Hybridity and Social Responsibility
In Techno-Anthropology and Engineering Education

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INTRODUCTION

During the past three decades the educational programs within the institutional framework of the university have undergone substantial changes. The changes that can be observed have, among other things, to do with disciplines and disciplinarity as the classical virtues of science is put under pressure by particular interests [1]. The dissolution of the monistic belief in science as the ultimate and absolute explanatory force was on its way before 1980 through the critique of idealistic social-constructivists like Berger and Luckmann [2], but it was not until the economical and societal conditions changed in the beginning of the 80's that we saw how multi-, trans- and inter-disciplinarity manifested itself in new university programs in engineering and science.

The American historian of technology and science Rosalind Williams described in *Re-tooling. A Historian confronts Technological Change* [3] how this took place at MIT, whilst she was dean at the faculty of science and engineering from 1995 to 2000. There she experienced how new educational hybrids came into being at the various departments within the faculty. She writes in dramatic terms about the substantial changes that took place within a fairly short period in the 1990's at MIT:

"There is no "end to engineering" in the sense that it is disappearing. If anything, engineering-like activities are expanding. What is disappearing is engineering as a coherent and *independent* profession that is defined by well-understood relationships with industrial and other social organizations, with the material world, and with guiding principles such as functionality. Engineering is "ending" only in the sense that

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nature is ending: as a *distinct and separate* realm. The two processes of disintegration are linked. Engineering emerged in a world in which its mission was the control of non-human nature and in which that mission was defined by strong institutional authorities. Now it exists in a *hybrid world* in which there is no longer a clear boundary between autonomous, non-human nature and human-generated processes. Institutional authorities are also losing their boundaries and autonomy" [4].
Williams indicates how engineering has lost its ties and bonds to nature and the natural sciences, because these entities have lost their precise contours and contents. This existential loss, which has been addressed by a diverse range of researchers and philosophers of technology as for instance Bruno Latour [5], Don Ihde [6], Carl Mitcham [7], Albert Borgmann [8] and Andrew Feenberg [9], just to mention a few, was, according to Williams, substituted by a new belief in the force of commerce, finance and market. Williams writes:
"In the 1990s, the trend toward hybridizing engineering and management only became more pronounced". [4]. Further down the line she underscores the new condition of engineering: "…engineering and management are the 'hot mix'" [4].

In a more recent context Jamison, Christensen and Botin claim in *A Hybrid Imagination. Science and Technology in Cultural Perspective* [10]) that the engineering managerial mix will not adequately address three epocal-typical challenges and detect potentials, new solutions to those challenges that transcend the engineering/management hybrids of the 80's and 90's.
They portray the three challenges in the following way: First engineering and engineering education need to address the challenges of sustainability in relation to climate change and scarce resources. Secondly there is a need to frame the techno-scientific development in a discourse of responsibility and ethics. Thirdly contemporary engineering has to address new ways of thinking about the relationship between science and technology, e.g. develop techno-science with a cultural awareness [10].
In order to meet these challenges Jamison, Christensen and Botin show that there are three overall strategies, which, inspired by Gibbons et al [11], are classified as modes. We use the concept modes as stylistic and paradigmatic ways of viewing knowledge-production. Modes can in this reading be compared to 'thought collectives' and styles as identified by the Polish physician, biologist and philosopher of science Ludwik Fleck [12] in the sense that they reflect different attitudes/holdings of individuals or collective subjects.
Mode 1 is described as the residual, classical and traditional scientific procedure, where in depth disciplinary knowledge and practice is conceived as true science. Many of the ideals of this specific kind of knowledge-production are rooted in positivist science and can also be inscribed in Robert K. Merton's ethos of science, CUDOS [13]. Mode 2 is described as the current dominant way of dealing with science and technology in institutional frameworks, and reflects in many ways what Williams described as the condition at MIT in the 90's. The strong influence of business on knowledge-production and research at universities has lead to commodification and commercialization, where the outcome of research and education is measured in financial terms.
Jamison et al. [10] is overly critical towards this commodification of knowledge, research and education and tries to install a third mode that takes into account the complexity in the challenges together with a caring and concerning attitude towards the humans and non-humans involved in engineering processes.
The strategy of mode 3 is coined as 'emergent or hybrid' and is characterized by a

