOGY STUDIES

Data is now collected, aggregated, processed, interpreted across multiple formats which are constantly rearranged and translated. For example, researchers growingly need to 'mash together' (Kitchin, 2014) data from different research projects across infrastructures and devices. The standardisation of data formats has thus become increasingly important for achieving interoperability.

Broadly, interoperability concerns the ability of separate technical entities to interconnect, 'speak' the same language and exchange data. Interoperability is everywhere in our everyday life. In some cases, it is quite visible (e.g., in the communication between devices through the Bluetooth standard, or in the use of apps in cloud spaces). In many others, it is an invisible background: it acts in many

websites (through scripts that send and/or receive data through standard formats like XML, Java or SQL), as well as, for example, in the internet of things.

Interoperability as a subject is studied in engineering and computer science. The ISO 13606 standard defines interoperability as «the ability of diverse systems and organisations to work together seamlessly (...) exchanging information and using the information that has been exchanged» (2008). Scholars consider it to be «a measure of the degree to which diverse systems (...) are able to work together to achieve a common goal» (Ide and Pustejovsky 2010). 'Internal' interoperability concerns the ability of a system's components to interact with each other. 'External' interoperability, on the other hand, concerns components of third-party systems (Elmir, Elmir, and Bounabat 2015). Materially speaking, interoperability is mediated by standards – protocols, formats, interfaces – that 'hold together' networks of infrastructures. A pervasive role is played by APIs (Application Programming Interfaces), i.e. packages of procedures that a software exposes to the outside so that other software can use some of its functionality.

There are few contributions on interoperability as such in social sciences. Most of them are in Science and Technology Studies (Edwards et al., 2007; Ellingsen & Monteiro, 2006; Sharma & Sawyer, 2016). Some authors (Mongili 2007, 2014; Cozza 2018) took up seminal contributions from the ecological strands of STS (Star & Bowker, 1999; Star, Bowker, and Neumann 2004) and bridged interoperability to the concept of 'convergence'. While interoperability regards the technical integration between infrastructures, convergence concerns the sociotechnical and mutual entanglement between social worlds and information artefacts. In particular, *convergence* has been defined as «the double process by which information artefacts and social worlds are fitted to each other and come together» (Star, Bowker, and Neumann 2004, p. 2). On the one hand, any given information artefact (e.g., the arXiv preprints repository) is partially constitutive of some social world (e.g., the physics scholarly community); on the other hand, any given social world (e.g., academic communities without/with few scientific journal subscriptions) creates through bricolage a set of information resources (e.g., free access research sharing portals such as SciHub, Library Genesis, etc.). Such co-constitution between social and technical processes does not happen linearly or once for all, as convergence emerges as an unfixed layering up of solutions, conventions, standards.

3. AIMS AND METHODS: REASSEMBLING AN ECOLOGY OF PLATFORMS

Except for the sporadic cases mentioned, the issue of connections between platforms has hardly ever been taken into account in sociological literature. The analysis of such entities has been made almost exclusively[3] through methodological atomism – as if they were unconnected monads, to be taken for granted and observed one at a time. Yet, the theme of interoperability is today of strong relevance and calls for sociological contributions. Following the intense digitisation of all spheres accelerated by the Covid-19 pandemic, this issue has indeed become a major factor in the law, politics on all scales, and the everyday life of social worlds today.

The aim of this preliminary paper is thus to take on an ecological gaze at the issue of digital platforms and infrastructures. An attempt will be made to observe how digital platforms entangle with each other in wider digital textures. To observe this in-betweenness and reassemble the ecology (Czarniawska; Latour 2005), the technical concept of 'interoperability' will be followed and three stories concerning interoperability will be narrated. These stories have been collected at a large university (from now on, 'Ateneo') in central Italy.

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[3] The exceptions include the STS works mentioned in the previous paragraph. In addition, among other contributions adopting such ecological sensitivity to digital platforms and infrastructures, Plantin et al. 2018; Van Dijck, Poell, and De Waal 2018 could be mentioned.

