Crossover research 2.0
Well constructed knowledge commons

We explore how an integrated project can help shape responsible Knowledge Commons structures by engaging its ethos.

1. Relevance relative to the call for proposals

The objective of our research is the development of a broadly enabling ICT-founded "Knowledge Commons" for the Life Sciences and the health and biotechnology sector. If well-conceived, such enabling Knowledge Commons structures will be transformative in many ways as they rebuild the structures of innovation for the whole of the Life Sciences. This project meets core aims of the call, by developing capacities within innovation structures to take responsibility for the ramifications of such transformations. The project thus addresses how ICT research and innovation may contribute to developing viable solutions to grand societal challenges.

A Knowledge Commons (KC) is needed to store and share life science knowledge in order to be able to rationalise and enable interpretation of the wealth of biomedical findings and health data, identified as a key computational challenge of ICT-pluss. The project supports the ICT-pluss aim to increase the relevance and enabling capacity of ICT research by addressing computational problems that arise in the border zones of the ICT-field and other disciplines. We identify such border zones as key venues for ICT induced transformations that are in need of being responsibly modulated. We meet the requirement to «practice RRI" by engaging values at stake in these venues. We identify, trace and evaluate normative drivers by paying attention to how epistemic and ethico-political quality measures cross-over in the construction of KC infrastructures in such border zones. Articulating the ethos is the first step of engaging a deliberation of the ethos as individuals are challenged to ask: is this really what we "collectively want science, technology and innovation to bring into the world?" A viable and robust ethos of such collectives will be one that can withstand the trial of moral scrutiny.

The project meets a national challenge for RRI identified in the SAMANSVAR program plan, namely "to further develop integrated approaches". We emphasise the need for productive academic collaboration, focusing collaboration efforts in areas where research fields need to be mutually engaged and mutually responsive. The project is situated in cutting edge and innovative research communities committed to building KC structures, but socially contextualised in order to unpack normative drivers. *Precision medicine*, or *personalised medicine* (PM) is one key visionary driver for KC, justifying why PM is chosen as our social context for KC infrastructures. Our project builds on collaboration that has been ongoing for over 10 years developing skills and personal relationships that significantly capacitate us in pursuing this kind of research. The project allows for refinement of research questions and inclusion of societal actors essential for comprehensiveness and productivity of joint work.

2. Aspects relating to the research project

The project is embedded in a global research collaborative setting, since building a KC servicing the entire biomedical domain for a comprehensive set of applications is clearly an endeavour that vastly exceeds the capacity of single research teams, universities or even countries. We are currently starting to see efforts to create new and interconnect existing knowledge base infrastructures into one comprehensive knowledge commons: an extensive scientific and social structure legitimised to solve grand health challenges of our time. The KC we are focussing on calls for the innovation of comprehensive experimental systems within the Life Sciences and ICT, implying novel forms of

organisation and collaboration, both materially and socially. The nature and quality of such an effort has to be informed by and demonstrated in a user context.

Researching social responsibility of KC structures starts with an analysis of general specifications of what it takes to collectively build viable knowledge commons. Our project focusses on a specific case, namely GRECO (http://www.thegreco.org/) , an emerging global "sandbox" initiative aimed atbuilding the Gene Regulation Knowledge Commons driven by two of the project's senior researchers: Astrid Lægreid and Martin Kuiper. Our project, Crossover Research 2.0, will socially contextualise this effort by collaboratively designing a "prototypical system" for KC building. The assumption is that this prototype enables us to map and take into account overlapping scientific and societal issues, problems and expectations, in the context of one overarching application: KC development for life science *systems modelling*, designed to release the potentials of precision medicine. The overarching research questions are therefore: What are the bottlenecks of the innovation system and what responsibility challenges do they pose? What solutions are feasible and what normative aspects of how the world will be restructured should be scrutinised and further articulated? Do solutions withstand the trial of moral engagement and scrutiny? These research questions involve interdisciplinary solutions and require joint work for refining research design, as issues that morally matter are identified.

