

## **Interdisciplinarity and Integration in the Horizon 2020 Program**

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**Abstract:** This paper presents findings from an empirical study, an exercise in observation and reflexivity in reference to five interdisciplinary innovation/technology assessment cases.<sup>1</sup> It responds to the Horizon 2020 framework program for research and innovation in its approach to *Responsible Research and Innovation* (RRI). Our concern is that *interdisciplinarity* and *integration* are treated as pre-given in accounts of what the RRI approach is in practice. We ask what actually happens when you get down to the business of bringing people together across disciplines, institutions and national borders in an attempt to achieve interdisciplinarity and integration in assessing new-emerging domains of innovation. We report on the procedural conditions in carrying out these assessments, however, the point of the exercise is not simply to identify a host of shortcomings and complications to which remedies are needed. Drawing on studies of disciplinary boundary work and interdisciplinary problematics, we argue that any bridge built across established practices, let alone an integration of approach and method is an achievement of hard work. We further argue the importance of addressing the singularity of each attempt at teamwork and leadership which can be described and explained, however, the way such work unfolds is very hard – if at all possible – to predict and prescribe for. Procedural conditions test the limits of participation and learning, knowledge creation, sharing and know-how. But, they also afford important opportunities to align methods and approaches, to deepen relationships, sort things out and lead the work forward. Crossing disciplines is a tool to find adequacy and sufficiency in what members know how to do well and the kinds of things they recognize they can do better. It is a test of the imagination and of working with others as *exploratory action*.

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## Observation and Reflexivity

The Horizon 2020 framework program for research and innovation is implementing and mainstreaming the so-called *Responsible Research and Innovation* (RRI) approach.<sup>2</sup> This is evident in directives requiring that research projects funded by the program embed actions on gender, ethics, science education, open access and public engagement. It is evident in calls for institutional change to foster more inclusive and sustainable innovation. For example, the RRI approach is anticipating of greater involvement by ALL societal actors throughout the entire research and innovation process. It calls for interdisciplinary solutions and integrated frameworks, conducive to better and more balanced assessments of the new-emerging sciences, technologies and other societal innovations. However, RRI is still work-in progress to which a number of discourses and practices speak, going back a couple or so decades (see Owen et al (eds), 2013). Calls for wider participation, engaging social scientists and publics with innovators, go back to at least FP5 in Europe (Owen et al, 2013). Such calls are now part and parcel of the innovation policy discourse, STS and ELSi scholarship, with emphases on notions such as foresight, value-sensitive design, convergence and socio-technical integration (e.g. Fisher, 2007; Barben et al, 2008; Owen and Goldberg, 2010; von Schomberg (ed), 2011), for example, embedding humanities and sociological expertise among innovators to raise with them issues of norms and values (Fisher et al, 2006; Schuurbiens and Fisher, 2009).

Collaborations across disciplines and professions are typically not initiated by innovators, but societal-scientific co-production is supposed to encourage reflexivity among innovators and, thereby, have the potential to widen the reach of strategic research and innovation management. There are calls to broaden the engagement in innovation/technology assessments as well, albeit, it is not clear how qualitative analyses such as ELSi, media analysis, vision assessments and STS, integrate with risk assessments and economic appraisals unless they are all encapsulated in a risk/benefit-based discourse. In light of that, it is cause for concern that **interdisciplinarity** and **integration** are treated as givens in accounts of what the RRI approach is in practice—in mandates to implement and mainstream RRI, as well as in accounts that aim to target policy development at the source of choosing and prioritizing innovation objectives. Our point of departure here is to ask what actually happens when you get down to the business of bringing people together across disciplines, institutions and national borders. We present our findings from empirical research we conducted which was designed to be an instrument of observation and reflexivity in reference to

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<sup>2</sup> See <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation> .

five innovation/technology assessment cases: 1) wearable sensors for health and self care, fitness and wellbeing; 2) autonomy in robotic systems for care and companionship; 3) synthetic/in-vitro meat, 4) the future smart grid, and 5) Data Protection Impact Assessment (DPIA) as a regulatory innovation. We attended workshops and meetings and we analyze the documents each of the teams has produced. We also conducted interviews with team members to hear about their expectations and reflections on the experience of working on these assessments, and of extending their reach to innovators, industry, policy makers, regulators, representatives of CSOs and activism.<sup>3</sup> We will not dwell on the details of each of these cases, i.e., what the teams discovered about research and development trends and future visions within the respective innovation domains, nor what they reported of relevance to policy involvement and intervention. That information is readily available elsewhere.<sup>4</sup> We report on the procedural conditions in carrying out the case studies, conditions we take to be indicative of *the kinds of things that can and should be expected* in bringing together expertise across disciplines and professions, not to mention, geographical locations. More specifically, we observe these conditions in reference to interdisciplinarity and integration being called upon to improve the culture of accountability in Europe.

The point of this exercise is not simply to identify a host of shortcomings and complications to remedy, although our research is suggestive of doable improvements for most cases and what to recommend to that effect. Rather, we contemplate how to make sense of procedural conditions, of what to expect and how to work with that. We explore how diverse, but vested, disciplinary-specific involvements in assessing innovation practices come together and drift apart—how they approximate and differentiate in sharing and communicating challenges, orientation to reasoning, findings and views, and choice of language. Drawing on studies of disciplinary boundary work, ecology and belonging (Stengers, 2005), and issues of inter/trans/multi-disciplinarity (Barry, Born and Weszkalnys, 2008; Huutoniemi et al 2010), we argue that any bridge built across established practices and disciplines, let alone an integration of approach and method is an achievement of hard labor, not a starting point. The definitional looseness of interdisciplinarity and integration and the fact that these terms are not qualified in Horizon 2020 documents, encourages idealizations and risks raising unrealistic expectations. For example, one can argue that interdisciplinarity stands for *collaboration* (narrowly conceived), or that it approaches a *radical refiguration of disciplines* (method, approach, output). One can argue that integration is achieved when one thing is loosely

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<sup>3</sup> We thank and phrase our colleagues for exceptional bravery in playing along with this exercise and us here—to engage a self-critical and all-round critical reflection for the greater good by providing us with important clues to mutual-learning, partiality and fragmentation in interdisciplinarity and integration.

<sup>4</sup> <http://epinet.no/content/epinet-project> .

combined or included with another. It can also suggest a merger, a mash-up, a sense of homogeneity and consensus. There is a lot of interpretative wiggle room here, but what is achieved by a team in terms of interdisciplinarity is typically fragmented and partial, involving disciplinary boundary work, identity politics, labor divisions, short-term entanglements, all of which achieves some level of integration and, importantly, can produce novel insights. In short, we observe approximations *and* distantiations which require diligent attention and care in the ongoing teamwork and in the leadership of that work. Procedural conditions will test the limits of participation and learning, knowledge creation and sharing and, more generally, they will test the limits of know-how, however, not precluding productive pathways to *sorting things out*, making good sense of the work at hand and leading it forward.

