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Can Art-Technology Co-Operations Provide a Paradigm for Artistic Research?*

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Abstract

"Experiments in Art and Technology" shows how artists and engineers can create art and genuine technological innovation. With examples from art-technology collaborations I want to discuss the criteria of knowledge production within art. In these works, it is not "research for the arts" which transforms art into Artistic Research, but the specific artistic stance taken during the research process. This idea extends the philosophical concepts of artistic research. Borgdorff (2012a) as well as Mersch (2015) defend the position of art in academia but put artistic research in a solitary position, unable to relate to other disciplines. With art technology examples I want to present works that correspond with the requirements of Artistic Research but do not match the theory. They do not only have a proximity to (applied) mode 2 research, but show a new kind of knowledge which stays in the experimental state. The paper addresses the question of how collaborations between engineers and artists can be considered in the discourse on research in the arts, and if they could turn out to be useful for a new paradigm on the notion of knowledge in Artistic Research.

Keywords

artistic research, art and technology, Experiments in Art and Technology, Dieter Mersch

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¿Las cooperaciones entre el arte y la tecnología pueden aportar un paradigma en la investigación artística?

Resumen

«Experiments in Art and Technology» («Experimentos en Arte y Tecnología») muestra cómo artistas e ingenieros pueden crear arte e innovación tecnológica auténtica. A partir de ejemplos de la colaboración entre arte y tecnología, quiero debatir los criterios de producción de conocimiento dentro del arte. En estos trabajos, no es la «investigación para las artes» lo que transforma el arte en investigación artística, sino la posición artística específica que se toma durante el proceso de investigación. Esta idea amplía los conceptos filosóficos de investigación artística. Borgdorff (2012a), así como Mersch (2015) defienden la posición del arte académico, pero posicionan la investigación artística en un lugar solitario, sin poder vincularla a otras disciplinas. Con estos ejemplos de arte y tecnología, quiero presentar trabajos que se corresponden con los requerimientos de la investigación artística, pero que no encajan con la teoría, ya que no sólo tienen una proximidad a la investigación (aplicada) del modo 2, sino que también muestran un nuevo tipo de conocimiento que se queda en estado experimental. El artículo aborda la cuestión de cómo las colaboraciones entre ingenieros y artistas pueden incluirse en el discurso de la investigación en las artes, y si pueden resultar útiles en un nuevo paradigma sobre la noción de conocimiento en la investigación artística.

Palabras clave

investigación artística, arte y tecnología, Experimentos en Arte y Tecnología, Dieter Mersch

1. Introduction

Maybe C.P. Snow's lecture "The Two Cultures" (1998) has also influenced how we perceive the relation between engineers and artists – art historian Zabet Patterson criticises, when writing about the engineers at the Bell Laboratories, that it is always represented as an opposition. In her work, she emphasizes the common results and the co-operation, and illustrates that with an example: "In the early work of Kenneth Knowlton and Michael [sic, it should be Leon] Harmon, for instance, a coin was flipped to see who would be the engineer and who would be the artist – just one instance of how irrelevant these labels could be" (Patterson, 2015, p. xv). Both were engineers at the Bell Labs at that time and only incidentally they happened to be introduced to one another during the launch of engineer Billy Klüver's and Robert Rauschenberg's initiative Experiments in Art and Technology, and then became well-known in the art world.

The example illustrates what this paper is aiming for: In art, as well as in research they "inserted" one into the other. So, art got its tools and inspiration from technology and technology was developed through the needs of art. In the debate on Artistic Research [AR] this kind of research activity I want to consider as AR is not present. AR considers itself to be a discipline that should remain pure. Even if it's called research, there is a wish not to collide with methodological constraints of other sciences (Borgdorff, 2015, p. 75f). There seems to be a fear, even, to consider artistic practices that implement other disciplines in their work, as if they could influence the genuine logic of AR (and are not AR themselves). This seems paradoxical since this exact methodology should be constructed, and AR should meet scientific demands such as objectivity, repeatability and communicability (Jung, 2016, p. 24-28).