2.1.1 Background: Building enabling knowledge commons structures

A comprehensive Knowledge Commons broadly enabling the entire Life Sciences is a grand challenge, but in order to have short-term results, our project will be assembled around knowledge-based development of computational models that can be used for simulating and predicting synergies of anticancer drug combinations. The project is an extension of ongoing work of our research groups in knowledge management and knowledge-based reasoning and modelling, brought together in an experimental model system that has already proven to demonstrate its potential for precision medicine[1]. We now want to exploit this as the foundation for a responsible research and innovation infrastructure situating the work of building KC in a broader disciplinary and societal context. The project includes four modules reflecting the different deliverables that are targeted in four workpackages: 1) Building communication structures for dissemination project aims and results, and engagement of a stakeholders group able to reflect on KC building approaches and use cases; 2) Analysis of KC design and development as an enabling resource; 3) Modelling drug responses as an example use of KC; and 4) Analyse and engage the ethos of KC, exploring the potential of reflexive engagements among all project partners to find ways of further facilitating KC for broader biotechnology and clinical application areas. In the following we outline the logic of the pipeline and explain how the KC prototype development will be jumpstarted by ongoing research in Nydal's, Lægreid's and Kuiper's intertwined research groups.

It is generally believed that the amount of biology that can be explained without the use of models is shrinking[2], and that the assembly of models accurately depicting biological systems needs knowledge about biological system components and how they interact. Designing and building infrastructures for a knowledge commons is furthermore needed to rationalise the analysis of existing big data, and even more challenging, to build bottom up knowledge-based research structures to *manage* and *engineer* knowledge in ways that enable precision medicine[3]. KC design and construction work therefore needs to be inspired by a broad range of stakeholders, potential data and knowledge providers, and a variety of end-users. Moreover, such structures should not

[1] Flobak Å, Baudot A, Remy E, Thommesen L, Thieffry D, Kuiper M, Lægreid A. Discovery of drug synergies in gastric cancer cells predicted by logical modelling. Manuscript submitted *PLoS Biology*

[2] Green, S., & Wolkenhauer, O. (2012). Integration in action. *EMBO reports*, 13(9), 769-771.

[3] Cases, Montserrat, et al. Improving data and knowledge management to better integrate health care and research. *JInt Med* 274 (2013): 321

only be comprehensive in terms of the number of involved institutions and professional activities, but also require novel ways of analysing and optimising the sharing of knowledge bases in such ways that they can seamlessly underpin analysis of data with different types of analysis objectives, confidentiality issues, and applicational practices.

The scientific community realises therefore, that the way forward for an effective scientific discovery and innovation process is the building of one "Knowledge Commons" available freely to academics and companies alike, where the combined discoveries about biological components (genes, proteins, other) and their interactions, together with their biological context (experimental system), is cared for, checked and preserved[4,5]. We are building an extensive experience with crossover activities in the domain of Knowledge Management (KM): the key enabling technology for building the knowledge commons. Not only are we making domain specific advancements in the technology that drives KM[6], we also consider cross-disciplinary aspects of the potential and hurdles that building a Knowledge Commons faces. Recently, Lægreid and Kuiper have initiated efforts to continue their work in a global scientific setting by establishing GRECO: the Gene Regulation Consortium (www.theGRECO.org). GRECO brings together major players from the global scientific community active in the domain of developing technologies and building resources for curating, or *taking care of* information and knowledge pertaining to gene regulation.

The GRECO initiative needs to be understood in a context of the growing number of large distributed pan-European research infrastructures that are now becoming highly visible in the Biological and Medical Sciences and are recognised to provide key pillars at all levels in the European research, training and innovation triangle. There is clear expectation that existing and new infrastructures, designed under the umbrella of the *European Strategy Forum on Research Infrastructures* (ESFRI[7]) will facilitate interoperability and improved use of health-related data to enable precision/personalised medicine across Europe and that shared infrastructure also takes into account human resources to ensure adequate cross-disciplinary education and communication. The ESFRI organisation is commissioned to ensure that the Research Infrastructures keep evolving, respond to current needs and prepare for the future. Communications with targeted ESFRI member organisations will be essential for our project as we seek to underpin our GRECO initiative with an RRI component realising how hurdles, gaps, cultural and epistemic practice issues observed in GRECO are intertwined.

