Capturing Serendipity: Reflexive Aversion in Production Science

Ariel Bineth[1]

Abstract: The Institute of Science and Technology in Austria held its annual science-industry talk, this year titled *Capturing Serendipity*. Considering the severity of the climate crisis, there were no research projects presented specifically dealing with the environmental issues faced today. By applying a theoretical distinction between production science and impact science, I analyze the content of the presenting researchers to determine which type of inquiry enjoys institutional predominance. Finding out that all research projects are utilizing an approach of production science, I ask how much reflexivity is applied in them, in light of the dangers of unrestricted technological intervention. Evaluating the rhetoric and exhibition style of three key speakers, and considering an institutional culture against 'technological aversion,' I conclude that IST Austria has a tendency toward what I call, *reflexive aversion*, if not constituting a force of anti-reflexivity itself. I connect the case of IST Austria to the larger problem of the increasing dependence of science on industrial capital which fosters cultures of reflexive aversion and anti-reflexivity. Finally, having this structural dependence in place is considered to be leading towards increasing risks of anthropogenic cataclysms.

Keywords: production science, industry, reflexivity, impact science, environmentalism

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Introduction

On the 19th of November the Institute of Science and Technology (IST) in Austria organized a science-industry talk titled *Capturing Serendipity*. IST Austria's flush Raiffeisen Lecture Hall hosted the event between 6:00 and 9:00 pm. The elegantly arranged occasion was aiming to bring together leading scientists and entrepreneurs under one roof to discuss best practices in seizing technological innovation for commercial purposes. Researchers, entrepreneurs, inventors and investors presented themselves in sophisticated outfits as they busily chatted away at the reception sipping fine wine and enjoying a three-course dinner. The entire occasion was designed to network and to make business. I was mesmerized by the elite atmosphere of the venue, as well as satisfied by the selection of desserts; nonetheless, what I heard at the main event raised serious concerns in me.

The main event presented influential industrialists and showcased the institute's most ambitious, commercially attractive research projects. In light of this fact, I should not be surprised that there was none, except one fleeting mention of the grave environmental issues being faced today. Most of the showcased projects were what Allan Schnaiberg calls *production science*, where inquiry is a means for commercial ends, opposed to *impact science* that investigates the harmful effects of technological intervention (1980). Regardless of being a science-industry talk, I find it unsettling that there were no projects of impact science and no projects even mentioned the climate crisis. It is unsettling because even a pessimist could have expected some projects in the spirit of environmental modernization (solving the climate crisis with new technology), but almost none of the presenters found this aspect important. Instead these researchers tried to present their innovativeness with bravado, valiantly projecting their voice to the furthest corners of the room – some more successfully than others – trying to impress the honorable audience. This brash confidence permeated all the voices of the conference, creating a cacophony apparently devoid of any reflexivity.

Consequently, in this paper I ask whether production science or impact science is more dominant at IST Austria. Finding the dominance of production science, I inquire how reflexive is production science at the institute? Based on my observations, I will argue that production science involves only little reflexivity in the case of the Austrian institution. I will begin my essay with a discussion on the concepts of production science and impact science, elaborating their relationship to the idea of scientific reflexivity as formulated by Ulrich Beck (1992). In the next section, I will summarize the projects of the research showcase to point out the predominance of production science and the lack of impact science on environmental concerns. Following that, I take a closer look at the rhetoric and presentation style of the event's participants and present three examples to show the lack of reflexivity in their scientific projects. Before concluding, I will also make a few remarks on the larger issue at place what I figuratively called the marriage of science and industry.

Production Science, Impact Science, and Reflexivity

Aaron McCright and Riley Dunlap make a crucial distinction between *production science* and *impact science* in their analysis of the American conservative movement's anti-environmental efforts (2010). They argue that impact science is a vital element of reflexive modernization and since the American conservative movement worked to undermine the legitimacy of impact science it is a force of anti-reflexivity. I find McCright and Dunlap's theoretical framework useful for interpreting the content presented at *Capturing Serendipity*, since it makes an insightful connection between the aim of a scientific endeavor and that endeavor's practice of "critical self-evaluation" (2010:103).