The conditions we describe and discuss in this paper have implications for promoting the implementation and mainstreaming of the RRI agenda, i.e., to develop interdisciplinary solutions to cut across Horizon 2020 objectives and create integrated approaches to more balanced assessments. It is against this backdrop of expectations that members of the case studies faced a twofold challenge when they came together and began their work. Each team conducted assessments of an emerging innovation domain, cutting across the disciplines available among team members, however, guided by considerations of relevance to the development of innovation policy for that same domain. Simultaneously, each team reflected upon the disciplinary traditions of their team members, and reflected upon their work on the research project, toward inter- or transdisciplinary solutions in doing these assessments.

In the following sections we address issues of inter/trans/multi/cross-disciplinarity to lead in our discussion of the procedural conditions we observe and the complications and shortcomings reported by team members. Thereafter, we look more closely at evidence of the cases in progress, the tools that are put to use to sort things out and move the work forward. We discuss what to look out for in this respect with examples, among other things, of the use of what we call *epigrams*.<sup>5</sup> We draw together examples of boundary-crossing and partial integration to make the argument that integration, as well as interdisciplinarity, are always situatedly specific and tangled up in technologies of belonging. We ask, as Barry et al do, “[w]hat is novel in the contemporary sense that greater interdisciplinarity is a necessary response to the intensifying demands that research should be integrated with society and the economy.” (2008, p.23). Or, as we reorient that question, we ask what to expect of *responsibilized interdisciplinarity and integration* in Horizon 2020. We

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<sup>5</sup> The term *epigram* was coined by Niels van Dijk in an Epinet workshop at Bergen University 17 December 2014.

argue that accounts of interdisciplinarity and integration are at best misleading when the two are responsabilized as prerequisites to better innovation/technology assessments. Such accounts mask the complexity of the two, in particular, in reference to considerations of how formal and informal assessments can be made to fit into a framework for more balanced assessments overall. They mask a debated aspect of interdisciplinarity which is the very *process of integration* (Huutoniemi et al, 2010).

### The issue of disciplinarity<sup>6</sup> and how to integrate

Within the Horizon 2020 program, interdisciplinarity is at the heart of a promise to engage all kinds of societal actors in research and innovation activities, where *forging the ties* is posed as a vehicle to bring scientific research, innovation and publics into much closer unity and to render innovation accountable to society (see Owen, 2014). The discourse on the need for such ties is in keeping with significant change in science, technology and society relations in recent times, i.e., the shift from a culture of science autonomy to a culture of accountability (Nowotny, Scott and Gibbons, 2001). Interdisciplinarity is seen as instrumental to the third pillar of the Horizon 2020 program: *societal challenges*, in building capacities to connect science to society, making the sciences and technologies more attractive, especially to young people, and raising society's appetite more generally *for* innovation.<sup>7</sup>

This trend is also broadly in agreement with contemporary accounts that model interdisciplinarity as either a pervasive form of knowledge production or a mode of discovery. It has become a major topic in academic and policy oriented discourse on knowledge production and research funding (Huutoniemi et al, 2010), raising the question how best to identify interdisciplinary research in practice, its epistemological contents, the different forms it takes or which general interdisciplinarity indicators might be most useful to innovation policy. The assumption has been that better understanding of knowledge co-production can improve policy-making practices, including decisions on funding.

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<sup>6</sup> We recognise the distinctions made between interdisciplinarity, multidisciplinary and transdisciplinary. Barry et al (2008) suggest that transdisciplinarity is primarily used by those who like to see boundary transgressions in deliberate attempts to improve on innovation practices and the culture of accountability. *Multidisciplinarity*, on the other hand, is typically used for cooperation and collaborations, albeit, with potentially transformative results in knowledge-creation and the shaping of disciplinary identity. We follow their reasoning here in adhering to the term *interdisciplinarity* and the definition of it as *barely collaboration* at its worst and approaching a *transformative recasting* of disciplines at its best.

<sup>7</sup> It is striking how the argument goes. Innovation is always inevitable and society should get involved in it, rarely the other way around. See also <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation>.

Working across disciplines is commonly linked to problem-solving in new areas in which problems and problem-solving emerge relationally and are constituted in and through experimentation, dialogue and recognition of the limits of isolated disciplinary instruments, for instance, building an airplane or getting a man onto the moon. The co-production of knowledge proceeds on the bases of already valued contributions and divisions of labor across disciplines. But innovation practices also acquire a taste for wider disciplinary inclusion for the sake of improvement. For example, the ICT sector which already depends on numerous disciplines in technology design (computer engineering, materials science, computer-human interaction, cognitive science and more) has a history of involving business expertise and ethnographers (anthropology and cognate disciplines) to engage with and investigate everyday life in bringing about new visions of future society, of product value and lead markets (e.g. Aarts and Marzano, 2003; Aarts and de Ruyter, 2009). But such a mode of integration and synthesis is not necessarily suggestive of radical shifts in ontological and epistemic orientations. Rather, it rests on a logic of innovation, as Barry et al put it (2008). As regards the logic of accountability however, the relationships that are forged between disciplines, professions and everyday experience, can be very contentious. Bringing artists, humanities and sociological expertise into collaborations with innovators to effect wider social engagement, does not always render such efforts reliable instruments of legitimation as far as innovators are concerned. Public engagements such as participatory integrated assessments can also be resisted by different socio-technical imaginaries, resulting in multiple accounts and accountabilities, rather than success in legitimizing an innovation.

One question to ask here is how to qualify disciplinarity in this kind of work and how to qualify integration. In other words, what can be said about the logics of ontology and entanglement, boundary work, technologies of belonging and, more generally, the ecology of practices?

### *Encountering interdisciplinarity and integration*

We proceeded with our observations in consideration of a key challenge faced by the case studies in conducting their innovation assessments, i.e., to contribute to a shaping of an integrated framework of formal and informal assessment methods.<sup>8</sup> The case teams were comprised of various combinations of expertise, including:

Ethics (situated/communicative);

Knowledge assessment (pedigree analysis);

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<sup>8</sup> According to the call, European Commission SiS WP 2011.1.1.1-4.

Law (legal analysis, legal concepts);  
Media and digital cultures (media analysis);  
Multi-scale integrated assessment;  
Risk and uncertainty analysis;  
Socio-technical evaluation (ethnography/document analysis);  
Vision assessment (document analysis).

The cases proceeded on the bases of common assumptions observed in the discourses on responsible innovation, focusing on the *turn toward futures* and futuring, and what to expect of *visions as key considerations* in assessments. They focus on the *integration of different groups and networks*, of coming together to produce *reflexive, responsive* and *anticipatory outcomes* for deliberation. They *evaluate institutions* as part of their assessments, e.g., if structural and/or procedural changes are needed. And, they proceed on the assumption that efforts to govern complex systems should *not be deterred by complexity*.

