BEYOND HUMAN

COLOPHON

EDITED BY
J.M. Kelder
A. Mouret
D. van Soest
K. van den Wijngaard

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ROOTS AND OF A BRAVE

ALEXANDER MOURET
Director of
Brave New World

Where do we come from, and where do we go? These basic questions have driven humanity since prehistory, and attempts to answer these questions have resulted in myriad cultural expressions and scientific breakthroughs. Man's place in the wider world, in our environment, was captured already by *Homo Sapiens* — our own species — some 17,000 years ago: think of the rock paintings at Lascaux (France), for example, with its numerous depictions of local fauna, such as wild bulls, horses and deer, and it is here, in a very visual and still recognizable form, that we may see a glimpse of what makes our species so special. One of the things that may cause modern people, homo sapiens, to stand apart from other animals, is our ability to communicate efficiently, most notably through linguistic and visual symbolism. It is our ability to *talk*, to tell stories, that allows us, for example, to tell the time, to transfer an idea from one person to another or, indeed, from one group of people to other groups. And this capacity enabled men to see the world differently, to measure it, conceptualize it and, eventually, organize and alter it. Domestication, the rise of agricultural societies and cities – the direct antecedents of our own society – were all enabled by that singular capacity to communicate, to talk.

The transference of ideas and viewpoints is a constant factor in the history of mankind, and even today, we are thinking about better, more efficient ways to transfer ideas to other groups and to the next generations, so that they may learn, and learn again, as Constantine Cavafy would have it, from those who know. But we are now at a stage that even the extraordinary natural capacities of our species to pass on knowledge may be superseded by the qualities of our creation, of Artificial Intelligence. This publication includes two essays that touch on aspects of our species' capacity to communicate, and our desire to improve this skill even further. One, by Richard Currier, offers a breathtaking overview of how Homo Sapiens' skills as a com-

CAUSES NEW WORLD

municator allowed it to become the world's dominant species, to build cities, and create civilizations. The other, by Gideon Shimshon, explores how natural limitations in our capacity to communicate and to teach may, in the near future, be overcome with the aid of Artificial Intelligence.

Indeed, our species' biological limitations appear to become increasingly irrelevant. We are now moving towards an age where the human body can, and is, modified according to our own wishes and requirements. And we are not just talking plastic surgery here, but about far more substantial modifications of our body. What to think about genetically altering a human embryo so that it may avoid contracting a deadly disease when it grows up? And if this is ok, what should we then think of the logical next step; the improvement of humans not in order to avoid genetically inherent diseases, but to boost its natural capacities: to make it stronger, taller, quicker, more intelligent? Biotechnological innovations are rapidly gaining pace, and we have to think about the consequences; about the ethical implications of our drive to become, as Yuval Harari recently wrote, a Homo Deus. Rob Zwijnenberg offers a thought provoking piece on precisely these ethical questions, whereas Mashya Boon explores another potential implication of human enhancement and, in particular, human cloning: how may these developments impact on our idea of identity – on who we are, and what we feel we ought to be. But this publication also includes a call to embrace these developments, to see what innovations might bring and improve on us – a call for the Technolympics; games for cyborgs. Brave New World was founded with the aim to bring together academics, artists, story-tellers and anyone who feels they have a claim on developments that may trouble or benefit us tomorrow. It is a conference about what dreams may come, how we ought to deal with radical new developments, whether we should be wary or embrace new opportunities, new discoveries and new technological advances. With this publication, and by looking not only towards the future, but also by looking back, we hope to offer some ideas about the aforementioned questions, where do come from, and where do we go.
As the director of Brave New World, I sincerely hope that you enjoy both this publication and the conference, participate in the discussions and share our interest for the world of tomorrow, and all that it may bring.

BACK TO THE FUTURE OR: HOW CLIMATE CHANGE SHAPED SOCIETY IN ANCIENT SYRIA

Interview with Peter Akkermans by J.M. Kelder

EXCAVATION AT TELL SABI ABYAD.