McCright and Dunlap borrows the distinction between production science and impact science from sociologist Allan Schnaiberg who argued that the social structure of industrial society is endangering the very environment it depends on (1980). Schnaiberg pointed out that since industrial society is organized for production, it prefers production science; a scientific project for finding innovative solutions in increasing the efficiency of production and establishing a greater control over natural and human resources (McCright and Dunlap 2010:104). On the other hand, impact science is aspiring to evaluate the adverse effects of scientific technology (e.g. unintended consequences); examples are environmental science, technology assessment or conservation biology. Dunlap and Catton notes that impact science became more institutionalized over the last thirty years by NGOs, policy makers and social movements (1994), however it is still largely overlooked by industrial interests (McCright and Dunlap 2010). This is crucial, because production science does not employ reflexivity on unintended consequences, because it runs against its immediate economic interests. Reflexivity in science is a signature of what Ulrich Beck calls reflexive modernization (1992). In his theory of Risk Society Beck argues that we are living in a transitioning society which due to the intensification of technological intervention is becoming ever more permeated by unforeseeable risks. Beck believes that we should be simultaneously critical and credulous towards science; while, it is yet the best way of understanding and controlling the natural environment, we must humanize this endeavor for the well-being of nature and society (1992). To practice reflexivity in science means employing a sufficient level of criticism or precaution, a necessary procedure to minimize risks of innovative technology.

In the second part of the essay, I will claim that there is a lack of reflexivity in the scientific projects presented at IST Austria because none of the presenters pronounced such a perspective. The question occurs whether not mentioning reflexivity can be considered as anti-reflexivity; the conscious, organized action against reflexive science. While this is debatable, I will present two reasons why presenters at IST Austria are actually anti-reflexive. First, several key presenters exhibited a rhetoric of overconfidence, a fact which can be connected to the second reason. Claus J. Raidl, Chair of IST Austria Board of Trustees, expressed that one of the aims of the institute is to overcome "technological aversion," the fear from innovation. I argue that this teleological statement is in fact a culturally organized effort against reflexivity. In light of this, IST Austria

can constitute a force of anti-reflexivity. But first, let me give an overview of IST Austria's most innovative research projects.

Production Science at IST Austria

The line-up of panelists contained influential individuals in science, commerce and politics. The scientific segment was represented by five researchers from IST Austria and one independent researcher, who presented their work as part of a showcase to give a taste for the audience about the institute's most promising projects. In order to get a sense of IST Austria's scope of research, I will summarize the projects of the panelists' who presented.

The first researcher to present was Georgios Katsaros (1), a physicist working on quantum computer technology with his team. In his presentation he emphasized the paradigm shifting possibilities in quantum computing as it allows to do calculations which standard computers cannot handle. The second in line was physicist Maria Ibáñez (2) who is working on creating metamaterials by using nanocrystals as artificial atoms. She stressed that nanocrystals can give greater control over physical matter which in turn leads to countless commercial applicabilities. One of them is a fabric which generates electricity through the heat of the body. The third presenter was Krzysztof Pietrzak (3), a computer scientist occupied with improving cryptographic technology. One of his main projects is creating a sustainable cryptographic system for Bitcoin, because the secure operation of the digital currency uses up more electricity than some countries do. He stated how this is economically and ecologically problematic. The fourth presenter was computer scientists, Bernd Bickel (4) who is trying to improve methods of digital fabrication by creating algorithms which can model and simulate material designs. He presented the success of his recent project (funded by the European Research Council) which was a software generating mold designs based on the digital simulation of a product. This allows businesses to efficiently produce products by plastic molding. The fifth researcher to present was neurobiologist, Gaia Novarino (5) whose team investigates the genetic basis and neurological functioning of conditions such as epilepsy and autism. She was very optimistic of creating pharmacological treatments to these predispositions, although there is a growing movement against medicalizing aneurotypically functioning people. The last presenter was Harold Vladar (6) the CEO of Ribbon Biolabs, a company selling synthetic DNA and located at the newly built corporate office park on the IST Austria campus. True to a good business pitch, Vladar exhibited his company's competence in supplying synthetic DNA for clients.

This birds-eye-view of the showcase illustrates the scientific portfolio of IST Austria. Certainly, the institute is very innovative as all the described projects are pushing the limits of existing scientific knowledge and its technological capabilities. After acknowledging innovativeness, the fact confronts us that all of these scientific projects are being conducted in the name of production science, as they aspire to find new means of enhancing production and establishing greater control over the environment. Production orientedness is obvious in project 2 (meta-materials), 3 (digital finance), 4 (plastic item production), 5 (pharmaceuticals) and 6