At the methodological level, a sociotechnical and relational sensitivity from Science and Technology Studies has been applied. According to such perspective, devices «are inseparable from both their social, cultural, political and economic processes of *production* and their socially, culturally, politically and economically *productive* effects» (Williamson 2016:124, italics in the original text). In particular, an «infrastructure inversion» has been carried out and «boring things» (Star 1999:1) have been thoroughly inspected to bring the background of standards and infrastructures to the foreground and struggle against their tendency to disappear (Bowker and Star 1999). Semi-structured interviews at Ateneo have been conducted with 4 developers at the Centro ICT ('ICT Centre') and 4 governance representatives; 2 CINECA[4] developers were also interviewed. Archival analysis has also been carried out on grey literature, drafts, papers and offline web pages reached through *The Internet Archive* (2019).

4. FOLLOWING INTEROPERABILITY IN THE 'ATENEO' UNIVERSITY

Interoperability will now be followed in Ateneo. In particular, three stories of interoperability in the observed university will be described: as integration and tinkering; as openness; as a collective and knowledgeable sociotechnical accomplishment.

4.1. INTEROPERABILITY AS INTEGRATION (AND TINKERING): THE 'IRIS' CRIS PLATFORM BY CINECA

IRIS (Institutional Research Information System) is the Current Research Information System (CRIS) developed by CINECA (Fig. 1), i.e. a digital infrastructure that store, manage and disseminate all the information about the research activity carried out at one institution (Leiva-Mederos, Senso, Hidalgo-Delgado and Hipola, 2017). It is «a set of modules that digitises all the processes related to Research» (CINECA 2020; translation by the author) and allows to manage a research catalogue, research resources, activities and projects, scientific evaluation, skills. The development of CINECA IRIS started in 2007 and was completed in 2013 as a best-of-breed solution between CINECA U-GOV Ricerca and CILEA SURplus products (Galimberti 2014; Colarusso 2017). As of 18/04/2018, IRIS was being used by 70 Italian HEIs, including 62 of the 91 Italian universities (U-GOV Wiki 2020).

Internal interoperability in IRIS is provided by the CINECA local rearrangement of the CERIF standard format. CERIF (Common European Research Information Format) is the most widespread[5] interoperability standard for CRISs. CERIF was developed by a European Union team with the aim «to overcome the information islands and to connect them towards a valuable knowledge infrastructure» (Jörg 2006). Technically, CERIF is a format for describing how data is structured. It is meant to allow the various digital infrastructures and platforms for management and research to talk to each other. It acts through a semantic middle layer that embeds a standard description of the entities in the R&D domain. It thereby aligns the different software dialects towards a common interpretation (Piromalli 2019).

Interoperability through CERIF is crucial in the Ateneo's IRIS enactment. It allows the exchange of potentially uneven data between the various IRIS modules (Institutional Repository; Resource Management; Activities and Projects; Scientific Evaluation; Evaluation and Review), between IRIS

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[4] CINECA (Interuniversity Consortium for the Automatic Calculation of North-Eastern Italy) is a consortium that includes the Ministry of University and Research, the National Agency for the Evaluation of the University and Research System and 79 higher education institutions. It has been developing software for the Italian Ministry of University and Research and higher education institutions since the end of the 1990s.

[5] The last CRISs global survey yielded 381 responses from 44 countries (Clements, de Castro, and Bryant 2019).

and the Ateneo's ERP (U-GOV by CINECA), between IRIS and external platforms and infrastructures (ANVUR[6], external repositories, etc.), etc. Through CERIF it is thus possible to transform the digital space of higher education institutions into all-encompassing and seamless 'one-stop shops'.