Our objectives centered from the start on how formal and informal methods come together and relate (or not) in working through the cases; how different orientations to study achieve disciplinary approximations and how they distantiate; and, in what sense these cases contribute to shaping an integrated framework to balance the many ways in which emerging sciences and technologies *can* be evaluated. The fact that each team also consulted with innovators, regulators, citizen representatives, policy and ELSi experts, gave us the opportunity to observe an expanding disciplinary and experiential base, how these events were lead forward and what they delivered as an emerging *epistemic network*, as members would phrase it.

Some aspects of our findings find resonance in organization studies, for example, in theories of *organizational commitment* which, among other things, explain loyalties to an organization and the work it produces (e.g. Meyer et al, 2002, 2006). They find resonance in studies of *social identity* (Haslam, 2004) which are good at explaining adherence and loyalty to causes and purposes. These study traditions draw on behavioral and social psychological reasoning with great explanatory powers, however, they are far less apt at predicting future turn of events. We recognize the same sort of shortcomings in the predictive capacity of sociological and cogent reasoning, however, we do not contend that this is an epistemological problem for which a remedy is necessary. Rather, we suggest that an orientation to social-epistemological reasoning and practice studies will adequately support our work with evidence of different thought-styles, articulations of potentials and limits of know-how. and the tools and techniques that are put to use to bring about social-epistemological



entanglements. We draw on Stengers' notion of *ecology of practices* (Stengers, 2005), alongside studies of interdisciplinarity, i.e., in supporting our understandings of what is at stake, of what is considered sufficient and adequate in conducting the case studies. Of particular relevance in that respect is to identify disciplinary favoritism, boundary work and reflexivity in orienting to, approaching and practicing expertise across disciplines. We observe this at work in the research output as well as in the expectations and experiences of the team members we interviewed, and what they have to say about learning and sharing.

### *Encountering shortcomings and complications*

In raising the question of what actually happens when people are brought together across disciplines and, not to mention, geographical distances, the first thing to encounter are the procedural conditions that should be expected in carrying out the kinds of studies we have observed. We do not present here a complete index of procedural conditions to keep in mind but a select list will give an idea of the extent of potential shortcomings and complications.

First on this list are the ***limits to participation***. Personal and inter-personal, professional and institutional dynamics will test those limits. Contracts are time-limited and come to an end, funds run out, family members die, accidents happen and people are unavailable for one or another reason or somehow not cued in. As one interviewee put it, Epinet was in some respects “really not happynet at all, I mean (laughter), rather unhappynet”. Secondly we mention ***barriers to communication***, some of which are relatively easy to manage with innovative uses of ICTs and provisions to meet regularly face-to-face. There are communication barriers when team members are rarely co-present and given the communication hurdles that need overcoming to achieve some degree of disciplinary approximation, we refer to those barriers as a *stress-text of resilience*. Communication, and *being in-communication*, is key to the necessary dynamism in keeping a shared study environment alive and going forward. Thirdly, ***myths of interdisciplinarity*** are exposed in the many ways in which a journey of working together tests the limits of learning, knowledge creation and sharing. We will discuss this matter in more detail in the next section, but these conditions of the journey also provide pathways to sort things out, to make sense of a case and lead the work forward. As we will elaborate, there are identifiers of what is going on (inter)disciplinarily, for example, when ***epigrams***, as we call them, are introduced to sort out what a case is a case of, to establish relations and hierarchies, and lead. Finally, there are ***limits to know-how***, i.e., in dealing with organizational, interpersonal and communications phenomena that can be



described and explained effectively but are not well predicted. Consequently, in relation to these conditions, any team crossing disciplines will have to find adequacy and sufficiency in what the members know how to do well and the kinds of things they recognize they can do better. It is a test of the imagination and of working with others as *exploratory action*.

Our interviewees report on their expectations at the outset and reflect upon matches and mismatches with their experience. The kinds of things that are reported are indicative of curiosity, openness and anticipation, although, it is evident that some members more than others, are familiar with collaborations across disciplines and national borders. Our interviewees speak of expecting an *open way of conducting research*, of it being *exploratory*, “a *demonstration project* in showing what different assessments can do and how they could be combined”. One member already familiar with good working relations between anthropology (ethnographic work) and media studies, reports the expectation of joining up with legal scholarship and more economical and technical analysis. A host of remarks centered around the value of face time with the case teams, and expectations of much more co-presence than actually came to pass. There also appears to be an anticipation of control, in the sense that all the bits and pieces would eventually be integrated, although, *how* that was supposed to happen was the *big question* they had at the outset, a curiosity about “how we could integrate all the different assessments”. One member talks about expecting to have “some kind of a catalog ...err ...a roadmap or something that you could use if you have a new technology”. Another member talks about “somehow merging, putting together different disciplines in... and organizing them, coming out with maybe one ...err ...big ...err ...protocol or one methodology that would ...err ...encompass all the others ...no?”

Expectations of interdisciplinarity are repeatedly reported with remarks that they were not matched somehow. Interviewees report on lacking a sense of participation in thinking through a case study, that an articulated discourse on how to combine methods and views was missing, and so on. But, there is also a reporting on discovering new ways of thinking about an innovation domain in and through networks, partly made up of new relations and partly consolidating existing research relationships. The most general observation is to say that the case studies all share a similar *character of initiation*. The partners first negotiated contributions in clarifying the boundaries of their disciplinary investment and came up with what one of them called, a *doability agreement*. Then everyone went off to do their own thing, as some of the interviews reflect upon in hindsight with remarks such as not really having a good sense of what other people have done. The result has

to some extent been that “I do my bit, you do yours”, rather than proceeding by looking at a shared question or concern, then asking “how can we jointly respond to it?”

## **Fragmentation and partiality**

Approaching practices as embedded in an ecology is multi-directional in the sense that each practice can be addressed in terms of the obligations that visibly engage practitioners in achieving their work satisfactorily, i.e., in serving and answering first and foremost to the requirements of their trade. The art of establishing working relations rests on a kind of diplomacy. Borders need to be taken seriously and approached cautiously. Common interest in some issue, a problem definition and problem solution, emerge not because these are somehow *the same* or even similar across disciplines, but because their alignment is approximated. To that effect, the relevancy constraints of a practice emerge in the course of two or more disciplines solving a problem *together* in some shape or form—i.e., in situations where misalignments are prone to emerge. Each party has different constraints, risks and vulnerabilities to consider and, while a working relationship is achieved in and through new articulations produced between the parties involved, they each produce as well their local disciplinary versions of what is the case and what is at stake. In that vein, integration in the sense of merging and achieving a sense of homogeneity and consensus, is not what is achieved by the case studies we observed. Rather, a whole host of tools come into play in the course of establishing pathways to address shared concerns and points of convergence.

### *Sorting things out: on the use of **epigrams***

What we call *epigrams*, are practical models for ordering pieces of knowledge and modes of production into constellations of relationships. They are indications of epistemic power and their identification can serve reflexively the need to install epistemic checks and balances. An epigram relates to the notion of a cosmogram (Ohanian, 2005; Latour, 2005) in that it is a provisional model of a world of one or another description with which one is working. It relates to the notion of a diagram (Foucault, 2001; Deleuze, 2006) in being a discursive map of relations that have the potential of creating a reality as much as representing it.