(biotechnology), however project 1 (quantum computing) also entail production enhancement, albeit in more indirect terms. Furthermore, all six projects present new means of establishing greater control over the environment. The example of meta-materials is a very literal instance of this point. On the other hand, based on the presentations none of the undertakings evaluates the adverse effects of technological intervention, therefore they cannot be categorized as projects of impact science. Perhaps, project 5 seems like an exception, because developing new drugs involves elaborate testing for side-effects. Nonetheless, it is still production science, since its goal is to establish control over the environment (i.e. neurological conditions) and its result will be used to produce more financial capital. Conversely, impact science is only seeking to evaluate and possibly predict harm by technology. Finally, none of the projects emphasized an environmental dimension. An IST Austria organizer could object that there was not any impact research because the event was exclusively focused on commercial applicability, also she could point out that project 3 mentioned environmental benefits. I would reply to the organizer that even if the event exclusively deals with production science, it is revealing – in an unfavorable way, considering the climate crisis – to have only one presenter mention his projects applicability in terms of environmental modernization; not to mention the even that comment was relatively brief. Based on these indications, it is reasonable to claim that IST Austria is overwhelmingly focused on production science. In the following section, I will assess the presence of reflexivity at the event based on the rhetoric and exhibition styles of key participants.

Reflexive Aversion

Following McCright and Dunlap a definition of reflexivity in scientific inquiry is the practice of "critical self-evaluation" to minimize unintended consequences resulting from the scientific project (2010:103). Perhaps, scientific reflexivity is captured in the precautionary principle which asserts the need for sufficient safety assessment before the implementation of a new technology; similar in essence to the Hippocratic oath "first, do no harm." Although the precautionary principle is practiced in policy making procedures it often underestimates the probability of catastrophic events (Ricci and Sheng 2013). However, reflexivity in the sciences also implies a meaning beyond policy and procedure, it implies a certain attitude or perspective that is similar to humility. Practicing reflexivity in the sciences also mean that the investigator is aware of the limitations and potential dangers of her project, thus she avoids giving an all-positive, one-sided impression of it. In this section I am arguing that three influential presenters at IST Austria employed a rhetoric of overconfidence signaling a lack of reflexivity. Furthermore, based on the speech of the institute's Chair of Board of Trustees it can be inferred that there are cultural mechanisms of anti-reflexivity at play.

The first instance of overconfidence was observed during the opening speech of Iris Rauskala, Federal Minister of Education, Science and Research of Austria. In her talk she elaborated how important it is for Austria to have such a competent research institution as it serves the best interest of the country. Nothing shows this benefit better than IST Austria's immense

development over the past 10 years reaching international recognition by being one of the fastest developing institutions of natural sciences, as well as regional recognition by having 50% of researchers acquiring ERC grants amounting to €65 million in 2018 (IST Austria 2018). Interestingly, when discussing capturing serendipity, Rauskala stated that "exploitation is the institute's guiding principle." Even when with a charitable interpretation of her statement, one could find overconfidence in her words telling of a perspective far from humility. The fact that exploitation is the Austrian government's perspective toward innovation is expressive of a value system with not reflexivity being in the first place. The second instance was noted during the presentation of biophysicist Gaia Novarino whose research project is focusing on investigating the genetic causes of neurobiological disorders. She eminently talked about the merits of discovering these genetic causes and proposed to develop a pharmaceutical cure for autism which is rejected as a disorder by social movements for autism. Although, Novarino did not seem to consider the negative outcomes of pharmaceuticalizing autism, because in her presentation she exhibited great prospects for creating a medication. This is concerning since she is the only one the presenters who has a full tenured professorship at IST Austria. Based on this fact, her research must constitute the core of the institutes program, nonetheless her talk did not reflect the existence of reflexivity in her research. On the opposite, her tone carried with daring certainty asserting that how biological wrongs must be made right.

The third instance of overconfidence was the presentation of Harold Vladar, CEO of Ribbon Biolabs. During his speech Vladar owned the stage as the best businessmen do when pitching an idea to investors. He smiled, he laughed, he was confident, maybe too much. The main product of Ribbon Biolabs is selling synthetic DNA for the new generation of biotechnology companies. On the company's website it says, "Whether you want to build genomes, build high-throughput libraries, make new products based on DNA, store data, compute with DNA, build DNA-based nanotechnological devices, or *whatever* your innovative application is, in Ribbon Biolabs you will find perfectly tailored solutions" [emphasis is mine] (Ribbon Biolabs 2019). Explaining the product of the company Vladar asked, "Why would we make synthetic DNA. Well, first of all because we can" [laughs]. Finally, Vladar jokingly remarked "when I became an entrepreneur from a scientist, I realized that before I used to ask for money to do science, now I am doing science to make money." These speech acts do not reflect reflexive thinking, on the opposite they are telling about an important facet of science in an industrialized country. It must be productive, and its product must be able to generate financial capital one way or another, more importantly a scientist must be able to sell his act. Probably, this is among the reasons why Vladar's biotechnological start up rents an office at recently finished IST Park. A complex that was built for housing companies who want to be literally close to innovation. All of the three examples mentioned share the attribute of overconfidence in one way or another, which is the sign of lack of reflexivity. Intriguingly, my friend who is studying at IST Austria made an interesting remark after the event, "I always get the sense here that I'm at the cusp of the wave that is breaking into the 'future.' It's slightly frightening."