PETER AKKERMANS

is Full Professor of Near Eastern Archaeology at Leiden University. He has been intensively involved in archaeological field projects in Germany, Bulgaria, Turkey, Syria and Jordan for over 30 years. He is director of one of the largest archaeological research projects in the Middle East: the Tell Sabi Abyad Project in Syria (until the start of the civil war). This extensive, interdisciplinary project includes surface survey and large-scale excavation at a number of archaeological sites in Northern Syria.

Most people will associate Syria with the catastrophic Civil War that currently rages there, and with the savagery of Islamic State, and envision an inhospitable country, with deserted villages set amidst a barren desert. But this wasn't always the case. In fact, much of what we, in the West, nowadays consider as 'normal' —a settled life, with flourishing towns and cities— was first pioneered in Syria and the region around it. From the 10th millennium BC onwards, humans appear to have gradually given up on their hitherto mobile life, exchanging a life as hunter-gatherer for one of agriculture. It is still debated why people decided to give up on their old and quite successful ways of life, but climate change has been a popular explanation —in this case, the end of the last Ice Age (the so-called Younger Dryas). Rising temperatures and increased rainfall would have made dry-farming an attractive way of life, and small groups of people, often no more than a family or so, started to tilt the lands. Barley, peas, lentils and bitter vetch and chickpeas appear to have been staple crops to the first farming communities, thus laying the foundations of some of the things that we today hold most dear: beer and falafel.

MUCH OF WHAT WE, IN THE WEST, NOWADAYS CONSIDER AS 'NORMAL' WAS FIRST PIONEERED IN SYRIA

The new way of life appears to have been a success story. By ca. 6500 BC, the Syrian steppe was dotted with numerous of such farming hamlets; small nuclei of habitation, often comprising only a handful of families that worked the nearby land. Despite the small scale of these settlements, they were not isolated from one another but well connected, and novel features such as pottery, which was introduced around 6800 BC, spread through the region. The 7th millennium BC, in sum, was a period of major change and innovations, most notably the introduction of pottery and the rise of the first villages; of sedentary life. Syria, it seems, was well on its way towards 'civilization'.

By 6,200 BC, however, the picture had radically different changed. Many, though (and this needs emphasizing, not all) of the hamlets and villages that had dotted the landscape appear to have been used as temporary (perhaps seasonal?) stopovers, or were abandoned altogether. Archaeologists were left baffled by this apparent regression: why would people who had inhabited a village for several generations, apparently quite suddenly, desert their village and ancestral lands?

It was long thought that climate change, in this case a particularly abrupt case climate change, was the culprit, but a team of archaeologist is now challenging this scenario. There certainly is good evidence for major climatic change around this time. "We are talking a significant drop in temperature of some 2°C over the course of perhaps as little as a generation", says Peter Akkermans, professor of Near Eastern Archaeology at Leiden University. At Tell Sabi Abyad, a Neolithic settlement hill north of Raqqa, Akkermans and his team saw the effects of this sudden cooling of the climate. "Where there previously had been several clusters of habitation, with houses that may have been in use for several generations, we noticed that several of these clusters were left abandoned around 6200 BC. Only in one part of the Tell did we find evidence for continued human habitation –but in a completely different way and at a different place on the hill from what had gone before". With cooler weather, annual precipitation decreased, leading to aridification of the steppe. "People had to adapt to new circumstances –and they probably had to do so quite quickly" Akkermans says, "but we need to be careful to attribute these changes solely to climate change." Based on the current evidence, it seems that at least some of the changes in life style may predate the 8,2K BP event (as it often referred to), as the sudden drop in temperature is often referred to. From ca. 6,300 BC onwards, there are indications that inhabitants of the Tell may have left their homes to take up a more mobile existence based on the exploitation of larger territories, as well as an increased importance of animal husbandry and a more diverse use of local resources. "Earlier settlements are abandoned or become significantly smaller, but what we can also see is that there was in fact a growing number of very small sites –we are talking less than 0.5 hectare here- that were probably used only for a short while, perhaps as seasonal camps", Akkermans continues. "The old settlement at Tell Sabi