Within the case studies, the making and use of epigrams serves us to explore emerging networks of innovation and assessment, but also how actors situated in or around these networks are reflexively trying to make sense of epistemic relations. The team leaders (and sometimes assertive

team members) come up with their own illustrations, diagrams and other schemas for what the innovation networks are, how to conceptualize them and how to integrate assessment efforts, even unify them. We argue that the making and using of epigrams is a display of epistemic power and the need for explication and confrontation. We take here four examples to address some of their key characteristics and functions in relation to the development of the corresponding cases.

**Epigram 1**, was presented to participants in a networking event for the Smart Grid case, involving innovators and whole range of different experts. It was used to frame the event or set the stage for the interactions. Here a photo collage (on top) illustrates a world of rising heat, war for easy oil out of middle-eastern deserts alongside environmental devastation. This collage is made to represent the current dominant model or a *flammable* if not *explosive* “energy system 'backstage’” to which a diagram underneath is presented as the projected solution. The smart grid is the 'clean break' so to speak, an idealized model of energy production, distribution and consumption. As the event leaders put it to their guests, “in its current state of emergence, smart grid is a set of promises, expectations and visions that shape innovation. These include claims about technological characteristics, societal usability and desirability”. And, to clarify how the meeting would proceed in relating to this vision, the stated objective was to “develop and test a framework for the systematic critical reflection on quality, pedigree, plausibility and social robustness of these claims and promises”.

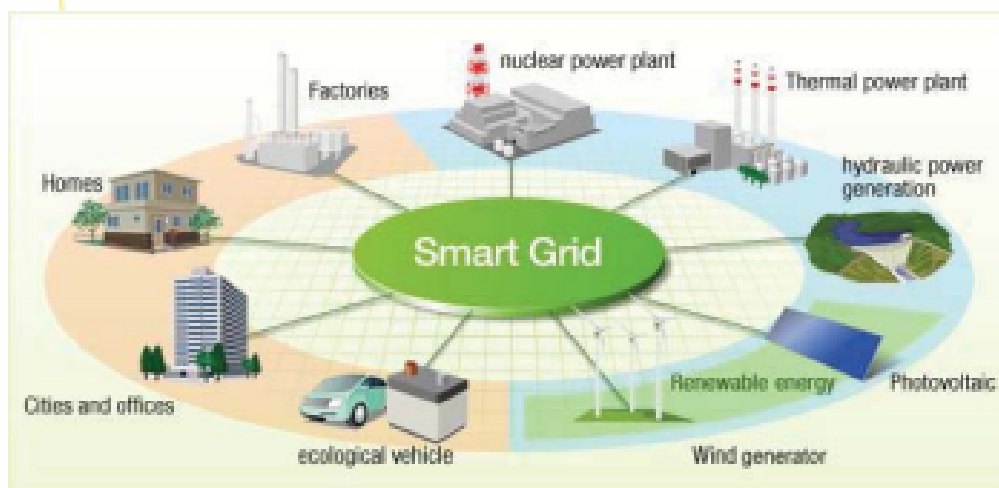
Here we see an epigram that has the power not only to confront but to provide an event with an epistemic lead. In particular, the diagram (bottom) depicts a systematic combined vision assessment on the basis of common depictions of what the future smart grid shall be. The epigram frames the technology as the “set of promises, expectations and visions” that constitute the focal points for both a convergence of assessment practices and the method of integrating them. To summarize, this epigram is the key identifier of how the case study became defined by this particular method of representing an ‘*integrated vision assessment*’ to the wider epistemic network as part of developing a “*framework for the systematic critical reflection*” overseen and directed by the leadership of the case study, thus also highlighting central focus on a proactive construction of a *systemic framework*.

**Epigram 2** was presented in a debrief at an Epinet consortium meeting, to elaborate and collectively reflect upon an observed disconnects between grass-roots activities associated with wearable biosensors and top-down thinking in EU policy in matters of healthcare. It was used to clarify the outcome of a networking event with a range of experts, experimenters and activists. It depicts the clustering of epistemic networks, indicating two areas of concern and disciplinary



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## The smart grid

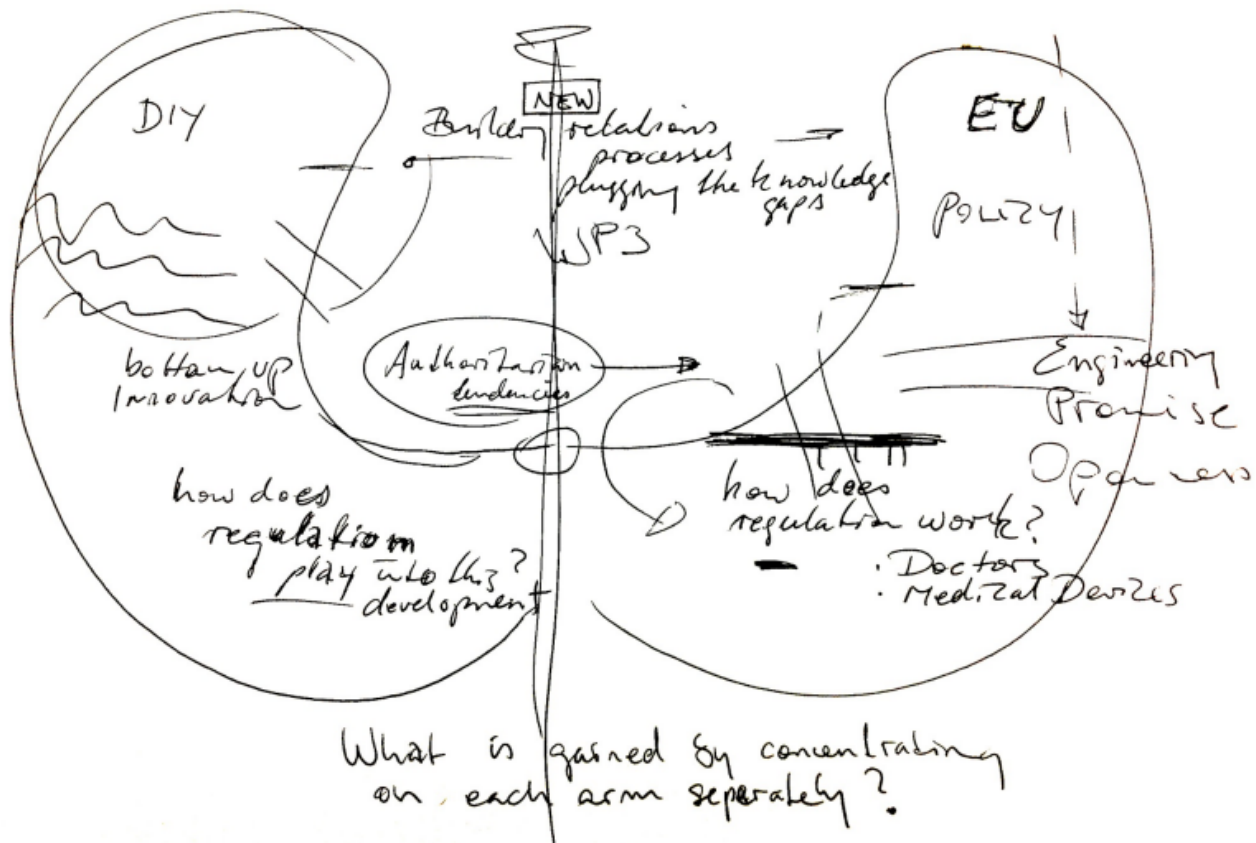


**Epigram 1:** Setting the stage for a networking event with experts from industry/SMEs, public offices of technology assessments and economic affairs, systems analysis and consumer organisations.