Here, thus, interoperability has as its premise and objective to transform a disconnected mess into an integrated whole. Order can thus be 'extracted' from chaos and complexity (Latour 2005). Thereby, loosely coupled and complex organisations emerge as perfectly integrated ones. This form of interoperability thus seems to embody a vision of 'knowledge management' where knowledge is a manageable and storable mental possession rather than an 'ongoing social accomplishment' (Orlikowski 2002:249; Polanyi 1958) – as well as the materialisation of a technocratic government of education.

Fig. 1 – *The CINECA IRIS platform*
(source: screenshot by the author)

The CERIF standard has been the subject of local rearrangements and tinkering practices at CINECA. The CINECA rearrangement of CERIF is characterised by the information granularity that has been introduced, which is much higher than what is normally provided in CERIF. It is an «extension» of CERIF so that «we detach ourselves [from the standard CERIF] at the physical, 'database' implementation level» and «we remain consistent at the logical, semantic abstraction level. Thus we have to operate with a precision that is certainly superior, at least from a semantic point of view» (CINECA Developer). This granularity was introduced for internal needs related to specific Italian policies (assessment requirements, the curriculum of teachers, tax regulations, etc.), local university cultures.

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[6] ANVUR (Agenzia Nazionale di Valutazione del Sistema Universitario e della Ricerca) is the Italian National Agency for the Evaluation of the University and Research System

4.2. INTEROPERABILITY AS OPENNESS: THE 'STUDENTPLATFORM' PLATFORM BY CENTRO ICT

StudentPlatform is the student career management platform used at Ateneo. It allows for university enrolment, printing bulletins, booking exams, printing certificates, visualising careers (Fig. 2).

StudentPlatform was created to digitalise the material processes of the student secretariat. It was developed by Auselda, one of the big Italian software houses, starting from 2003; it was then taken into local development by Centro ICT from 2013, after the bankruptcy of Auselda. Many interviewees consider StudentPlatform as the beginning of the informatisation at Ateneo.
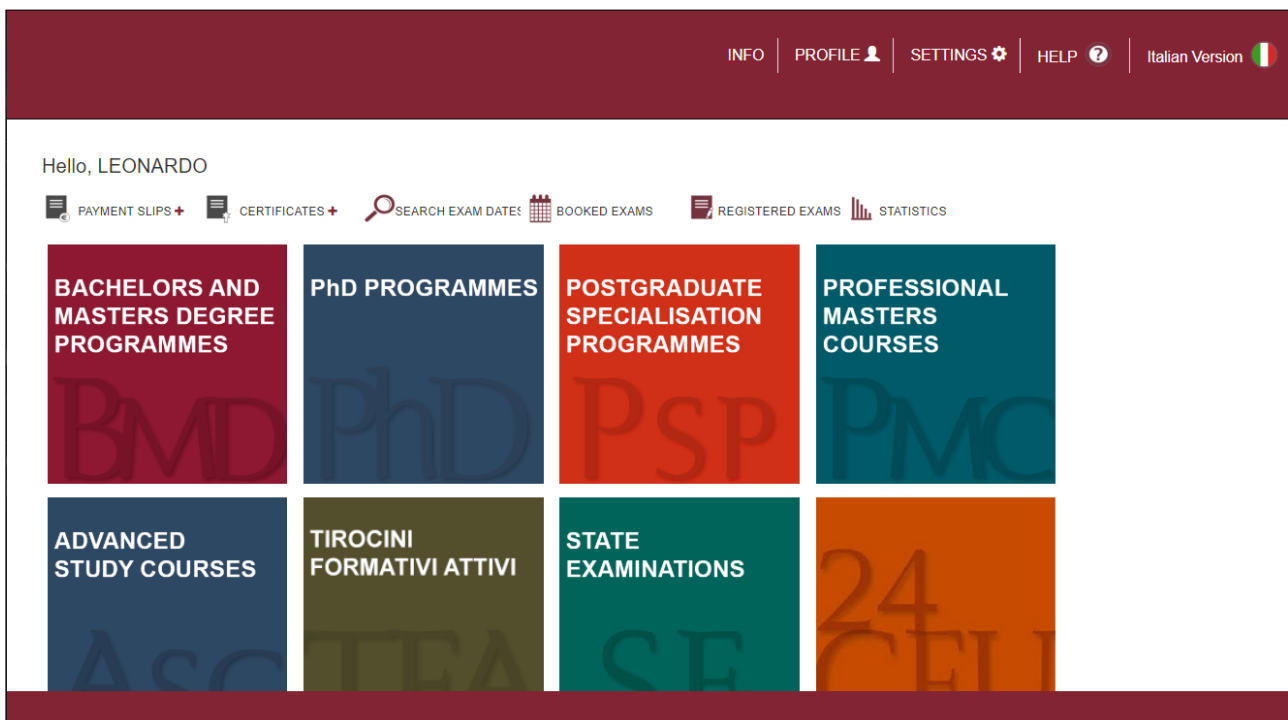