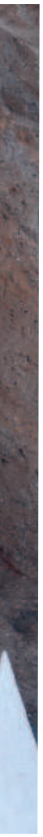
Abyad, meanwhile, had essentially been abandoned, though a new settlement appears to have sprung up elsewhere at that site. We have found traces of what appear to have been sizable rectangular warehouses with multiple storerooms, as well as some circular structures –perhaps the dwellings of the remaining population, or perhaps accommodation for seasonal occupants of the hill." And this was not all, Akkermans and his team also found evidence for an important innovation: traces of milk –and this suggests that people now made use of animals not only as a source of meat, but also as a source (in the case of sheep) of wool and (sheep, goats, cattle) milk, as well as their ability to pull things (such as a plow). These were revolutionary changes, that facilitated the changes that were needed to survive the changes in the local landscape.

Thus, the interesting thing about Tell Sabi Abyad is that is shows us not only that climate change can heavily impact on existing ways of life, and even may force people to (temporarily or permanently) abandon their homes ---we know all that because of recent tragic events in, for example, the Caribbean, with Hurricane Maria leaving numerous people homeless. What is interesting is how fast people appear to have been able to find new ways to make a living, to exploit the changed environment ---which was, as far as we can deduce, not only significantly colder but also much drier. People were able to rethink their way of living; they became less bound to their ancestral grounds, they learnt to spread risks by exploiting larger territories, they were more mobile, probably following their herds of domesticated cattle and sheep, or trailing migrating animals to hunt. And because of that mobility, they also interacted far more frequently than before with other people. Indeed, what we see in Syria around 6200 BC –at a time when the climate changed so dramatically, in such a dramatically short time- is the emergence of what can perhaps be called one of the first regional cultures, named after the important site of Tell Halaf in northern Syria. People started producing and decorating pottery in similar (though not exactly identical) ways and, and –if we may judge the sheer size of the

PETER AKKERMANS AT THE EXCAVATION IN TELL SABI ABYAD.

warehouses at Sabi Abyad- cooperated in harvests, the storage of goods and other valuable or important items, such as amulets. Indeed, whilst we may think of climate change as a trigger for social collapse, it appears that the people of Neolithic Syria rose to the challenge, stuck to the aspects of life that worked for them and changed and improved on other aspects: they exchanged novel ideas and new ways of food production and storage –and in doing so, laid the foundations for what in the 6th millennium would develop in larger settlements and eventually, the first cities.

Akkermans: "Climate change is undoubtedly a daunting prospect, and we ought to do what we can to mitigate some of its worst effects. But we should also be confident in our abilities to change our ways, to use our environment in a different, more sustainable, manner, and find new ways to cooperate. The 8,2K BP event most certainly had a major impact on the lives of the ancient Syrians, but it did not mean the end of their society –it was not a collapse, but rather a transformation of society. As Ralph Waldo Emerson once remarked: The history of man is a series of conspiracies to win from nature some advantage without paying for it. I am hopeful that we can keep it up."



WE SHOULD BE CONFIDENT IN OUR ABILITIES TO CHANGE OUR WAYS, TO USE OUR ENVIRONMENT IN A DIFFERENT, MORE SUSTAINABLE, MANNER, AND FIND NEW WAYS TO COOPERATE

HUMANS AND SYMBOLIC COMMUNICATION: SHARING KNOWLEDGE, DEFINING ETHNICITIES, CONCEPTUALIZING TIME, AND FUELING THE RISE OF CIVILIZATION

FIRST EXAMPLES OF ARTIFACTS THAT WERE CREATED FOR "SYMBOLIC" RATHER THAN "PRACTICAL" PURPOSE.