commitment for each assessment methodology available on the study team, one for each *arm* so to speak. But, this depiction of two arms was primarily represented to indicate a lack of mutual learning and knowledge exchange, one arm presenting policy initiatives and investments infused

with engineering visions of health care and a promise of a health care revolution, the other arm representing do-it-yourself care and associated grass-roots innovations and activities. It was used to state the need to *plug knowledge gaps* for better understanding of the state of the art and of probable futures of wearable biosensors for health and self care, fitness and well-being.

Here an epigram is put to use to sort out relations and lack of relations—a sorting instrument to explicate, to lead on what the status is overall with this innovation domain, and to provide suggestions on how to move forward with the case. In doing that, the epigram was also explained in reference to how the members of the study team each take interest in and stock of what is happening on both sides, share observations of normative presuppositions and values, epistemic commitments, relations and gaps.



**Epigram 2:** Elaborating and reflecting upon an observed disconnect between grass-roots activities and top-down thinking in EU policy. This finding was one of the outcomes of a networking event, involving experts from industry, ELSi scholars, policy-makers, regulators and activist representatives.

<b>Risk-Right Logic</b> ( <i>Nature of Relation</i> )	<b>Operating Modality</b> ( <i>Institutional or Societal</i> )	<b>Risk Conception</b>	<b>Right Conception</b>	<b>Aligned Expertise</b>	<b>Type of Public</b>
<b>Right at Risk</b> ( <i>Mutual Disentanglement</i> )	Civic ( <i>Civil Society</i> )	Uncertainty Qualitative/Normative Perceived Threat	Political Right: Social Valuation, Collective Good	<ul style="list-style-type: none"> <li>- Social Sciences (PTA, STS, Surveillance Studies)</li> <li>- Computer Science</li> <li>- Law</li> <li>- Politics</li> </ul>	Publics in Risk  Concerned public of participation
<b>Right as Risk</b> ( <i>Factorial Incorporation</i> )	Organizational ( <i>Business</i> ) ➤ <i>Current Narrow DPLA Version</i>	Probability  Quantitative	Risk  ( <i>to the Organization</i> )	<ul style="list-style-type: none"> <li>- Organizational Management</li> <li>- Risk Assessment</li> <li>- Information Security</li> <li>- IT architecture</li> </ul>	Public as Risk  Public Relations & Perceptions
<b>Risk vs. Right</b> ( <i>Balanced Trade-off</i> )	Governmental ( <i>Government</i> )	Probability  Quantitative	Political Right: Collective Good  ( <i>General Mechanically Balanced Weight</i> )	<ul style="list-style-type: none"> <li>- Politics</li> <li>- Intelligence Analysis</li> <li>- Risk Assessment</li> <li>- Information Security</li> <li>- IT architecture</li> </ul>	Public Interest at Risk  (Phantom) public of political representation
<b>Risk vs. Right</b> ( <i>Proportional Adjustment</i> )	Legal ( <i>Court</i> )	Proportion  Contestable Evidence Normative	Individual Legal Right  ( <i>Specific Proportionally Mediated Weight</i> )	<ul style="list-style-type: none"> <li>- Law</li> <li>- Science at the Bar</li> </ul>	Public Interest at Risk & Publics of Rights: Individual Rightholders
<b>Risk to a Right</b> ( <i>Procedural Comprobation</i> )	Legal ( <i>Court</i> )	Environment  Harm	Individual Legal Right  Procedural (Fair Trial)	<ul style="list-style-type: none"> <li>- Law</li> <li>- Science at the Bar: Impact Assessments</li> </ul>	Public of Rights: Individual Rightholders  Figure of Affected Public
<b>Risk to a Right</b> Mutual Transformations - Proportional - Environmental	DPLA ➤ <i>Lessons for a Broader Version</i>	Proportion Contestable Evidence Normative Harm Perceived Threat	Procedural (Fair Trial)  Scope: - Individual Legal - Social Value	Ecology of expert practices  Include insights from: - Law (speculative jurisprudence) - Social sciences	Who participates? - Affected public - Concerned public

**Epigram 3:** A grid of legal concepts, operating as conductors for assessment proceedings.



**Epigram 3** is a grid of legal concepts that operate as conductors for assessment proceedings, here of Data Protection Impact Assessments (DPIAs) for assessing risk to privacy rights which has been a concern for three of the other cases. The table displayed here was the result of exploratory research in mapping different fields of experience in striking a relation between the concepts, *risk* and *rights*. The epigram consists in the identification of those fields and disciplines (STS and law) that are currently ignored in developing this assessment methodology and stating that lessons from these disciplines should be taken into account. The epigram represents *due process* considerations for assessment proceedings and on *proportionality* for aligning technology assessment lessons: *purpose specification*, *purpose legitimacy*, *fitness for purpose*, *alternatives* and *proportionality* (narrow). One aim of putting it to use is to chart the importance of checks and balances on knowledge claims produced in proceedings.

We argue that epigrams signify orientations to sorting things out, making claims and leading, which then are indicative each of an emerging trend in the ecology of practices in which they are presented, discussed and developed. They draw attention to opportunities (or lack thereof) to compare and combine methods and perspectives. They draw attention to inclusion and omission of approaches to assessment and a hierarchy of disciplines. It is perhaps most obvious to point to diagrams or other pictorial schematics in this regard, because of the strength of representation they possess. But, other ways of creating and sharing epigrams can be found in the development of the cases, for example, in the actual structuring of reports and other documents.