There is an element of fear in innovation, in discovering the unknown. There is another kind of 'fear' which IST Austria must deal with according to its Chair of Board of Trustees, and President of the Austrian National Bank, Claus J. Raidl. When speaking during the opening of the event Raidl held his smart phone in his hand and explained that although we are surrounded by technology, many of us are still afraid from it; he called this "technological aversion." He expanded on how an institution like IST Austria must grapple with technological aversion if it wants to succeed in innovation and transfer it from the laboratory to the market. I found this concept of technological aversion interesting, because it explicitly captures, in some sense, a force of anti-reflexivity. Technological aversion means having some sort of unwillingness or discomfort when it comes to innovation. Being at the cusp of the wave is frightening for a good reason, one cannot fully predict what will happen next. While scientific inquiry of this sort definitely needs a breed of bravery, conceptualizing this fear as a weakness which must be eliminated is an overstep. I would argue that in fact this fear can be a source of reflexivity; it can urge the scientist to reflect on the possible negative consequences. The institutional culture of eradicating technological aversion – the fear prompting critical thought – can be considered as a force of anti-reflexivity, as it consciously strives to block critical self-evaluation. Due to the aforementioned reasons, I understand that IST Austria is lacking reflexivity in its communication of research projects, if not actually constituting a force of anti-reflexivity in its 'anti-technological aversion' conduct. Overall, based on these findings, I consider it meaningful to claim that IST Austria – ironically – is imbued with aversion from reflexivity.

Marriage of Science and Industry

My account of reflexive aversion at IST Austria is only one example of a much larger issue of scientific institutions operating within free-market, capitalist economies. This issue is structural in its essence, as scientific institutions exist in a network of inequal dependency with industrial entities due to need for funding. I will illustrate the problem by invoking an analogy of a traditional, heterosexual marriage. Of course, the comparison is not perfect, it only wishes to illustrate the importance of power relations in the production of scientific knowledge. I will argue that the dependency of science on industry creates a cultural environment which encourages a set of values mirroring those of a neoliberal capitalist economy (e.g. accumulating financial capital), as well as it encourages a manner of conduct which privileges action over reflection. In turn, this commercial mindset hinders the solidification of reflexive practices leading to an increased exposure to anthropogenic risks.

In the marriage of science and industry both parties bring something different to the table. Science brings innovation and creativity, while industry brings commercial applicability. One cannot help but think of this dual of division of labor analogous that of traditional gender roles within heterosexual marriages. With its uncertainty, but latent potentiality for giving birth to something novel, science embodies feminine attributes. On the other hand, industry brings applicability with its exploitative infrastructure of innovation resembling masculine attributes.

While engendering the relationship of science and industry is merely illustrative, it does convey an important point about power. Just as in the heterosexual marriage it is usually the male member who wields more power, comparably science is dependent on the determinations of industrial entities. The analogy is even more fitting if we consider marriage as an economic relationship. One does not have to be an economist to understand how crucial funding is in scientific research and how accessibility to financial capital influences the possible avenues of research projects. Just as a wife who is dependent on the financial decisions of her husband, science is constantly seeking opportunities to favor commercial agents to keep their funding. While these commercial agents are extremely wealthy and like to present themselves as champions of equal opportunity, they are controversial. Let me give you an example from *Capturing Serendipity*.

The star speaker of the event was Babak Parviz, Vice-President of Amazon. It is important to summarize some key points from his address as it reveals significant elements about the philosophy of industry, the husband in the marriage. In his talk Parviz emphasized the importance of innovation at Amazon. He explained that the company invests $22.6 billion into research and development projects every year which ranks Amazon number one on R&D spending charts world-wide; the second being Alphabet (Google) with $16.2 billion. These numbers are larger than the annual budget of some countries, yet Parviz claimed that there is no central R&D organizing at Amazon, rather it is decentralized and oriented towards independent work. For example, Parviz shared how any of the 650,000 employees at Amazon, regardless of their position or geographical location, are able to pitch an idea which can be picked up by the company. He noted that just as everything else, pitching only occurs on paper at Amazon to counterbalance personal biases of a powerpoint presentation. Parviz didn't mention how frequently pitches are picked up, nonetheless if they do Amazon creates a budget for the project and puts the pitching person as the lead. The organizational infrastructure to capture serendipity from all corners of the corporation struck me as a remarkably resourceful solution showing Amazon's emphasis on originality. On the contrary, this vision of opportunity does not fit well with the testimonies of Amazon employee's recounting harsh working conditions and high rates of injuries. My friend commented after Parviz's talk "Amazon is inhuman in a strangely empathetic way." I believe what my friend was talking about is the tension between industrial values and humanitarian values, as the former does not always meet the latter. In Amazon's case the opportunity for upward mobility is theoretically there, but in reality, most workers are under so much pressure that they can hardly use it.