Writing on collectivity in AR, Ziemer (2015) even avoids mentioning transdisciplinary approaches. In academia, it also seems far-fetched to think about co-operations outside the art context if you look at Robin Nelson's (2013) examples. In the same book, though, he states that co-operations with industry and science should be considered as the most important ones.

There seems to be large skepticism on whether art and technology can work together or maybe even do research together, which starts already in the everyday perception of their relation: When Ryoji Ikeda was an artist-in-residence at the Large Hadron Collider at CERN, he tried to create a work on the harmony between particles that goes beyond standard physics. Whilst the researchers were quite lucky with the artist (Doser, 2014), it was seen differently in the media:

> This is not a work of art about physics. It is a work of art about how crazy everything is. That's a trivial misunderstanding of what goes on at Cern, surely. […] I see this as the artist's view of physics, just a different language that makes no sense at all.

> Art and science, we feel, should have something to say to each other. But perhaps they speak different languages after all. [T]he language of science […] is concerned with the wonder of nature. There is a depressing lack of wonder in this technically sophisticated but intellectually and emotionally empty art. (Jones, 2015)

Taking all these somehow connected thoughts as points of departure, I want to propose that some co-operations between artists and engineers can serve as examples for AR. Though the examples I use are not considered as such, I want to insert them into this framework: They are considered as art and they produce communicable research. Communicability has become a central point in research and we should (re-)consider art and technology in terms of AR. This should also let us rethink a history of AR, and the place of these artistic positions within art history. At the same time, the interpretation of these examples as AR might add important questions on how art can carry out scientific research.

2. Experimenting between art and technology

There seems to be a more colloquial notion of "experimentation" than what is used in the sciences but this everyday understanding of "experimenting" has also found its way into the language of engineers who speak of "experiments" when they test new developments and optimise them after failure. This understanding seems also widely accepted among artists.

When Christopher Frayling (1993) described different types of research in the arts, the third form "research for art and design" contained everything involved in the process of making art. The definition allows anything from the collection of material to an inspiring image. Mona Hahn and Robert Pfaller (2013, p. 34-36) show the danger lying within such an account of "research based art": there is almost no art that would not be "research based" in that sense.

Within this schema, Henk Borgdorff's (2012a, p. 37-39) notion of "research in the arts" underlines that there is no distinction between theory and practice and that the artistic process becomes research itself. This exceeds Frayling's idea of "research for art and design" which still was the mere combination of interests, experiments, and investigations of artists on certain topics – something that artists have probably always done and will always do, no matter if they or any other person would consider their work as research.

One possible way of founding AR as a scientific discipline is to explain the knowledge gained by the artists as an embodied epistemic practice. This account dates back to the 1990s when creative processes and the artists' privileged access to their work were investigated – in contrast to the research areas of art history (Kjørup, 2012, p. 25). Recently, this idea has been reinforced through the theories of "embodiment" which combine cognitive sciences, psychology, phenomenology, and philosophy of mind (Fingerhut, Hufendiek and Wild, 2013; Borgdorff, 2012b, p. 48; Johnson, 2012). Current AR in this area mostly assembles analyses of performances and actions exploiting the framework of embodiment theories and artists conducting artistic experiments to prove or explain them. Due to these strong theoretical constraints, it seems implausible that a performance could contribute anything to the discussion – as it is already "biased" by the application of a certain theoretical stance, namely that art represents an embodied form of knowing.

Martin Tröndle (2012) uses the concept of embodiment to explain the transformation of the specific knowledge in the arts into certain practices. It describes the nonlinear processes which become art. For the creation to take place, there are no disparate elements that are simply added in a brain process. All decisions depend on psycho-physical interactions that make the tacit knowledge of the artist relevant for any creation. The artist's work becomes manifest in an experiment which is itself characterised by not simply accumulating elements formally or externally but is an experiment "through the material" which represents the context that cannot only be understood (ie as propositional knowledge) but experienced.