RICHARD L. CURRIER

received his Ph.D. in social and cultural anthropology from the University of California at Berkeley and was a professor of anthropology at three American universities. The author of publications about paleoanthropology, ancient civilizations, contemporary society, and the Greek Islands, his most recent book, UNBOUND, was published in 2015.

AUTHOR'S NOTE: The following article was adapted from Chapters 5, 6, and 7 of my recent book, UNBOUND: How Eight Technologies Made Us Human, Transformed Society, and Brought Our World to the Brink (New York: Arcade Publishing, 2015).

THE ANCIENT ORIGINS OF SYMBOLIC COMMUNICATION

The use of language, art, and writing to communicate ideas and information is surely one of the most unique of all human capabilities. While many other animal species regularly communicate by using inherited body postures and vocalizations, only humans are endowed with the ability to invent tens of thousands of visual and vocal symbols and transmit them to their offspring and future generations through the process of teaching and learning.

Thus, our species has developed two very distinct and very different modes of communication. The first mode consists of the inherited forms of emotional communication, including facial expressions such as smiling, frowning, puzzlement, and disgust as well as vocalizations such as laughing, chuckling, crying, screaming, snarling, and groaning. These forms of communication are encoded in the human DNA, are found in all human populations, and are instinctively understood by people of all ages. The second mode — the communication of information through linguistic and visual symbolism — is unique to our species, is entirely learned and culturally patterned, and can be shared and understood only by members of the same cultural and linguistic group.

The great flowering of symbolic communication in our species doubtless began with the development of human language. Yet, unlike tools, fire, habitations, or diet, language leaves behind no physical evidence and cannot be dated by any of the normal tools of the paleontologist. Although the true antiquity of symbolic communication remains one of the great mysteries of prehistory, there are some intriguing scraps of evidence from the paleontological record that suggest that both spoken language and the use of signs or symbols may have developed well before the appearance of the anatomically modern human, *Homo sapiens sapiens*.

Perhaps the oldest evidence of human symbolism is a fossilized elephant bone, once used as a percussion tool for finishing Acheulian hand-axes, from a site in Bilzingsleben, Germany inhabited by the emerging human *Homo heidelbergensis*. This tool, found in a stratum nearly 400,000 years old, had been engraved by its maker with seven cut marks in one area, fourteen cut marks in another area, and had a third area which had been broken off and lost. It has been suggested that this third area had also contained seven cut marks and that the total of 28 cut marks on the elephant bone was actually a primitive lunar calendar. Numerous other artifacts from Bilzingsleben were also engraved with suggestive and unexplained markings, although most prehistorians have yet to be convinced that *Homo heidelbergensis* — most likely an ancient precursor to the Neanderthals — was actually using symbolism at such an early time period.

OUR SPECIES HAS DEVELOPED TWO DISTINCT MODES OF COMMUNICATION.

The oldest evidence of the possible emergence of spoken language survives as the fossil remains of the hyoid bone of the Neanderthals. This small U-shaped bone, slightly more than three centimeters in diameter, is located just above the larynx in the human throat and plays an important role in the production of human speech. And while the hyoid bones of other animals — including our closest relative the chimpanzee — are of a distinctively different shape from the human hyoid bone, the hyoid bones of Neanderthals and modern humans are nearly identical. This suggests that the Neanderthals may have been speaking an early form of human language as early as 100,000 years ago.

The use of vocal symbols to represent places, objects, animals, people, and actions made it possible for prehistoric humans to share the personal knowledge of their own experiences with others, and this ability to share knowledge in an abstract or symbolic form led to an immense expansion of the information available to each member of the group. Examples of the transmission of "cultural knowledge" have been recorded for chimpanzees, elephants, prairie dogs, and many species of birds. But only humans can transmit knowledge in

PREHISTORIC PEOPLE WERE USING PURE SYMBOLISM TO RECORD AND COMMUNICATE INFORMATION

symbolic form, and only humans can use language to impart the personal experience of one individual to other members of the group in a matter of hours or days.