2.1.2 Background: Working units of research, and "integration" as RRI strategy

The innovative and transformative powers of science can be studied in terms of how actions are mediated through the field's experimental systems. In Rheinberger's words, an experimental system is the smallest working unit designed to give unknown answers to questions that the experimenters are not yet able clearly to ask. The process of constructing these systems is governed by an internal dynamics, what Hacking described as the "self-vindicating" dynamics of laboratory research. Scientific work, when succeeding, may be controversial as it involves building machineries for

[4] Good BM, et al Organizing knowledge to enable personalization of medicine in cancer. *Genome Biol.* 2014 Aug 27;15(8):438 - Friend SH1, Norman TC.Metcalfe's law and the biology information commons.*Nat Biotechnol*. 2013, 31(4):297

[5] Lægreid A, Kuiper M. Health and the information commons. Pan Europ Netw: Government Magazine, *in press* Issue 13, February 2015

[6] Antezana E, Kuiper M, Mironov(2009). Biological knowledge management: emerging role of the Semantic Web technol. *Brief bioinf*, 10, 392

[7] The ESFRI (European Strategy Forum on Research Infrastructures; http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri) organisation is commissioned to "support a coherent and strategy-led approach to policy-making on research infrastructures in Europe, and to facilitate multilateral initiatives leading to the better use and development of research infrastructures, at EU and international level."

creating common futures, which is particularly evident in large experimental systems built to enable innovation.[8]

The notion of experimental systems identifies the task of RRI research initiatives in the context of the need to "rethink science".[9] With reference to Pickering and Jasanoff, we may speak of three "idioms" for thinking about science, technology and society.[10] The "representational idiom" casts science as an activity that seeks to "produce knowledge that maps, mirrors, or corresponds to how the world really is". This has been extensively analysed as a dominating idiom substantiating sharp normative divisions of labor between ethical-political activities and the epistemic activities of science, in what Taylor calls an "epistemologically modelled" normative order. [11] These orders have been identified and discussed in terms of the "social contract" between science and society, ideals that have been argued as necessary to be reconsidered in light of what science has become.[12]

The "performative idiom" expresses scientific truths in terms of what we have to deal with, rather than what we may represent, accounting for the epistemic activity of the experimental sciences as the one of creating orders or "stability"[13]. Such stable or reliable orders crosses over the natural and the social, often referred to as "socio-technical" orders. Building such orders is increasingly explicitly expressed as goals of large scale scientific initiatives (typically labelled as *enabling* or *converging* technologies). RRI/ELSA initiatives emerged in the context of such priority areas where changes in modern science are particularly evident (widely discussed as shifts from normal to "post-normal", academic to "post-academic" or Mode 1 to "Mode2" science). RRI initiatives reflect how scientific activities increasingly are seen to be a collective social concern as they perform "collective experiments" on our common futures. Shifts in modes of knowledge production do in many ways come in conflict with historically fine-tuned normative orders we live by and are committed to. The shifts appear both irreversible and urgent as grand challenges call for "well constructed collectives" implying coordinated scientific, industrial and societal efforts. [14]

RRI activities are widely recognised as urgently needed, despite of few generally recognised success stories and lack of unifying analysis across sectors of the why's and how's of RRI. State-of-the-art RRI actions are basically still at a stage of outlines of frameworks and definitions.[15] Being aware that this may lead to new forms of dogmatism, disciplinary unproductive positioning and fragmented RRI communities, we have taken responsibility for creating venues for a multidisciplinary research community in Norway in general as well as building robust research groups in particular.[16]

In our analysis, the work of restructuring *normative* orders are critically challenging for RRI initiatives. The "co-production idiom" for thinking about science, technology and society calls for

[8] Hacking,I. 1992 The Self-Vindication of the Laboratory Sciences. In Pickering 1992 (ed.) *Science as Practice and Culture*. - Rheinberger, H-J.1997 *Toward a History of Epistemic Things* - Rabinow,P.et.al.2005 *A Machine to make a future*.

[9] Nydal,R.2005 *Rethinking the topoi of normativity.* Phil. dissertation, NTNU - Nowtny, H. et.al.2001 *Re-thinking science*

[10] Jasanoff,S.2004 The Idiom of Co-Production.In Jasanoff (ed) *States of Knowledge* - Pickering, A.1995 *The Mangle of Practice* (p5-7*).*

[11] Taylor, C. 1984 Philosophy and Its History. In Rorty et.al. (eds.) *Philosophy in History*. Rorty 1980 *Philosophy and the Mirror of Nature – Latour, B. 1993 We Have Never Been Modern* - Hacking, I. 1983 *Representing and Intervening*

[12] Winner, L. 1993 A New Social Contract for Science. *Technology Review* (96) 65. - Lubchenco, J. 1997 Entering the Century of the Environment: A New Social Contract for Science. *Science* (279) 491. - Guston, D. H. and Keniston, K. 1994 Updating the Social Contract for Science. *Technology Review* (97) 60. - Gibbons, M. 1999 Science's New Social Contract With Society. *Nature* (402) 81.