Fig. 2 – *The StudentPlatform platform*
(source: screenshot by the author)

StudentPlatform is at the heart of a dense network of infrastructures and platforms to which it sends and receives data: Ateneo platforms (the GOMP platform for educational offer), but also State infrastructures (INPS, SPID, ANS, PagoPA).

Materially speaking, StudentPlatform is built as a collection of micro-services, i.e. API interfaces. This makes the software naturally oriented to interoperability – or rather, to «applicative coopera-tion», as defined by the developers: «We lay out a set of APIs with which the application can basically do a lot of things. You have to actually think about cooperation if you want to do it. All the other things that are being done now all around are just patches to make applications talk to each other» (Centro ICT Developer).

StudentPlatform's interfaces for interoperability are publicly exposed: «Everyone can use them to develop her own interface. There is nothing secret about it. In fact, there are several apps for third-party mobile phones – from Android to iOS (...). Very nice, very well made, of course free of charge. And then clearly Ateneo has developed its own because one has to fit» (Centro ICT Developer). These third-party applications are often the result of experiments by students[7], but software embedded in

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[7] For instance, OpenStud (Sarra 2020) and StudentPlatform CLI (infostud_cli 2020).

the Ateneo ecology (e.g. GOMP) also interacts with the StudentPlatform APIs. Since the APIs are public, «if you want you can take the terminal, query the StudentPlatform APIs from there, log in and do everything you wish from there. Of course, the web interface is nicer. But anyone can do what she wants, you just have to query the APIs».

Hence, StudentPlatform's APIs represent a gateway and an obligatory point of passage for the interoperation between a wide range of software that constitutes the University's ecology. In this case, interoperation happens through an algorithm that is inscribed with an open and transparent vision. Rather than a tooth-wheel transmission mechanism holding the organisation together, interoperability appears here as openness towards the outside and sharing through which the ongoing infrastructuring of new networks is made possible.

4.3. INTEROPERABILITY AS A COLLECTIVE AND KNOWLEDGEABLE SOCIOTECHNICAL ACCOMPLISHMENT: THE 'CATALOGUE' PLATFORM BY CENTRO ICT

Following interoperability leads to describing it not only as an already closed artefact – albeit unstable – but also as an indefinitely unfolding epistemic object (Knorr-Cetina & Harré, 1981). This is the case of an innovation introduced in the Catalogue platform by Centro ICT.

The public Catalogue platform (Fig. 3) shows the catalogue of the educational offer at Ateneo with every detail relevant to students. The platform interoperates through APIs from three data sources: StudentPlatform, GOMP and a database of editorial information compiled by faculty managers.

Fig. 3 – *The Catalogue platform*
(source: screenshot by the author)

Since 2020, the Italian Ministry of University and Research has made mandatory the public display of the curriculum vitae (CV) of university professors on university websites. In the case of Ateneo, all professors already had to upload their curriculum vitae within the GOMP platform. However, the Centro ICT had to figure out how to publish the CVs in the public Catalogue platform too. Centro ICT had three possibilities: «To have the CV uploaded again within Catalogue, or have them [the professors] upload it within the department or faculty websites... or interact with the supplier [the GOMP platform developers] and get a new API method that has that field structure too» (Centro ICT Developer). The evaluation phase was thorough and included an examination of economic elements

as well as human interaction («the 3/4 of professors could send you to hell because they'd tell you 'I've already put the CV over there!'»).