**Epigram 4** belongs to a set of epigrams used in the case work on assessments of autonomy for robotic systems in care and companionship. By framing the study of this phenomena in the workshop report as a question of *how it is made* through science and law, the disciplinary participation in the workshop is situated on the back of an object of assessment presented to participants in the introduction to the event, as the '*official*' vision directing European innovation policy on the development of future robots—a yardstick participants were asked to measure their expectations against. As epigram 4 indicates, the focus is on the quality of articulating *how* different disciplines relate to the vision and assess it. This is reported in structured ways to represent the actors involved and to represent qualitatively their contributions. For example, on the first day, roboticists report on assessments of *clinical work*, *basic research and experimentation*. The epigram is also an evidence of roboticists encountering and reporting on *technical problems*, *ethical issues* and on *coding ethics into robots*. The reporting of the second day is structured to foreground relations between robotics and law, robotics and ethics, robotics and society, of integrating



## Report from workshop in Utrecht 16-17 Feb 2014: Making robotic autonomy through science and law?

<b>First day – Robotics</b> .....	3
1. Roboticists relate strategically to robot autonomy in their daily work, be that in teaching, research or clinical care work.....	4
a. Clinical work.....	4
b. Basic research.....	5
c. Experimentation.....	6
2. Envisioning <i>aims</i> and <i>purposes</i> and encountering problems.....	7
a. Technical problems.....	8
b. Ethical issues.....	9
c. Coding ethics into robots.....	10
3. Assessing the <i>official</i> vision.....	11
4. Summing up.....	12
<b>Second Day – ethics, law and governance</b> .....	14
1. Autonomy is an ethical and philosophical term with a long history in philosophical treatise on free will. The term is also implicit in legal frameworks where it is qualified in relation to human agency and responsibility.....	14
Ethics.....	14
Law.....	17
2. Facing problems.....	19
3. Solutions for protecting human autonomy were proposed, and ways to improve on the relations between robotics and relevant societal actors: technical, disciplinary and institutional relations.....	21
Standardization and standardization bodies.....	21
Integrating technology assessment, ethics and law into robotics projects.....	21
Allowing for public concerns to be expressed bottom-up.....	22

### Epigram 4: Framing assessments of autonomy for robots as a question of it being *made* through science and law?

assessments into robotics research and development and listening to public concerns. In this depiction, participation, issue framing, interdisciplinarity and epistemic checks and balances, become the focal points for the ongoing case work which effectively was centered on *assessing existing assessments* with contributions from these expert networks: robotics ELSi, STS and vision assessment.

The key lesson to take from the use of epigrams concerns the evidence they give of how a study is proceeding. They are indicative of the leadership and direction in doing this work, and they are also indicative of various styles of leadership and choice of direction. Taken together, we heuristically distinguish three ways in which epigrams can be characterized in terms of the direction they give. **System-based** orientations in epigrams are biased towards preset analytic criteria and frameworks. In epigram 1, the association is with complex multi-scale, multi-layered systems but

also in other system-based orientations we observe, the association is with concerns over how to integrate different assessments of such systems or perform *causal-chain* assessments of them. **Network-based** orientations in epigrams lean on issues, actors, practices, performance, mediation and other factors that get taken into account in a cartography of connections and disconnects *in practice*, which also produces novel leads to take forward. In epigram 2, these leads point to the need to establish new relationships and plug knowledge gaps. **Proceedings-based** orientations in epigrams seek adequacy and quality in preparing for or reporting on legal and other proceedings. Primary elements in them concern process relations, purpose-specificity, participation and clarity in epistemic quality checks and decision-making. In epigram 3, the elements are preparatory for proceedings (lesson in law), whereas in epigram 4, they dictate the reporting of proceedings (lesson in innovation practices).

Epigrams evidence the strengths in doing this work as well as the weaknesses of the teams and within them. Instruments like these are important in sorting things out, however, each element, a category, a classification and the types of connections that are made seen, will always silence someone's point of view, while valorizing someone else's. Epigrams are also the one instrument most clearly illustrating how the case study leaders conceive of the task at hand. They are indicative of thought-styles in trying to bring the study groups together and the material they are working with, i.e., they indicate attempts at *structuring*, *networking* and *processing* in some combination. But we also observe in their uses the difficulty in bringing together formal and informal assessments, knowledge claims, experiences and views on the progress of an innovation domain. We observe that the partners on all sides become hard pressed to expand their horizons to learn and share. The manifestations of this dynamic lie primarily in positions of disciplinary favoritism in what gets included and what gets filtered out, but also in efforts to overcome procedural complications and barriers in communication.

### *Learning and sharing*

There are clear indications of the case studies being segmented, the project and the participation in it segmented, but also case-bound for some members who only participated in a single case, rather than two or more of them. Communication has been fragmented, we see evidence of uncertainty about participating in thinking the cases through over time and there has been partiality at times in the leadership. We see difficulties in sustaining connection and intellectual development, and finding a place for one's practice so to speak in situations where boundary work and boundary

negotiations have posed a significant challenge and no *extra-territorial* methods ready-to-hand to define what matters the most to each of the parties involved.

However, we also see in these developments the kind of diplomacy in approach that Stengers talks about (2005, 2006), i.e., in acknowledging the different species of practice, although, no practice is ever *just* a social practice or a technical enterprise, and there is no guarantee that one practitioner can take the place of another solely on the basis of *some overlap* in orientation to problem-finding and problem solution. There is nothing to indicate that these case studies are any less (or more) coherent, efficient and effectively led than other projects commissioned by the EC to work across disciplines and national borders. Rather, we are questioning here the expectations and the responsabilization of interdisciplinarity and integration for the purpose of improving innovation/technology assessments, as well as public and expert engagements in such assessments. From what we have gleaned, these expectations are misleading or worse, they are unrealistic.

Among the many suggestions we heard from interviewees is the importance of providing *structural leadership* and have built-in processes of commitment. For example, it helps to build a protocol for coming away from meetings always knowing that the team is meeting again on X date and in-between will have done X, Y and Z, always knowing who is following up on what and exactly when you will be hearing from them about it. It helps to write in capacities to provide a better sense of intellectual development and progression. For example, case studies like that will benefit from generous allowance of face-to-face meetings in spite of the travel costs, and especially during early-stage development to deepen relationships and intellectual investments. Planning a number of joint panels at conferences will also help to develop and sustain momentum and the necessary dynamism to enable thinking about the material at hand in novel and engaging ways. Perhaps the most telling observation here is that when participants use terms like *interesting* and *stimulating*, and make of point of saying that they quite enjoyed themselves and felt included, they are typically referring to being in the same room or garden as someone else on their team.

What we are listing here is not a complete index of comments and suggestions we heard but although many of these items seem minute and stating the obvious, they should absolutely not be trivialized and waived off as a matter of *just getting a job done*. They point to the importance of *caring* for organizational, professional and inter-personal conditions in carrying out teamwork and leading it. What we see is evidence of a lack of clarity on what *integration* stands for and what can be expected from bringing together expertise across disciplines, professions and borders like these case studies have done. In short, it is in the actual execution of teamwork and leadership which has

been set up to achieve idealistic goals of interdisciplinarity and integration, that the know-how can come up short in building and sustaining momentum, precisely because *trivial* details of care are missed.