Henk Borgdorff (2012b, p. 48-53) separated AR from other forms of theory and practice: Like in Frayling's "research for art and design" these can be part of an AR process but the research is not reducible to this background knowledge. To consider it as AR, all decisions have to be based on the artist's aesthetic considerations – the other scientists involved can only be co-workers. If this is not the case, the research process is based on other paradigms, namely those of the (applied) science that was involved. The results of AR transcend the scope of a tacit knowledge or knowledge that is embodied in the results. Borgdorff remains with the hypothesis that AR does not produce knowledge but rather "a not-knowing, or a not-yet-knowing" (2012b, p. 61). Thus, AR only points at non-propositional knowledge by transcending its own materiality – because art is based on the principle of discovery and not on hypotheses.

2.1. Lilian Schwartz: Pixillation (1970)

In the framework of Experiments in Art and Technology (E.A.T.), a 1966 founded initiative to bring together artists and engineers, Lilian Schwartz created "Pixillation". Earlier, the two engineers Knowlton and Harmon worked with E.A.T. and developed a new algorithm. Starting from the visualization of images with ASCII characters, it could identify edges and had features such as copy and paste, soft-focus or sharpening filters (Patterson, 2015, p. 61f). Both of them started as engineers and soon became recognized for their work as artists, especially after the presentation of "Computer Nude" – a huge depiction of naked dancer Deborah Hay in ASCII characters, but clearly visible from a distance – during the launch event of E.A.T.

In 1970, artist Lilian Schwartz had the possibility to join Bell Laboratories, the partner institution of E.A.T. and one of the most

renowned research and development departments in engineering at that time, and work with them. She could use the programs BELFLIX and EXPLOR which were developed there to create "Pixillation" in 1970, already showing the possibilities of digital animation. The use of these programs led to their further development (with her as a consultant) and to the creation of an artist residency at the Bell Labs – which was a novelty, but not as much as Schwartz later working at the laboratories (Patterson, 2015, p. 85-99). This does not only reflect the artistic quality of Lilian Schwartz's work but also the intimate connection between the development of the software code and the digital movie created with it; the entanglement of the artistic and the software engineering research processes.

These examples show that the use of computers in general has changed the situation of research. More than simply building foundations on deduction, new paradigms in science are interested in the process of development (or in computer-based simulations and experiments) rather than in the stabilisation of theories (Gramelsberger, 2012, p. 102-104, 107f.). Thus, new knowledge is often produced in experiments, or even in a mode of trial and error – in this framework the abovementioned films and pictures can be considered as experiments which created certain needs for certain developments (*eg* algorithms).

These practices can be analysed in terms of aesthetics but are not aesthetics themselves. This conflation of research on art and artistic practice may be one of the major problems with the theory of AR. As the technology-based art practices – which are originally not considered as AR – do not bother about theoretical implications of their work (as most AR projects seem to do, and are even explaining themselves and their research goals excessively), we can easily explain the research process and find out about possible findings within the artists' work – be it inside or outside art.

3. Aesthetics and/vs. Artistic Research

For Dieter Mersch (2015) knowledge production is rooted in our conception of thinking. He criticises that within it, language and propositional rows are dominant. Hence, we only think in concepts mediated by language. An artistic approach to the world is not subjugated to these discriminations and separations.

Mersch's conception suggests that art is equivalent to irreducible perception (perception that has not been reduced by the discriminations through concepts). It has the power to capture and represent alogic and non-propositional connections, in contrast to the usual conceptions of thinking – always taking something *as* something already. In this conception of art, research functions for, through, and with art as a medium; art is the practice in which knowledge production takes place that is not result oriented but remains in the mode of quest (re-search). It is not only searching for something but is doing so through a constant self-questioning, searching for the research method. Research in the arts is a quest within the perception which is constantly discriminating the whole breadth of percepts anew. Since art is defined as an epistemological practice, Mersch's opinion is that if we accept this way of thinking through and with the material as a practice which is pointing to the unknown of perception, it can lead to knowledge.

This avoids the connection between the concept of "tacit knowledge" and that of non-propositional knowledge. But Polanyi's "tacit dimension" has more to offer than an embodied way of knowing: he also speaks of recognising symptoms (eg for diseases, or features of certain animals, flowers, etc.). Polanyi manages to add individual aspects of knowledge that are neither opposed to propositional knowledge nor can be described by it (Jung, 2016, p. 31-34). Mersch, on the other hand, is criticising propositional knowledge and is able to show its insufficiencies, that art could "fill", but he fails to provide an account as to why and how this knowledge is produced in a specific situation – that is, why it seems more plausible to think of art being able to grasp the whole perception only in terms of having a certain sensibility to symbols for something, and being able to use them, too.