quest for: “contextualization, engagement and cross-disciplinarity” [10].
The strategy is finally described as hybrid imagery and: “In order to meet the challenges facing science and engineering in the world today it is not sufficient to reaffirm a traditional faith in reason and truth and reassert the importance of a largely outmoded form of imagined academic community. There is instead a need to foster a hybrid imagination, connecting science, technology and society in new ways, by combining scientific knowledge and technical skills with cultural understanding, or empathy” [10].
The Dutch pragmatist philosopher of technology Martijntje Smits has developed a theory of monsters [14] and defines monsters as hybridizations of opposites in dynamic cultural environments. She detects four types of approaches to cope with monsters of technology: exorcism, adaption, embracement and assimilation. The exorcism strategy demonizes the monsters and hence expels them from e.g. engineering education. The adaption strategy reduces the monsters to rational models (whereby the monster character disappears and dissolves). According to the embracement strategy we fully accept the monsters as part of reality and are engulfed. The assimilation approach portrays the technological monsters in their cultural context and in that way reveals the opposite as uniting rather than absolute. Conventional mode 1 and mode 2 engineering would turn towards the three first categories whereas, according to Smits, appropriate engagement with technological development and innovation would try to assimilate.

It is this intertwinement of science, technology and cultural imagination/appropriation which characterizes how we, in a post-normal reality, should deal with responsible innovation because either way we look then there is no categorical or absolute answers to be found about scientific and technological evolution.

Christensen and Boersen [15] observe that new university programs have emerged as reactions to the challenges identified by Jamison et al. and Smits, and hence see a need for mode 3 university education. They continue by portraying central traits of such programs and question that these traits are actually present in the new so called hybrid university programs.

1 TECHNO-ANTHROPOLOGY

Techno-Anthropology is the title of new bachelor and Master’s programs at Aalborg University offered by the School of Engineering and Science. The programs are not conventional science or engineering programs. They are interdisciplinary endeavours integrating different disciplinary approaches: anthropology and social studies; philosophy and ethics; natural and technical sciences of instrumental character. Indeed it is this mix of different disciplines that the designers of Techno-Anthropology consider truly scientific.

Christensen and Boersen [15] argue that the legitimation of new university programs is based on performativity (that is, they need to provide solutions to potential challenges as perceived by the takers and users) or paralogy (that is, the ability to relate the challenges to new ways of thinking in local contexts). It is argued that new study programs need to be 1) in constant flux, they are always in the making, and 2) interwoven with the demands of the local context, e.g. potential takers and users.
Hence, Techno-Anthropology as new study-programs needs to liaise to the requirements of the surrounding society by performativity (instrumentally solving

external stakeholders' challenges) or paralogy (reformulating challenges by new ways of thinking, so that they take a manageable form).

Following the recommendation of Christensen and Boersen [15] the study program designers and the study board for Techno-Anthropology have interacted with a number of potential takers of Techno-Anthropology candidates. The on-going interaction has so far resulted in the following list of challenges that Techno-Anthropologists can solve or re-think. The list is constantly developing:

- **Incommensurability between different professions and expert groups**. The hospital is an iconic example of such a Techno-Anthropological challenge, where different professions and expert cultures (e.g. doctors with different specialties, radiographs, nurses, public health specialists, management, the administrative and political layers, and management) fail to interact properly. Lack of understanding between hospital staff, patients and relatives increase the complexity of such challenges and makes optimal healthcare services difficult.
- **Cultural clashes between users of techno-scientific products and the technical experts.** Genetically modified as well as radiated foods, geo-engineering and different forms of technical enhancement illustrate this cluster of challenges: new technology often becomes the focus of controversy and conflict, rather than problem solving endeavours.
- **Problems facing technology users when they try use the technology.** Technology is not also ways user-friendly and this makes it difficult to use. One example is the difficulty of young people using the Danish tax authorities web resources, another difficulty is the understandability and transparency of manuals of technical artifacts for domestical purposes.
- **Unintended (and undesirable) cultural and ethical consequences of new technology.** The introduction of a new technology will lead to unintended uses and consequences for the users and society as such [16]. An illustrative example is that the introduction of information and communication technology in schools, that should have resulted in richer learning outcomes in many cases have the opposite effect if the ICT equipment is used for other purpose such as social media or sending text messages to friends, and thereby divert attention from the teaching.
- **Dysfunctional technology**. The list of technology that does not function is long, and covers a number of mega-projects in the West as well as developing projects in the South. Often problems are tried solved with technological fixes, which means that technology is used in problem-solving without making sure that the problem at stake really can be solved by that technology. The use of drones in Afghanistan is one example, as drones will not solve the root causes of that conflict.