The 'empathetic inhumanity' is also present in the relationship of science and industry. It appears science has no restriction in what kind of research it engages from industry money; there are no ties attached. At IST Austria, for example, it is highly emphasized that scientists are engaging in strictly curiosity driven, basic research. The idea being that by nurturing 'child-like' curiosity and providing technical infrastructure one has a better chance capturing serendipity. Although, this freedom might not be as free as it appears. Since industry controls financial capital which puts research in motion, science must *behave* in ways favorable for industry. The multilayered

dependency of science on industry creates a milieux of soft power; soft in the sense that power is not exercised by physical coercion, but by the availability of opportunity. This way industry can softly impose – in other words, encourage – a specific set of values when it comes to determining research projects. Research which has the potential to create financial capital is always prioritized. In the same fashion, if scientists want to be successful in this environment, they must adapt a certain manner of conduct. To get funding a scientist must be able to 'sell' herself, to appeal to investors and find more efficient ways to do so. Soft power operates quietly. No one forced the scientist to act like they are pitching a business idea during their *Capturing Serendipity* presentations, they had to do so to open up more opportunities. The problem which arises from this cultural environment is reflexive aversion, the reluctance to engage in critical thought, and anti-reflexivity, the conscious effort to reduce and eliminate critical thought altogether.

Impact science is not funded by industrial entities because it does not bring immediate benefits, while production science does. Based on the content of the IST Austria panelists, it is clear that industry is not interested in impact research considering environmental issues. What is more, not even production research of environmental modernization seemed to be of interest to them. This does not reflect favorably considering the severity and publicity of environmental concerns in late 2019. Given this context, there is convincing justification for the separation of science from industry to facilitate research projects which aid the climate crisis. Thus, the question arises how can science achieve sufficient independence from industry? Clearly, this is not the question what IST Austria was interested in. An intuitive objection to my argument could be asking whether there is no merit to innovation? Could it be completely wrongful? Of course, technological innovation has tremendous potential in terms of changing the infrastructural landscape of society. It carries the promise of doing things better and faster. The series of panelists at IST Austria testify to this promise with their research pushing the limits of existing technical possibilities in the natural, biological, and information sciences. From this perspective, technological innovation is undoubtedly useful. What I was contesting, on the other hand, is the unjustified funding inequality between production sciences compared to impact sciences stemming from the institutional culture created by the growing dependence of science on industry. I agree that innovation can be good but not in unrestricted quantities. The maxim of toxicology, "sola dosis facit venenum," credited to Paracelsus, translates to "the dose makes the poison." Reflecting on research expenditures of production science through this analogy, we are overdosing on innovation and it has visible symptoms. An institutional culture aversive to thorough reflexive thinking, including funding impact research, is establishing a scientific practice leading to an increased exposure to anthropogenic sources of risks.

Conclusion

This essay started out with my realization that none of the presented projects at *Capturing Serendipity* was concerned with environmental issues or solutions, even when both the current

political discussion and the mean temperature of the planet is getting heated. I used a distinction between production science and impact science to understand my question more precisely. I asked whether production science or impact science has more space at IST Austria? After summarizing the research showcase at the event, I came to the conclusion that production science dominates the institute, since all of the presented projects aim to increase industrial production and establish greater control over the environment. Then, I asked how reflexive is this production science, given the importance of critical self-evaluation in projects entailing high-risk technological intervention. Based on the rhetoric and exhibition style of three influential speakers and considering the institutional culture against 'technological aversion,' I determined that IST Austria lacks reflexivity at least, if not constituting a force of anti-reflexivity. In light of this, I ironically noted that the institution has a tendency towards what I call, reflexive aversion. In the last segment of the essay, I explored how my account of *Capturing Serendipity* is possibly a reflection of larger, structural issues sourcing from the dependence of science on industry. While my argument is certainly not conclusive, in its own right it wished to indicate that the increasingly closer intermingling of scientific inquiry with commercial interests encourages a certain set of values and a certain conduct which privileges action over reflection, confidence over suspicion; therefore, production science may become an increasing source of risk of anthropogenic catastrophes.

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