Another problem with theoretical accounts such as Dieter Mersch's is that this general notion of knowledge may apply to the arts in general, but not to AR. The latter must be directed towards something specific and non-arbitrary. The method of AR must have the strength to contextualize materials historically, politically, and socially to create an intended meaning. Judith Siegmund (2016) who takes this position, thereby relegates AR to mere performances, the as-if-science, and to the application of already existing scientific methodologies.

The simple point that artists engage with any material in their work does not make their practices research practices – these practices lack the specificity of research (see also the argument in Hahn and Pfaller, 2013), namely that research happens within a certain context in a certain time and therefore has specific goals. As seen in the examples above, research practices are investigating something – considering the application-driven developments in technology and also co-operations in the context of art and technology. There are usually certain criteria that can be successfully matched, but with a high degree of openness towards incidents.

Reinhold Schmücker (2016) could sum up these thoughts with his criteria for a theory of AR:

- research does not happen incidentally and has the goal of the proliferation of human knowledge
- either the agents are artists or they agree on the result as being art
- not every experiment is a contribution to research and research does not necessarily have the form of an experiment
- if art is research then the experiment is probably the most common form of AR, written results are seldom

And he adds important clauses later, that can easily be turned against Mersch:

- only part of the art production is interested in gaining knowledge, therefore we cannot speak of all art as epistemic practice
- knowledge from art that can be expressed as propositional knowledge is implausible if it is referring to non-propositional knowledge

3.1. Merce Cunningham and John Cage: Variations V (1965)

Variations V[1] premiered in 1965. The piece was developed by John Cage, Merce Cunningham, several dancers and technicians and the engineers Billy Klüver and Robert Moog. Variations V is a dance performance where the dancers interact with the technology on stage. Basically, there are several antennas visible to the audience as well as video projections on stage. John Cage with his assistants was in control of all the technical equipment that created additional soundscapes – as also presented in the later version Variations VII during the E.A.T. event "9 Evenings in Theatre and Engineering", reflecting the sounds of media technology.

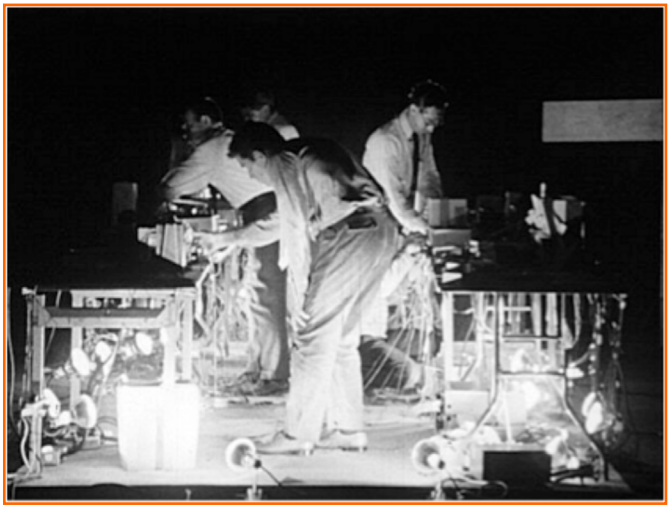

Image 1. <http://www.fondation-langlois.org/media/activites/9evenings/video/variations.mp4> John Cage: Variations VII, Performance in the Framework of 9 Evenings: Theatre and Engineering, The 69th Regiment Armory, New York, N.Y., USA, October 15-16, 1966. Extract of 9 Evenings: Theatre and Engineering / produced by Experiments in Art and Technology; camera: Alfons Schilling, 1967, original material in b&w, 16mm. Fondation Daniel Langlois pour l'art, la science et la technologie, Fonds 9 Evenings: Theatre and Engineering. © Experiments in Art and Technology