The Neanderthals also left behind the first examples of artifacts that were created for a "symbolic" rather than a "practical" purpose. They created prehistoric "jewelry" in the form of seashells with holes drilled through them that were probably worn as amulets or as bodily adornment. Large primary feathers – perhaps used for earrings or headdresses – were plucked from the wing bones of eagles, vultures, and crows. And numerous Neanderthal grave sites show evidence of deliberate burying of the dead, often decorated with red or yellow pigments. In fact, pollen analysis of a Neanderthal grave site in Southwestern Asia showed that flowers were placed in the burial site, an act which some have interpreted as a belief in the afterlife.

DEFINING ETHNIC IDENTITIES

With the appearance of the Cro-Magnons and other anatomically modern humans in Europe and Asia roughly 50,000 years ago, however, graphic symbolism in the form of prehistoric art becomes both abundant and undeniable. Small humanoid figures carved from stone or bone appear in Palaeolithic sites throughout Europe and Western Asia. These include numerous examples of so-called "Venus figurines" — female statuettes with oversized breasts and sex organs — which have been found as far west as Southern France and as far east as Siberia, and which date from 40,000 to 10,000 years ago. And the presence of these Venus figurines over this incredible span of time and space provides the earliest evidence that, unlike the Neanderthals, the Cro-Magnons had begun to differentiate themselves into distinct cultures and leave behind unmistakable evidence of humanity's first true ethnic identities.

While the Venus figurines all share common anatomical characteristics, they also reveal the emergence of cultural differences, because the artistic styles with which these figurines were rendered differs from region to region and from one time period to another. As time passed, these stylistic differences were reflected in the decorations prehistoric people left behind on their tools, weapons, cave art, and pottery, and *it is these characteristic decorative styles that make it possible for us to identify the presence of distinct cultures* among the various populations of prehistoric people.

Of all the evidence of symbolism that has survived from prehistoric times, the proliferation of Paleolithic cave art is doubtless the most striking. Pictorial representations of game animals and hunting scenes have been found in abundance in cave sites throughout Europe, Asia, Africa, and the Americas. Drawings and paintings of deer, horses, bison, mammoths and wooly rhinoceroses are clear evidence that these animals were hunted–and possibly worshipped–as highly valued game. And representations of people–often drawn as simple stick figures–depict unmistakable scenes of hunting and warfare.

But prehistoric people were also using pure symbolism to record and communicate information, and we know this from the tens of thousands of "petroglyphs" that were carved and painted on rock faces and the walls of caves throughout the entire inhabited world. They survive in myriad forms: shapes that resemble dots, bars, rods, feathers, combs, triangles, pentagons, and hexagons, sometimes combined with hand prints or pictures of animals. Many consist of odd shapes filled with engraved lines suggesting basketry or woven cloth. Significantly, unlike the realistic paintings of animals or people, *we cannot interpret the meaning of the petroglyphs because they are purely symbolic representations of information*. In short, they are a form of cultural knowledge which has been lost when the cultures that produced them became extinct.

TELLING STORIES AND CONCEPTUALIZING TIME

Symbolic communication had another profound impact on human life when prehistoric people began to string together groups of words to describe events that occurred in a particular sequence over a period of time. This use of language to express the *narrative story* expanded the power of language beyond the mere sharing of information into an entirely new capability,

unknown by any other animal species: the conceptualization of time.

When the hunter returned from the hunt, he could describe the entire sequence of events that encompassed the hunt: finding the spoor of a game animal, tracking down the game, selecting the weapons for the attack, stalking until the prey was within range, attacking, killing, butchering, and bringing the game home to the encampment. When the gatherer returned from the field, she could describe the story of her day: travelling to the location of the fruits, roots, vegetables, or bird's eggs, recognizing the tell-tale signs of the foods, gathering them, and preparing them for transport back to camp. In this way, other members of the group, simply by listening to these narratives, could go forth on similar expeditions armed with the knowledge and experience of others who had gone before them.