[13] Fujimura, J. H. 1996. *Crafting Science*. Galison, P. 1987. *How Experiments End*. Pickering, A. 1995 *The Mangle of Practice*. Rheinberger, H-J. 1997. *Toward a History of Epistemic Things*. Knorr-Cetina, K. 1999 *Epistemic Cultures*

[14] Latour, B 2004 "Which protocol for the new collective expeiments?" In Schmindgen,H. (ed) *Experimental cultures European Commission reports a) Nordmann A. 2004 Converging Technologies - Shaping the Future of Euopean Societies.b)Hoven J 2013 Options for streghtening responsible research and innovation.* Latour, B. 2004 *The Politics of Nature*.

[15] Rip, A.; Schot, J.W.; Misa, T.J. 1995 *Managing Technology in Society. The Approach of Constructive Technology Assessment* - Guston, D, og Sarewitz, D. 2001 Real-time technology assessment. *Science and Public Policy* (33) 5-16, 2001 - Conferansen I rom, Rip, RRI boken

[16] Myskja,B et.al We have never been ELSI researchers. No need for a post-ELSI , Nydal et.al ELSA Norway in review, ELSA-Norway network (ntnu.edu/elsa). RESET research group (researching the ethos of technology ntnu.edu/reset)

structuring the epistemological modelled practices of western societies.[17] The challenge of RRI thus needs to be understood in terms of how professional identities and goals are challenged. The very understanding of the ethos of one's professional practice includes how it is to be conducted well in relation to other adjacent practices. Integrated projects appear to us as one, among many, important RRI approaches as they provide an important venue for engaging the ethos of collectives as well as constituent fields of practitioners.

2.2. Approaches, hypotheses and choice of method.

We have been inspired by the design of "integrated projects", in particular Fisher and his colleagues at Arizona State University and Rabinow and Bennett at Berkeley University, California. Integrations were framed as a call for "post-ELSI" approaches, criticising ELSI research for lack of interventionist capacity, downstream, consequence and disciplinary oriented. We criticise the post-ELSI framing, reading ELSI as applied ethics attempts to take on a responsible role as co-constructors in a more participatory and integrative way than they have been used to.[18]

Applied ethics is interdisciplinary; being knowledgeable of ethics is not enough as specific urgent 3ethical issues of the sciences give directions to the academic work.[19] Applied ethics seeks integration in order to increase relevancy, quality and researcheability of the ethics and politics of science. "Integrated projects" are STS informed, a field marked by its history of criticising the normative order of the representational idiom. STS seek integration in order to mold socio-technical systems, equipped with means to understand *how* such systems evolve. Desirable directions of research are, however, not researched - as in the case of "midstream modulation", the aim is to increase "reflexive capacity" in order for the research system to find ways to improve itself. We integrate applied ethics and STS perspectives seeking ways to identify and evaluate normative drivers embedded in the system.

We engage the ethos of socio-technical systems by means of articulating and critically evaluating values essential for the practice.[20] Human agents cannot escape evaluating their own actions, although the evaluation may be weak or strong, that is, even crucial decisions we live by may be more or less well explicitly deliberated or more or less well argued.[21] The notion of ethos of socio-technological systems draws attention to immanent evaluative traces of human action. Researching the ethos is to engage human identities individually and collectively through addressing institutional practices. We practice RRI by not only aiming at delivering relevant and convincing reanalysis but also through collaborative engagement in the research settings under scrutiny.

Our mode of integration is symmetrical, i.e. we aim at creating research venues where everyone may contribute professionally in productive ways, or not participate at all.[22] The Knowledge Commons was investigated and confirmed to be a productive "interaction zone" at an International Workshop that we arranged as part of our Crossover 1.0 research project, September 2014.[23] Our

[17] Nydal, R. 2005 *Rethinking the topoi of normativity*. Phil. dissertation, NTNU

[18] Rip, A.; Schot, J.W.; Misa, T.J. 1995 *Managing Technology in Society. The Approach of Constructive Technology Assessment* - Guston, D, og Sarewitz, D. 2001 Real-time technology assessment. *Science and Public Policy* (33) 5-16, 2001 - Fisher, E. et.al 2006 Midstream Modulation of Technology: Governance From Within. *Bulletin of Science, Technology & Society* (26) 485-496, 2006.