The overall research domain of Techno-Anthropology is *Technology*, which is a term with many facets and must be addressed from different angles. Three of the facets are: technical products (artifacts designed procedures), technical experts, users/other stakeholders. Techno-Anthropology focuses on those and their relations (cf. figure 1).

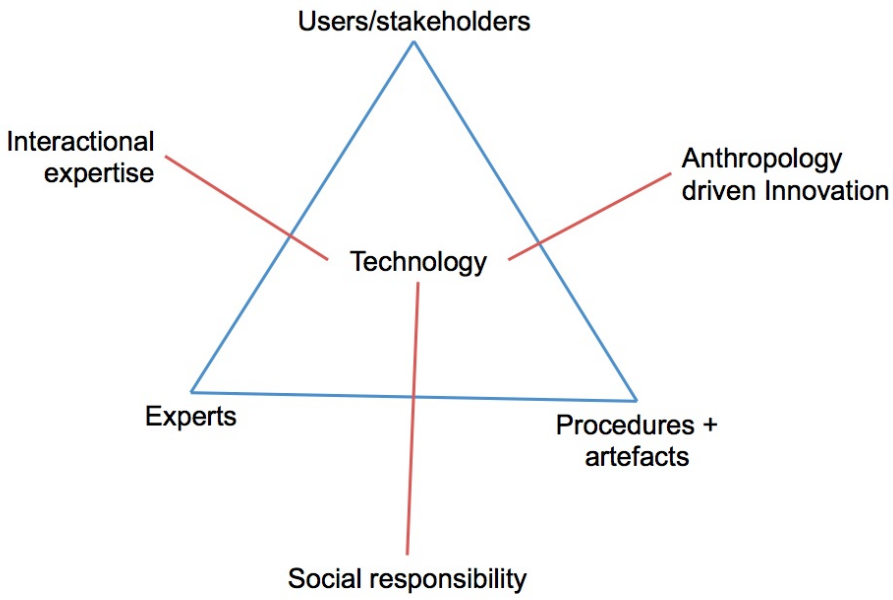

Figure 1: The Techno-Anthropological field. This figure shows the various components in the Techno-Anthropological research domain: technical experts/procedures+artifacts/users+stakeholders. It also shows the components of hybrid imagination: interactional expertise/anthropology-driven innovation/social responsibility.

The central Techno-Anthropological competencies can be seen as reactions to the listed technological and techno-scientific challenges, and are found in-between the three corners of figure 1:

1. Expert-user interface: Here is interactional expertise a competence that can 'repair' a lack of understanding between experts and lay-people, cf. public understanding of science.
2. Expert-artifact interface: Here we argue that Social Responsibility Competence is central. This quality is about ethically sensitizing technological expert cultures so that they are able to make informed robust and committing ethical judgments about their scientific and technological production.
3. User-artifact interface: This interface we coin with terms anthropology-driven innovation and value sensitive design.
   Techno-Anthropology is also action-oriented. Hence, it is also the intention of the Techno-Anthropology programs to enable students to actively take part in bridging opposing perspectives on concrete SET projects by initiating value-sensitive design or anthropological-driven innovation.

By addressing such issues the Techno-Anthropology study programs link Science and Technology to the wider society, and thereby follow another recommendation of the Globalization council [17]: To bring science and technology closer to society. A number of scientific organizations argue that the proximity between the wider society and Science, Engineering and Technology (SET) requires ethical and social responsibility competences. In UNESCO's medium term strategy for 2008-2013 it is stated that:

"The ethical dimensions of the current scientific and technological evolution must be fully addressed. Ensuring the world remains secure for everyone means that scientific and technological progress must be placed in a context of ethical reflection rooted in the cultural, legal, philosophical and religious heritage of all our communities" [18].

Our short introduction of interactional expertise misses a focus on the potential consequences on humanity's biological and cultural constitution of given technologies. To make such assessments all legitimate voices need to be synthesized into future projections. Such projections are by nature uncertain. This does not mean that they are worthless. What is also missing is a discussion of the responsibility of the involved experts.

Social responsibility brings attention to these neglected points. Crucial in this regard is not to neglect important perspectives or uncertainty issues. Experts are responsible for not overselling their results (and neglecting patterns of ignorance), and they can be blamed for doing so.