The narrative story thus became not only a way to communicate a personal experience to other members of the group, but also to conceptualize the passage of time. Thus, the telling of stories enabled human groups to think about the passage of time and to recognize and describe chains of causality.

This unique capability may have been the critical catalyst that made it possible for Neolithic societies to conceive of, and describe, the months-long sequences of events that would have to be understood and remembered for the successful practice of agriculture: preparing the soil, planting the seeds or cuttings, watering, weeding, and harvesting the crops, and processing and storing the fruits of their labor.

It is therefore not surprising that no evidence of food-production has been found from the hominins' three million year history until after the end of the most recent glacial maximum 18,000 years ago. Yet from that point forward, agriculture was invented independently in at least eleven different locations throughout the world as the global climate grew warmer. Before this, an interglacial period had occurred between roughly 130,000 and 120,000 years ago, but there is no evidence of agriculture from this previous warm period. This was long before the appearance of anatomically modern humans in Europe and Asia, and was probably well before the development of human language sophisticated enough to conceptualize the passage of time.

During the last ice age, the habitats favorable to agriculture were either too cold or too dry to support the kinds of crops that would have allowed the nomadic people of that age to replace their ancient hunting and foraging adaptation with the revolutionary new subsistence method of food-production. But with the tool of the narrative story, humans succeeded for the first time in planting, growing, and harvesting crops. This made possible not only the settlement of large populations in sedentary villages but in fact set the stage for the rise of urban civilizations.

FUELING THE RISE OF CIVILIZATION

When ancient people began to devise systems for translating the auditory symbolism of language into the visual symbolism of writing, humans gained the ability to communicate information over time and space, and this — combined with the invention of technologies of transportation over land and sea — made possible the rise of civilization. Writing made it possible to record the inventories of the storehouses of ancient kings, for rulers to issue orders to their armies in distant lands, for merchants to trade over vast distances, and for dynasties to record the histories of their achievements for posterity.

It is therefore not surprising that complex and sophisticated systems of writing first evolved in the places where the earliest civilizations arose, notably in Mesopotamia, Egypt, India, China, and Mesoamerica. Each of these systems of writing arose independently and were eventually adopted by neighboring cultures and societies.

In the final analysis, the written word has enabled humanity to create societies consisting of millions of individuals and to dominate all other forms of life on earth. It is fitting, therefore, that this ultimate means of symbolic communication is the means which we have used to create this booklet and with it, transmit to each other our thoughts and ideas about this Brave New World. —

BUILD YOUR OWN PROFESSOR: THE RISE OF THE AUTOMATED CAMPUS EXPERIENCE

BUILD YOUR OWN PROFESSOR.

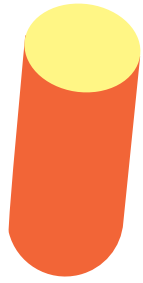
GIDEON SHIMSHON

is director Digital Learning Hub at the Imperial College London. In this role, he is tasked with increasing the level of online and digital innovative education-related activity across Imperial, with the ultimate goal of establishing the College as a center of excellence in this area within the sector. He also plays a key role in delivering the College's new Digital Learning Strategy.

"Education world-wide is currently undergoing a massive transformation as a result of the digital revolution. This transformation is similar to the transition from apprenticeship to universal schooling that occurred in the 19th century as a result of the industrial revolution. The central challenge is to ascertain whether our current sites of formal learning will be able to adapt and incorporate the new power of technology-driven learning for the next generation" COLLINS AND HALVERSON (2009)

THE FUTURE IS HERE. IT'S JUST NOT EVENLY DISTRIBUTED

WILLIAM GIBSON



If there is one thing that lecturers in universities dread in their job, it is marking large volumes of assessments every term. It is a repetitive, time-consuming and often mind-numbing exercise, especially in large undergraduate programmes. While teachers in higher education are trying to deliver on these workloads with fewer hours to do so, students often are frustrated by a lack of responsiveness from their lecturers and crave for continuous feedback on their work and progress. From a pedagogical perspective, we know that more formative assessments of all sorts and feedback leads to better results in terms of learning[1], yet more testing is time consuming and thus more expensive.