The antennas in Variations V are based on the idea of the Theremin, an instrument that was invented in the 1920s and further developed by synthesizer pioneer Robert Moog – who was part of the team for Variations V and whose version of the Theremin became famous from 1966 on. Though the possibility of playing the instrument only through hand movements was already known, it was the first time the same technology was used to illustrate the relation of body and sound, of technology and body – and not the mere curiosity of the antenna synthesizer (Holl, 2010, p. 254f.). Merce Cunningham's choreography was a combination of dance and everyday movements. The dancers in the piece were closely coupled to the technology, the sound depended on the movements they made. Klüver built photocells that produced noise as soon as the light source that triggered them was disconnected by the moving performers, Moog constructed antennas controlling the sound depending on the dancers' moves. Additionally, radio programs broadcasted during the performance, tape recorders, and even videos were manipulated, distorted, and blurred – combining all of that to produce an intermedia performance (Breitwieser, 2015, p. 58-64).

When perceiving the piece as a visitor, it seems to be the perfect example of the above-mentioned non-reductive view that art can have – by providing a blurry image of mass media of the time and the relation humans develop with it. The research process obviously was very focused on the use of technology in dance, though, and on the authorship of the composition which was led by the choreography and not meticulously developed by the composer.

4. Art and Technology as Mode 2 Research?

The examples from collective works between the arts and technology show that research is possible in the arts – or rather that there is the possibility of transdisciplinary research inducted by an artist. I suggest the term "transdisciplinary AR" for the intersection of disciplines where technology is not only an aid but a productive impulse for the artistic development. TAR might be equivalent to what is called "Mode 2 research" – in contrast to "Mode 1", ie research based on the justification of hypotheses. Mode 2 is driven by application and context, therefore it is influenced by its surroundings and necessarily involving different disciplines (Gibbons *et al.*, 1995, p. VII; Dunin-Woyseth, 2010, p. 73).

In Mode 1 problems are solved within the disciplinary boundaries, following the methodological approach of the discipline. In Mode 2, knowledge is produced through application. The transdisciplinary coupling – depending on the problem – leads to a more homogenous mix of methods and involves theoretical as well as empirical elements. The findings are often not published but stay within the sphere of application and are developed further there. One positive aspect of this

1. Visit: <http://dancecapsules.mercecunningham.org/overview.cfm?capid=46119>.

kind of approach is that (social, ethical, political, economic, ecological, etc.) responsibility is always already a part of the research process because these issues occur in the translation between the disciplines as a common background. To have these issues at the core of research processes can be traced back to the lamenting of C.P. Snow on the difficulties of communication between "the two cultures". In thinking about AR as being close to Mode 2, there is also a preference to the collective creation against the idea of a (genius) individual (Gibbons *et al.*, 1995, p. 2-10).

As Carmen Mörsch (2015) notices, it is strange that the theory of AR is arguing on the one hand against the statement of innovativeness, ie that AR does something completely different than traditional research (or Mode 1); on the other hand, it contrasts "artistic" with "scientific" and thereby creates a separate research sphere for the arts, that is not integrated in the history of science. The tensions that result from this are (among others) between the singularity of every AR process and the urge for translation and generalisation, and between the declared uselessness of the arts and the usefulness of research.

This also seems to be the reason why the compatibility with Mode 1 is still defended (Dunin-Woyseth, 2010) which is problematic because it limits research in the arts to what is transferable into propositional knowledge. These positions go back to the idea that there is one methodologically coherent form of knowledge production – a questionable position since the 1970s (Chalmers, 2001, 121ff, 131f, p. 197-201) – that could serve as a paradigm for the arts. In contrast, the proponents of Mode 2 focused on "innovation" (Nowotny, 2005, p. 166f) by bracketing the epistemological implications and fulfilling demands from industries. Considering this, some contemporary art can be research, as innovation and novelty were the core concepts of art after concept art. I want to come back to the criteria of Schmücker (2016); according to these, AR wants to count as research all that shows a structure similar to sciences and can be interpreted as science and represents individual questions, and is at the same time art.