Setting these issues aside, there are important clues in the reporting of members on what the benefits are working together, more specifically, *working as a network* as one of them put it. This work has been affording of opportunities to be cued into new insights and relevant events—into ways of seeing and explaining phenomena that would otherwise be missed. We observe a mention of another member or one of the *other* practices being a good resource in that respect and, overall, participants report on successes in taking advantage of opportunities to collaborate and coordinate efforts. For example, the workshops with innovators, regulators and other groups turned up issue-driven opportunities, “thanks to the dialogue that we had and the interactions, then we were able to ...err ...put everything on the table and see what was most important [...] everybody says, ok this, I think this is the problem, I think this is the problem, I think this is the problem... and in the end there was some agreement, ok, those are the priority areas”. Some of the workshops also supported team cohesion, as one member put it, “in that moment we were forced to act as a team, no... that the Epinet team interviewing all the experts that we invited, so... it was interesting to see ...err ...the different reactions that different people on the team would have to what the experts were saying and how our ...err ...personal visions coincided or were in contradiction with what the others were saying”. Then again, the workshops are frequently foregrounded in the interviews as key events for learning. “[W]e don't go so much into practical challenges ...err ...about regulation for example or pilot projects or ...err ...how to collect information from the users of this technology so, all of these very specific ...err ...things I, I learned thanks to ...err ...thanks to the workshop more than reading the papers”.

That said, key learning to take away from our observations is how selectively and pragmatically experts learn in approximating other disciplines and in distancing themselves. There remains a sense of unease with unfamiliar scholarly and methodological terrains which may require proactive mitigation and mediation, however, we also observe that a sense of integration to take away from case work like this, should not have to be *the* priority. Rather, this work ought to enable thinking about the material at hand in multi-dimensional ways, while aiming for novelty in knowledge creation. The learning here is perhaps stating the obvious that if we confront the fact that the making of contemporary technologies navigates multiple sites, then gaining a good sense of the

nature and extent of this multiplicity is better facilitated by engaging with people across different disciplines, occupations and experiences. But, as one member put it, “part of this is the fact that I have realized that it is not so easy to ...err ...really work together with different ...err disciplines or different approaches, no, because at the end of the day I still understand ...err ...my methodology better than the others and I'm ...I still do what I do”. We can argue in this respect, as Stengers does, that there are good reasons to adhere to ones disciplinary home base as a source of legitimacy and authority but also perhaps that, in this *process of integration*, we become much clearer about what our own disciplinary base has to offer into the mix.

Interdisciplinarity, except in the most basic sense of *collaborating*, is not likely to be achieved by just putting different disciplines together to work on a project. It should be considered an achievement of hard work and, as we observe, such an outcome is more likely to emerge on a much smaller scale than is expected from a large-scale 'interdisciplinary' project. Disciplines tend to collaborate one-on-one or in very small-scale teamwork and we observe that such occurrences are taking place in the absence of formal attempts at integration and often with surprising result. They typically happen in the course of exploring a common assessment issue that produces an ontological entanglement while encouraging a quest for belonging. There are many such small-scale entanglements to observe within the case teams.

One example is when members are shown how to look at an issue from a different perspective or when members are getting a wider picture of actors and sites through which the emergence of a new technology circulates. Our interviewees took time to express their awe, for example, of “some analysis of, you know, these visions of the globe and energy, you know the cities and kind of anthropocene feeling to it. [...]...big cities, the electric globe, you don't see any people, you just see lights and infrastructure...”. Or, in working on a joint paper, “...don't get me wrong, I make a contribution from my kind of angle but their angle is really good”. They also took time to articulate the inspirations they took from the work of others. “[T]his opened a new world ...err ...because I was not so... Well, I had a kind of reductionist view [...] ...I mean, very individualistic and, but then I saw it is much more than that actually. It's a whole movement, it's a ... its really a public issue and it's stretching way into the technology communities and, and... so it's really really a broad ...err ....development”.

Other examples of entanglement are when members are participating in a joint mapping of actors

and networks; when members become aware of phenomena previously unknown to them, “you start out on your own and then you start mapping, you know, and then you see the mappings of the others and then you gradually try to integrate this into something more ...err ...joint paper.”. Here, we can argue that members are reporting on not only plugging knowledge gaps but co-creating new knowledge on the basis of entanglement of method and approach. Team members also report on having a change of heart on some position or other. They get a clearer picture of how their discipline can contribute and how it relates to technology assessments if they are new to it, as one member put it, “I got to see things as more diverse and nuanced”. But, they also report on borrowing models, sources and theories and they take examples of certain methods being extended to new areas of concern. The most prominent example is using Knowledge Assessment Methodology, traditionally used to assess policy documents but extended to assess knowledge creation in blogs and online consultation. Another example is to take interface analysis and layer it with legal analysis. These two examples signify radical shifts in methodological and topical focus which is also observed in cases where members join up to mobilize and align lessons from their home discipline to address a common problem or a commonly perceived insufficiency in innovation and policy practices. Key example of that is the joint effort to study how risk assessment is migrating into DPIA and also into vision assessments.

As some the examples above indicate, opportunities are frequently realized in and through writing projects which should not come as a surprise, given that writing together is reported as a method of alignment, of deepening intellectual development and *de facto* integrating or combining approaches and view. “Well, lets see what will be the outcome of this paper [...] ...and I think we are, we have discussed it at length and we are aligned”. Some of these writing projects emerge in conjunction with more formal meetings and events, “and then the three of us sat in the hotel lobby [...] ...and for about 40 minutes and just planned a paper [...] and, and agreed a division of labor and, and, and a theoretical focus and a title actually”. But, this is an area where also some of the key disappointments lie as examples of *things not working*, “at that point when we wanted to get deeper into the issues and to really combine two approaches in a paper...err ...it didn't work that well and I think it was because ...err ...for some reason we, we tried to ...well, we just had one meeting”.

These and similar remarks really draw attention to the import of academic and associated output and the essence of co-presence which then calls for ways to accommodate academic and/or professional expectations alongside expectations of what a teamed-up evaluation of some

innovation domain can produce together which then also has policy-relevance to meet the demands of those who fund such projects—what the novelties are in the research and policy reporting of a study team against the individual and/or combined disciplinary commitments of its members.

## **Concluding remarks**

At the heart of what we observe is the willingness (or not) to overcome disciplinary barriers, as much as that is indeed possible, and how that then works with more explicit concerns about integration as a cross-cutting issue in the Horizon 2020 program. From what we have learned to-date, we suggest that each case study is an exploration, a laboratory of assessment practices aiming to grasp their ecology in order to tie the question of what constitutes a practice to the question of its co-existence in an environment of other practices. Each case is approximating and distantiating disciplines, and entangling them in ways in which leads each case to a *mode of integration*, so to speak. Looking now through the developments within the case studies, we can say that the different modes of doing this work hinge in part on technology-specific issues, in part on knowledge sector-specific issues as well as more generic issues. For example, ICT-based innovations which essentially are key enablers in most innovation domains nowadays, constantly call for a distinction between technology-specific, societal and generic problems.