[19] Tuana.N.2010 Leading with ethics aiming for policy. Synthese 177:471-492 - Toulmin S. 1982 How medicine saved the life of ethics. Perspectives in Biology and Medicine. 736–750.

[20] Nydal, R. 2013. Normative crossover: The ethos of socio-technological systems. In Goldberg, D et.al (eds) Philosophy and Engineering: Reflections on Practice, Principles and Process. Chapter 19 – Nydal is part of the RESET reserch group (Resarching the ethos of technology) aiming at researching the ethos.

[21] Taylor, C. 1995 *Philosophical Arguments*.

[22] Nydal,R, Efstathiou, S and Lægreid, A. (2012) Crossover Research: Exploring a collaborative mode of integration, In van Lente H et.al Little by Little. Expansions of Nanoscience and Emerging Technologies 181-194

[23] Knowledge management and the future of our societies. September 8-9 2014, Trondheim. Sattelite to Virtual Physiological Human Converence 2014. http://www.ntnu.edu/web/vph2014/home.

shared goal now is to investigate conditions for well-constructed KC structures. Epistemic and normative quality measures overlap, and therefore participants are professionally motivated to perform time-consuming interdisciplinary work including the need to acquire necessary "interactional expertise"[24]. It is critical to ensure joint ownership, long term commitment and high quality professional and scientific outcome of collaborative integrative research of the sort we aim at. We have an additional moral obligation to find ways to efficiently engage human academic resources by having the research question defining research action. Choosing project partners is particularly critical in our case as they are to be resources within a 'prototype system' which we construct in order to imagine futures. We will enroll these partners in the initial phase of the project through tasks defined in a dedicated workpackage.

KC will be broadly enabling, if potential hurdles for its construction, maintenance and uptake are properly remedied. We therefore aim to reflect on past and current KC engineering efforts and assess strengths and weaknesses in what is achieved in the border zones of a variety of activities: knowledge management technologies, epistemic practices, professional disciplines, societal expectations and solutions sought, and relationship between basic science and applied biomedical science. We aim at jointly building a prototype system of knowledge commons production and use to research its ethos, paying particular attention to how the ethos is shaped in bottlenecks and border zones. Engaging the ethos opens up black boxes of normative commitments, what is valued by whom for what reasons? The prototype helps to achieve feasibility, reduce the complexity, and allows us to start operating in a well-known environment.

We will recruit postdocs trained in computer sciences and humanities who can meet work descriptions based on their respective academic expertise while still being jointly committed to an RRI project.

3. The project plan, project management, organisation and cooperation

3.1 project plan

The project work is organised in 4 workpackages, involving three postdocs/researchers

WP1: Workshop planning and effectuation

Aim**:** We aim to found the project on a well-developed communication structure that involves a project website, stakeholder's representation and topical seminars and workshops. This will support the dual aim of exploring conditions for feasibility and moral acceptability of WP2-4.

Method: Efficient and dedicated communication- and dissemination structures will include a project website and seminars and workshops that involve the project partners and stakeholders in collective RRI discussions. The project is centred on our efforts to contribute to the gene regulation Knowledge Commons (WP2) and to develop KC-based predictive modelling for anti-cancer combinatorial treatment response (WP3). As this work exemplifies how KC will enable modelling and analysis of Big Data we will assemble a stakeholders group affected by this. We have already identified some categories of key players and stakeholders that are of special interest to our project.
The first six months are devoted to a) create a common understanding of the different research levels of the project, and contemplate the RRI model as a means to reflect on how our work will affect societal challenges; b) outline a KC-enabling prototype system based on this understanding to remedy current bottlenecks; c) identify critical stakeholders to engage with, based on this analysis. We communicate our findings in a position paper that also helps unifying the efforts of the group.

WP2: GRECO, international consortium building the Gene Regulation knowledge commons

[24] Galison P (1997). Image & logic: - Collins H M, & Evans R (2002). The third wave of science studies. *Soc Stud Sci*, 32, 235

Aim: Explore conditions for GRECO to meet key bottlenecks of utilising Big Data through engaging research stakeholders involved in building a knowledge commons for the domain of gene regulation. The identification of bottlenecks of effective structures will support work of building such structures, and help to identify normative drivers.