After the analysis phase, the third option was chosen: the development of a new API interface. Such API was meant to act as a new method of querying – a way of 'asking' for information that couldn't be formulated before – that allowed to extract information about the CV from GOMP and make it appear on Catalogue without duplicating the data (Fig. 4). This technical modification could not be done autonomously by the Centro ICT as it needed an insider knowledge from the GOMP developers. It was therefore necessary to «study together a technical analysis and modification».
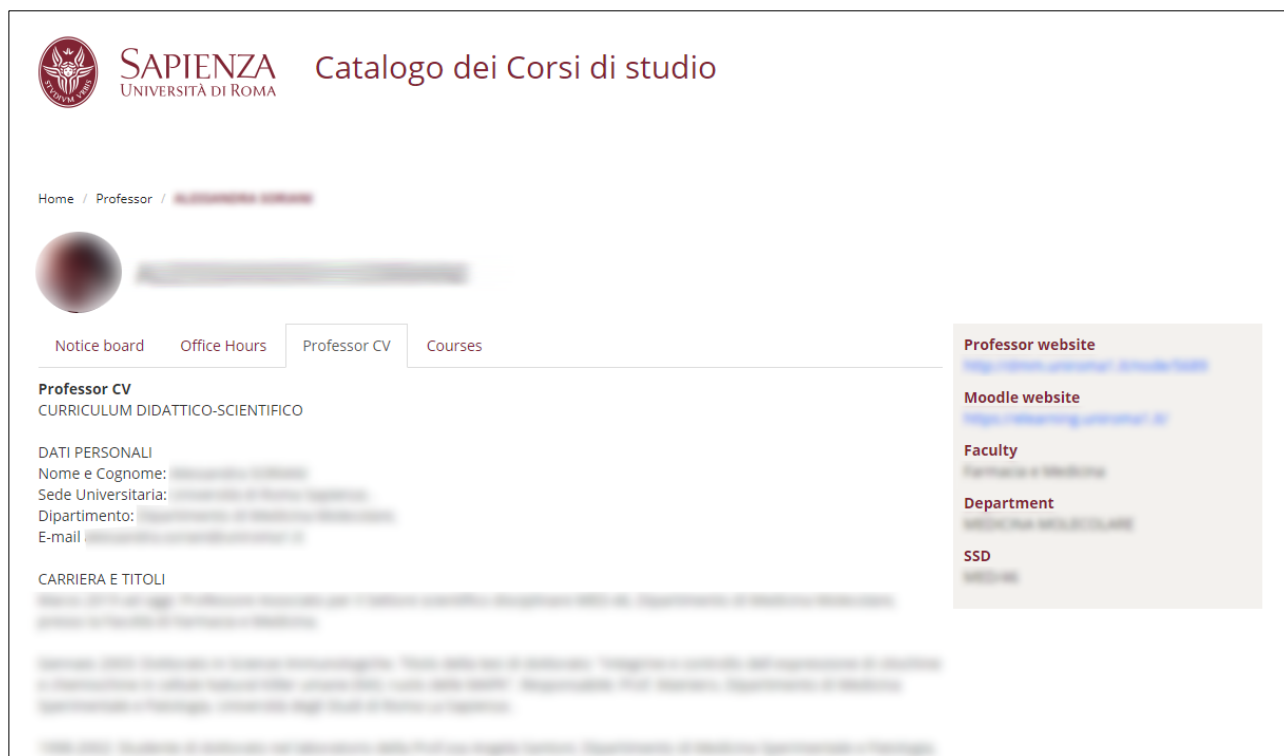

Fig. 4 – *The Catalogue platform – Curriculum page (query from GOMP)*
(source: screenshot by the author)

In order to comply with policy requirements, a work of articulation and concertation was therefore carried out between the Centro ICT and GOMP's developers which led to the co-participated developing of these interfaces. Within these knowledgeable and sociotechnical practices of interface construction, interoperability was thereby collectively accomplished.