Modes of doing this work also hinge on differences between the epistemic networks in question, for example, who the actors are who get involved, their import and influence in the world of innovation, assessment and governance, the complexity of the technology in question, and the amount and nature of pertinent 'hot' issues the innovation-domains engender. Great efforts were put into extending the case work to innovators, policy experts, regulators and user groups, but there are still many disconnects with relevant expertise, experiences and opinion, which points to the question who indeed was included or left out. And, it goes without saying that matters of inclusion and exclusion hinge not only on available resources, but also on partiality in choice, top-down vs. bottom-up approach to study, and so on.

The dynamics of leadership are also at the center here along with a responsibility for coherence and convergences in the work of teams and team members. There are many *styles* to consider in that respect. We could for instance think of leadership as primarily facilitation, i.e., to foster connections between participants and provide for opportunities in the broadest sense. We can also conceive of leadership as a proactive role in proposing models of integration for the combined work. As one



interviewee put it, someone “is the olive of things, you know, and coordinates all these ...err... coordinates these inputs and shows the others how it is fitting”. Making the most of available resources, the networks started on a premise of a small set of assessment methodologies but were enabled to grow experimentally, to reshape and restructure through dialogue and mediation. In other words, the work of each Epinet case study was indeed one of *shaping a field* which then has claims upon know-how and future action, i.e., something to contribute to ongoing and future work of innovation, assessment and governance.

That said, given the evidence that interdisciplinarity and integration are works-in-progress as well as the RRI agenda that responsabilizes them, we can argue that leadership, under the circumstance, would be right to proceed in appreciating the value of *exploratory action*. Study groups like that should also value the opportunity to critically address the institutions that make demands on their work in ways that can and should be resisted. “[T]he experience of these [workshop] conversations was very good and the experience of our internal conversations was very important. [...] ...it was an encouragement rather than anything else [...] it was not difficult to challenge all these narratives [...] these policy initiatives at the European Commission. We found out that through exploring them, through exploring these documents and through exploring these discourses and but... [...] they make claims that they... what are they talking about?”

It is precisely being utterly vexed like that by the political climate in which European innovation policy proceeds with crucial decisions, which leads us to argue that projects like the one we have observed, need to proceed in a mode of *trial and error*, of qualifying on a case-by-case basis what interdisciplinarity and integration constitute as achievements (partial and situated) and what that delivers of relevance to innovation policy. They need to proceed in a mode of learning and sharing among everyone involved, also among the beneficiaries in the wider epistemic networks, whose institutions and practices are being assessed. The expectations of those who actually get involved are certainly on par with that conclusion, as one of them put it, “you really have to be there to know what happens”.

## References

- Aarts, E. and Marzano, S. (2003) *The new everyday: views on ambient intelligence*, (Rotterdam: 010 Publishers).
- Aarts, E. and de Ruyter, B. (2009) New research perspectives on Ambient Intelligence, *Journal of*

*Ambient Intelligence and Smart Environments*, 1(1) pp. 5-14.

- Barben, D., Fisher, E., Selin, C. and Guston, D.H. (2008). Anticipatory governance of nanotechnology: foresight, engagement and integration. In O.A. Edward, J. Hackett, M. Lynch and J. Wajcman. *The Handbook of Science and Technology Studies*. MIT Press, pp.979-1000.
- Barry, A., Born, G. and Weszkalnys, G. (2008). Logics of interdisciplinarity. *Economy and Society* 37(1): 20-49.
- Bowker, G. and Star, S.L. (2000). *Sorting Things Out: Classification and Its Consequences (Inside Technology)*. MIT Press.
- Deleuze, G. (2006). *Foucault*. London: Continuum.
- Fisher, E. (2007). Ethnographic intervention: probing the capacity of laboratory decisions. *NanoEthics* 1(2): 155-165.
- Fisher, E., Mahajan, R. and Mitcham, C. (2006). Midstream modulation of technology: governance from within. *Bulletin of Science Technology Society* 26(6): 485-496.
- Foucault, M. (1991). *Discipline and Punish*. London: Penguin.
- Haslam, S. A. (2004). *Psychology in Organizations: The Social Identity Approach (2<sup>nd</sup> edition)*. Sage Publications.
- Huutoniemi, K., Thompson Klein, J., Bruun, H. and Hukkinen, J. (2010). Analyzing interdisciplinarity: Typology and indicators. *Research Policy* 39: 79-88.
- Latour, B. (2005). *Reassembling the Social: An Introduction to Actor-Netork-Theory*. Oxford University Press.
- Meyer, J. P., Stanley, D. J., Herscovitch, L. and Topolnytsky, L. (2002). Affective, Continuance and Normative Commitment to the Organization: A Meta-analysis of Antecedents, Correlates, and Consequences, *Journal of Vocational Behavior*, 61: 20-52.
- Meyer, J., Becker, T. and Van Dick, R. (2006). Social Identities and Commitments at Work: Toward an Integrative Model. *Journal of Organizational Behavior*, 27: 665-683.
- Nowotny, H., Scott, P. and Gibbons, M. (2001). *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*. Polity.
- Latour, B. (2005). *Reassembling the Social: An Introduction to Actor-Netork-Theory*. Oxford University Press.
- Owen, R. (2014). *Responsible research and innovation: options for research and innovation policy in the EU*. European Research and Innovation Area Board (ERIAB), Foreword Visions on the European Research Area (VERA).
- Owen, R. and Goldberg, N. (2010). Responsible innovation: a pilot study with the U.K. Engineering and physical sciences research council. *Risk Analysis* 30: 1699-1707.
- Owen, R., Bessant, J. and Heintz, M. (eds) (2013). *Responsible Innovation. Managing the responsible emergence of science and innovation in society*. John Wiley & Sons Ltd.
- Owen, R., Stilgoe, J., Macnaghten, P., Gorman, M., Fisher, E. and Guston, D. (2013). A Framework for Responsible Innovation. In R. Owen, J. Bessant and M. Heintz (eds.) *Responsible Innovation. Managing the Responsible Emergence of Science and Innovation in Society*. John Wiley & Sons Ltd.
- Ruggiu, D. (2014). Responsibilisation phenomena: the EC code of conduct for responsible

- nanosciences and nanotechnologies research. *European Journal of Law and Technology*, 5(3).
- Schuurbiers, D. and Fisher, E. (2009). Lab-scale intervention. Science and society series on convergence research . *EMBO Reports* 10(5): 424-427.
- Stengers, I. (2011). Comparison as a matter of concern. *Common Knowledge* 17(1). pp. 48-63.
- Stengers, I. (2006). *La Vierge et le Neutrino*. Paris: Les Empêcheurs de penser en rond.
- Stengers, I. (2005). Introductory notes on an ecology of practices. *Cultural Studies Review* 11(1).
- von Schomberg, R. (ed) (2011). Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields. *European Commission (DG-Research)*.
- von Schomberg, R. (2013). A Vision of Responsible Research and Innovation. In R. Owen, J. Bessant and M. Heintz (eds.) *Responsible Innovation. Managing the Responsible Emergence of Science and Innovation in Society*. John Wiley & Sons Ltd.