Method: GRECO is dedicated to building a KC for the domain of Gene Regulation. We will use GRECO as a "sandbox" model effort to contextualise the Knowledge Commons in the medical research application that it is to enable. Its members bring together the necessary expertise in building ontologies for annotating biological components with knowledge about their function and interrelationships resulting from scientific experiments and described in literature and databases. A postdoc will be working with Kuiper's group and contribute to producing an exhaustive Transcription Factor – Target Gene knowledge base, extending on our existing TFcheckpoint database (www.TFcheckpoint.org[25]); add to the development of new ontology terms and relationships; and help establish curation guidelines and protocols (including web 2.0 and web 3.0 approaches) for data from new technologies in order to aid in the design and building of the open and transparent Knowledge Commons for Gene Regulation.

This work critically depend on identifying requirements for the integration of this data with border zones to other fields of expertise, like found in the other domains of the GRECO or users including researchers in Lægreid's group working on predictive modelling for rational design of combinatorial drug treatments. Carrying out an initial GRECO KC design will constitute a sandbox project where the scientific bottlenecks can be identified and further socially contextualized in terms of how stakeholders' interests and values are perceived and implemented.

WP 3: Predictive drug response modelling empowered by the knowledge commons

Aim: Explore conditions for the practical use of the GRECO KC for the development of computational models in the specific case of in-silico drug testing. Establish what the key KC requirements are for successful use of such modelling approaches in drug development and health care. The identification of key success criteria will support both RRI-enhanced KC development and help identify normative drivers.

Method: We will focus on the different aspects of the Knowledge Commons that are needed to underpin modelling for drug development and precision medicine, seen from the perspective of the different user groups/players along the knowledge discovery chain. We will focus on our ongoing development of ICT technology and tools for the automated generation and simulation of models assembled from the KC resources, in order to predict a rational choice of combinatorial drug treatment in cancer tailored to a specific cancer subtype or a specific patient. This will position us well to identify challenges related to the use of such modelling in pre-clinical biotech/pharma-industry pipelines and in clinical decision making. We will flesh-out the different aspects of the Knowledge Commons that are needed to underpin modelling for biotech/pharma and precision medicine.

WP4: Engaging the ethos of KC

Aim: Articulate the ethos of KC, exploring the potential of engaging the research of ethos as ways of founding integrated ICT projects as joint RRI approach.

Method: The work of constructing KC structures addresses issues of distributed responsibilities for the machineries we choose to make, what they enable, or possibly disable by hindering building of other machineries. This workpackage rests on and feeds back into the work of WP2 and WP3

[25] Chawla, K., Tripathi, S., Thommesen, L., Lægreid, A., & Kuiper, M. (2013). TFcheckpoint: a curated compendium of specific DNA-binding RNA polymerase II transcription factors. *Bioinformatics*, btt432.

engaged in building such machineries. Key work of these workpackages consists of identifying bottlenecks and challenges in meeting the needs and requirements of border zones in other fields. It involves work of creating productive trading zones where participants need not only be prepared to mutually adjust one's practices but also one's aims including what one professionally finds worth doing. We expect most of this work to have little normative relevance. We aim at identifying key transformative sites that matter as our prototype model allow for contextualising GRECO work in the entire "biomedical production chain". We foresee key issues to arise a) when tracing ramifications of scientific quality requirements like openness, sharing, unifying of private and public knowledge providers. These are areas where a number of questions of distributed responsibility of Knowledge Commons arise, like the role of funding agents, working scientist, journals and member organisations of ESFRI; b) in curation of knowledge, KC is controversial and unclear with terms like "background knowledge", "knowledge engineering", "knowledge rediscovery" or "recycling" - we only have started to unpack and investigate what is at stake in these innovation terms[26] ; c) in downstream interface of the models aiming at personalised medicine.

WP4 includes a reflexive part focusing on the project's desired impact to engage the ethos of KC in the context of the work flow of establishing a prototype system enabling personalised medicine. If powerful technologies come at the cost of moral confusion, how can we find creative ways for continuous societal and ethical exploration and evaluation to live alongside this inevitability? To what extent did topics cross-over and make a difference to the broad domain of KC? To what extent have we succeeded in working together in a truly engaged way? To what extent have we succeeded in providing substantial analysis that can make a difference? What has changed in our own work practices, what resistances to change are there, and why are there these resistances? In the normative sense, what is the justification of these modifications and resistances?

[26] Efstathiou, Nydal,Lægreid,Kuiper: 2015 When knowledge become something to manage. In review.