The communication with other sciences is also opposing to the argument that AR itself has to adapt to another methodology – in many experiments results occur that have not initially been part of the research. These upshots can also occur in an artistic process where the goal is the creation of art. In taking this stance, in analysing art tech we can explain the research process to create the art project and at the same time acknowledge the upshots that can be used in other contexts (or in art).

A problem with this argument is the view that the incident is the way to knowledge production, as sometimes in science incidents are the most interesting findings. The mere facts that important results of experiments happen incidentally, that experimenters influence the process, and that their prejudices and concepts are part of the experimental setting – a common view – do not mean that these are necessary conditions for the production of knowledge. It is dangerous to reduce AR to the intended production of incidents, because the application of art (to stay in the Mode 2 terminology) is usually a certain production for a certain context. Incidents within these processes directed towards something can be results of the research process but they are not the defining parts of the research – which would be the intention to research something.

Mersch's (2015, p. 39-43) criticism of AR in terms of Mode 2, that it is only pragmatically trying to produce stable objects and not interested in producing knowledge, would only apply to the standard definition of Mode 2 but not if we consider art as the primary context of application and further disciplines taking advantage of the research only as lucky incidents.

4.1. Performance Electrics: PV Guerilla (2014/15) and Off Road (2014)[2]

In 2012, artist Pablo Wendel founded a company with the goal of producing electricity through, from, and with art – Performance Electrics operates as an electricity supplier in Germany where Wendel and other artists may realise their ideas of power supply and production (Performance Electrics, 2016, p. 32).

Often the installations that serve as power plants create iconic images for complex issues of electricity production and power supply, eg the project "PV Guerilla", 2014-2015 that took its departure from the process of dismantling electricity pylons throughout Germany and replacing the landlines with underground lines. The red and white pylons were cut into pieces and equipped with photovoltaic panels – which were taken from insurance returns after hail damage, officially not usable and repaired in DIY workshops with different groups, for example 12 year-old students. By installing micro-inverters on every sculpture, each could produce a small amount of electricity individually. During the process of refurbishing the panels and installing the electricity modules, the students gained knowledge of the possibilities of building de-centralised power networks. But even more, in the experiments on the ideal number of layers of resin on the panels, the workshop group and the artists involved found a way to reuse the damaged panels and bring them back to up to 90% of their original effectivity.

"Off Road", 2014, is a wind power plant built from recycled material from roads (signs, pylons, etc.) that would not be used anymore. Again, the idea was to transform the energy that has already been invested in the production of these objects into a power plant that reproduces this energy as electricity.

2. Most of the information was gained during an internship at Performance Electrics in 2014/15 and in interviews with the engineers and artists for the author's MA thesis in 2016/17.

Image 2. Performance Electrics: Off Road, different recycled material, "B1IA40 – Die Schönheit der großen Straße", Dortmund 2014. © Performance Electrics

Two engineers were involved in the construction of the wind farm. The shape of the rotor, ie the definition of the heat pressing of the pylons, was developed by Performance Electrics and tested at the University of Stuttgart. The shape turned out to be extremely effective for small-scale wind farms which led to requests from the industries to use the shape for equivalent products.

Jörg Nitsch, one of the engineers, found his way to the project incidentally when he saw the wind farm stand still – he developed the control to assure the safe operation of the system. Because of the uncommon size and type of material, he had to develop new concepts to obtain and transform the electricity.

Similar to Jean Tinguely's patents for his drawing machines, "Off Road" hit a barrier that was not foreseen by law – in Germany, sculptures had to have insurance as if they were normal-sized power plants. In the end, the sculptures only produced electricity in situ for one day, visitors could charge e-bikes, smartphones, etc. directly from the sculptures.