5. DISCUSSION AND FINAL REMARKS: FROM INTEROPERABILITY TOWARDS CONVERGENCE

This work aimed at experimenting with an ecological view on digital platforms and infrastructures and to observe how they connect with each other. The observation has therefore been shifted from the microscope slide isolating each platform to the wider interconnected ecological tangle they chorally perform: «What can be studied is always a relationship or an infinite regress of relationships. Never a 'thing'» (Bateson 1978:178). To access this complexity, the technical concept of interoperability – the capacity of technical entities to interconnect, 'speak' the same language and exchange data – has been followed. Three stories about interoperability have been collected in a large university in central Italy through semi-structured interviews.

In the first story, interoperability is inscribed with an 'integrative' algorithm, based on a knowledge management logic. The various 'parts' of the organisation, by interoperating through a common standard (which was, however, reinvented and tinkered with), are meant to hold the organisation together and maximise efficiency. In the second story, the StudentPlatform APIs become an open and publicly accessible access point that third parties can embed to develop their own platforms. In the third story, interoperability is built through and around sociotechnical processes, i.e. due to policy demands and through a collective work between two software manufacturers.

This research thus shows that the interconnection between platforms occurs as an intertwining of technical and social processes. When discussing what holds platforms together it thus seems appropriate not to constrain the observation to the technical notion of 'interoperability' alone but rather to complement it with the sociotechnical concept of 'convergence'. Both concepts seem indeed useful for the empirical exploration of platform ecologies. On the one hand, the idea of interoperability makes it possible to frame the installed base (Star & Bowker 1999) that allows infrastructures to technically interconnect; however, it is arguably inscribed with a technical and purifying vision (Latour 2005) which relegates technology to an extra-social domain. On the other hand, the concept of convergence of information systems and social worlds allows to think and explore sociotechnical co-constitution of ecologies: how do social worlds and information artefacts come together?

In particular, through the concept of convergence it seems possible to trace social process in technical ones and vice versa. Such sociotechnicality emerges indeed in the stories collected. The 'technical' processes and artefacts described are in fact inscribed with hidden cultures and normative values which tell stories about logics of action and orders of value to which abide (Cabitza and Mattozzi 2017). Also, as shown in the case of the fabrication of API connectors through situated practices of co-design and articulation of work, interoperability appears as an ongoing process which is continuously co-constructed and rearranged in smoke-filled rooms (Bowker & Star, 1999) rather than a fixed and transcendent state.

Hence, broadening the gaze to observe ecologies and relations rather than individual entities has given a first impression of how ecologies of digital platforms are held together, i.e. through sociotechnical encounters. Digital platforms appear performative not only as isolated and singular entities: their convergence – i.e., the ecological 'coming together' and 'holding together' between platforms – does work on the world too. The convergence[8] between platforms, in this respect, is endowed with its own agency, just as individual platforms do. It is dense with values, non-neutral, never detached from the social, and it happens around more or less opaque seams.

This preliminary paper paves the way for new research questions. Some of them will be tackled in a broader project on interoperability in higher education and platform ecologies. In the first part, the platforms used in a large Italian university will be disassembled (van Dijck 2013) and the translation in practice of its informatisation will be reconstructed (Gherardi & Lippi 2000). In the second part, the concept of 'interoperability' will be followed in space and time (Czarniawska & Joerges 2011) and the previously disassembled platforms will be reassembled into a wider ecology. Further reflections on the agency of ecologies will also be articulated as well as additional inquiries about convergence in higher education.

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[8] Probably, it would be even better to talk about 'converging', following John Law's (1993) invitation for a 'sociology of verbs' that would accentuate processuality.

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