Value sensitive design (VSD) has since the middle of the 1990's had certain impact on ICT and at the core of VSD is the assumption that technology mediates reality, which means that our access to reality passes through technology [19], [20]. VSD places itself in-between the poles of endogeneous/internal and exogeneous/external theories on values in relation to technology. This underpins the hybridity of VSD, because "people and social systems affect technological development, and new technologies shape (but do not rigidly determine) individual behaviour and social systems" [21]. If technology mediates and constitutes it is imperative for VSD to set up regulations and requirements in relation to design-processes and Mary L. Cummings indicates twelve human values, which should have the attention of the design: "human welfare, ownership and property, privacy, freedom from bias, universal usability, trust, autonomy, informed consent, accountability, calmness, identity, and environmental sustainability" [22].
Cummings describes how technology projects direct our focus towards two or three of these values, hence generating an interdependent focus that merge the context and the technology. The actual design-process is divided into three phases: conceptual investigation, empirical investigation and technical investigation. The conceptual investigation is characterized by enquiry of philosophical and theoretical character, which according to Cummings is fairly distant from conventional engineering design practices. The empirical investigation is based on quantitative and qualitative analyses of the social context. The technical investigation is a classical engineering practice where the designer focuses on the technical performance of the design through experiments and tests. VSD is according to the Dutch philosopher of technology Jeroen van der Hoven an appropriate answer to the challenges that engineering and technology is facing right now. He writes: "If I am not mistaken we are now entering a third phase in the development of ICT, namely one where the needs of human users, the values of citizens, patients, and some of our social questions are considered in their own right and are starting to drive research and development of ICT" [19].
Anthropology-driven innovation is derived from the Scandinavian model on participatory design or/and user-driven innovation [23]. The specific anthropological approach is that the Techno-Anthropologist observes all directly and indirectly involved actors in the innovational process through intensive and extensive field-studies and hereby draws heavily on classical anthropology. The Techno-anthropologist observes and interacts with the end-users as well as the technical experts in the lab and tries to bridge and connect as she moves forth and back on the field.

2 CONCLUSIONS

As all other study programs at Aalborg University Techno-Anthropology applies the Aalborg Model of Problem Based Learning [24]. This means that each semester contains approximately of 50% course work and of 50 % project-work that is driven by the students under supervision of one or two supervisors. In the course modules tools to identify and analyse the technological challenges mentioned above are presented and exemplified, while it is in the project modules that the Techno-Anthropology students work themselves with these challenges. All of this requires, as we see it a *hybrid imagination* and Andrew Jamison is very eloquent on this point, as he writes: “Hybridity, or a hybrid imagination, is something that has to come from within; it requires a student who is interested in obtaining what might be best characterized as a dual competence. But it requires something else, as well: a motivation, a commitment, a sense of engagement in the broader process of social and cultural change that is sustainable development” [25].

In this paper we have identified three components of the hybrid imagination: interactional expertise/social responsibility competences/abilities to conduct anthropology-driven innovation and value sensitive design.

We have pointed towards fruitful and appropriate approaches that are present in contemporary theorizing and practice, i.e. Jamison’s *The Making of Green Engineering* [25], and Smits’ pragmatic concept on ‘monster assimilation’ [14]. We think that Techno-Anthropology is part of this avant-garde on new ways of conceiving and practicing engineering. We think that for Techno-Anthropologists to have an impact on and relevance in engineering and engineering education this *greening, artistry and assimilation* has to be present in the actual technology domain. It is not something that can be impressed or imposed from the outside by anthropologists or philosophers with an interest in technology. It has to be present, nurtured and fostered from within engineering, which also means that as we *green, create and assimilate* then we apply the modes and styles of inter-disciplinarity with the aim of promoting and provoking cross-fertilization. Techno-Anthropology places itself in between culture/humanities and techno-science/engineering and searches to bridge the gap and create gateways and paths for dialogue and interaction. The main focus is to enhance and support this dialogue and interaction as a way of fostering and nurturing appropriate processes and solutions in a complex post-normal reality.

The conclusion here is that Techno-Anthropology fuels hybrid imagination and can create a platform, program, projects, courses and supervision that nurtures and fosters empathy, cultural understanding and social responsibility in science, engineering and technology – if representatives of these endeavours embrace and collaborate with Techno-Anthropologists.

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