5. AR as a pre-paradigmatic science

Søren Kjørup (2012) proposes to put AR in the realm of the "Wissenschaften", this German term covers different disciplines and methodologies. He argues that AR has a family resemblance to scientific practices. As there is no established methodology, paradigms, ie examples that make others see how the practice could be defined, can serve as a basis for research as long as there is no definitive set of rules (Kuhn, 1962). In science, conflicting paradigms lead to crises – and to solutions; the balancing of several conflicting paradigms at a time could be seen as something positive. Since in AR there will never be one dominant paradigm (if this would happen, the research practice would probably not be considered 'artistic' anymore), it can remain in the state of a pre-paradigmatic science. Kuhn's defining features of a reife science would only apply if there is one dominating paradigm. There should be a shift to searching for best-practice in AR because the search for the definition of a method and the adaption to the scientific ideal seem hopeless – even in laboratories these ideals do not apply. Kjørup also insists on the usefulness of research, a feature of science defined by Kuhn which is often forgotten – but is a part of current artistic practices.

Many artists take up current political or social issues in their work, and some of them even intervene – in the case of technology and art, we can see this development eg in the later projects of E.A.T. ("Projects Outside Art", Children and Communication", "The Anand Project", and many more), in the ideas of Performance Electrics, but also in many other projects with DIY workshops and critical technology use. These developments might also be continued in other disciplines and enable innovation there. This was also the idea, inspired by C.P. Snow's "The Two Cultures", that Billy Klüver had in mind for E.A.T.; that a meaningful connection of art and technology reaches out into society. Again, this emphasises the importance of communicability of research in the arts.

This recognisable effect that these projects have seems to be more important than the definition of an exclusive concept of knowledge in the arts. This concept only claims a new sphere of knowledge that has always existed, the knowledge of artists. But if that suddenly becomes an epistemological aesthetic, we would gain nothing but a blurry concept (Jung, 2016, p. 39).

Additionally, this strategy fails to define a concept of knowledge and research in the arts. It is not that which is created and that can afterwards be interpreted, ie translated into propositional knowledge.

Even when technological innovations are the results of these processes, it remains visible that there was "another" part, that transformed them into art – similarly to other sciences' specific approaches (Hahn and Pfaller, 2013, p. 35). Artistic practice manages to introduce new differentiations between forms of knowledge and concepts, engage with unintended topics, and represent these varieties within one or several media (Mersch, 2012). If we take AR seriously, we have to take its results into account – and not create a mysticism about the way of knowledge production within the arts that becomes the only way of perceiving AR. This creates tensions between the undefined form and the aim for being understood (Mörsch, 2015).

The results of AR are results of research activities but at the same time they are perceived as art, too (Schmücker, 2016). I hope that the interdisciplinary examples that provide possible interpretations in the directions of art and technology can help to see both sides within AR. There is art on the one hand which has to be explained, maybe, and there is a research component on the other hand that has to be made communicable within or through the art project, if possible.

6. …understanding the examples and their consequences

According to Kathrin Busch (2012, p. 151-147, 158) the demands of science cannot be fulfilled by the arts because the singularity and subjectivity of knowledge are opposed to repeatability and objectivity. Nevertheless, she also criticises contemporary researchers for not making their insights communicable, so that science is only present as information but not as knowledge. This is where she sees potentials for art that can educate its spectators. Still, she remains skeptical towards the knowledge production – which can only happen at the intersections with art history, visual studies, etc.

In contrast, we saw that art can have a family resemblance in its research processes, and the examples illustrated these possible findings in art. Also, Schmücker (2016) concludes that art can be interpreted as research if it is structurally similar to empirical research and if it can be seen as an experiment, ie that the actual or hypothetical relations are clearer than in everyday experience. So it is not only the intention but also the representation that finally turns art into research. We also have seen this in the results (dance-technology-relations, new algorithms, rotor shape, etc.) of the projects in this paper. The main concern of AR is always to be art, no to be research.

From here, we can conclude with a preliminary definition of AR that involves the examples from art and technology:

- examination of a defined object/problem of everyday/science/…
- the process of research is carried out in a way related to (1), in a way defined through AR, or in nonspecific ways that get shaped during the process
- the process has an outcome
- the process is essential for that outcome (and can also involve agents from other fields following their own disciplinary logic)
- the outcome can be seen as the outcome of the process
- the outcome lets others have experiences of the process

This definition makes it necessary to consider further examples of art and technology as AR, and to examine whether they fit into this framework. Working on these examples might also add some early and contemporary chapters to the history of AR and thereby create paradigms for building a theory of AR, with all its inconsistencies.

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