Today, Higher Education institutions are facing mounting pressure to increase student numbers to generate funding while maintaining (and preferably increasing) the quality of the educational experience both for staff and for students. On the social side of things, there is an increasing demand for education, with student numbers that are expected to double between 2012 and 2025[2]. This, in turn, leads to a rising shortage in teachers[3].

Digital technology can increase student numbers if it enables teachers to spend the same or less amount of time with a larger number of students while delivering on the same or a higher quality learning experience. This means that a strategy where digital innovation enables expansion needs to focus on key bottlenecks in terms of time required by staff to teach and organisation of the learning experience. The barriers to scale can be defined as:

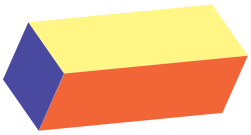
1) time spent giving/organising feedback to students(tutoring)
2) time spent on grading and
3) time spent on lecturing.

We should place these developments in the context of how technology is affecting and changing the role of the teacher and how learning happens in 21st century. Digital learning platforms like Coursera and EdX took the higher education sector by storm a few years ago with headlines about the end of the brick and mortar campus. Yet, these platforms still have to properly address these challenges in order to truly create education at scale. When the first massive online courses came online it caused panic amongst academics – that they will be replaced by technology. Recent developments in the EdTech show that some of the technological solutions will replace the traditional role of the teacher. This means that the teacher's role changes and their effort can be better distributed to facilitate learning.

VIRTUAL TUTORS & AUTOMATED GRADING

Recently, Georgia Tech professor Ashok Goel made headlines with his chatbot for education, which provides students with feedback in answering course related questions[4]. Students could not tell the difference between the bot providing feedback and human interaction. The quick gains are in the area of scheduling and assignment routine questions at first, in a way a passive Artificial Intelligence (AI) – Responding to queries of students. Goel's goal is to have the virtual teaching assistant answer 40 percent of all course related questions by the end of year. The number of chatbots for student feedback R&D projects is rapidly increasing and the research is still very preliminary. The next stage in the

[1] With thanks to dr. Monika Pazio who suggested to think carefully about how more formative assessments serve as a vehicle for feedback support learning, but more summative assessments do not. And how we should look at better results in terms of learning, not in terms of test scores as the former does not mean the other. See, for example, Gibbs, Nicol, Jessop.
[2] http://www.universityworldnews.com/article.php?story=20120216105739999
[3] http://uis.unesco.org/sites/default/files/documents/fs33-sustainable-development-goal-for-education-cannot-advance-without-more-teachers-2015-en.pdf
[4] http://www.news.gatech.edu/2016/05/09/artificial-intelligence-course-creates-ai-teaching-assistant



HOW POWERFUL CAN AI BECOME AS IT ENTERS THE HIGHER EDUCATION SECTOR

development will be more active bots, which look at coursework of students – who will be posing problems and guiding students through their learning processes.

The next phase in this would be that of automated grading. Currently, this works well for multiple choice questions but open text and more complex grading is more difficult. The first step in this direction will be the development of online grading support tools: Automated/machine supported grading tools will create process-driven improvements helping lecturers grade faster. A next step will be the application of AI to automate parts of grading, saving lecturer's numerous hours in marking papers and exams. This will go hand in hand with the rise of better and better proctoring tools to validate the identity of the student taking the exam and prevent cheating. On the credential front, cryptocurrency technology platforms such as *Etherium* and *Bitcoin* will make sure that earned diplomas are always traceable and linked to the one who earned the credential.

BUILD YOUR OWN LECTURER

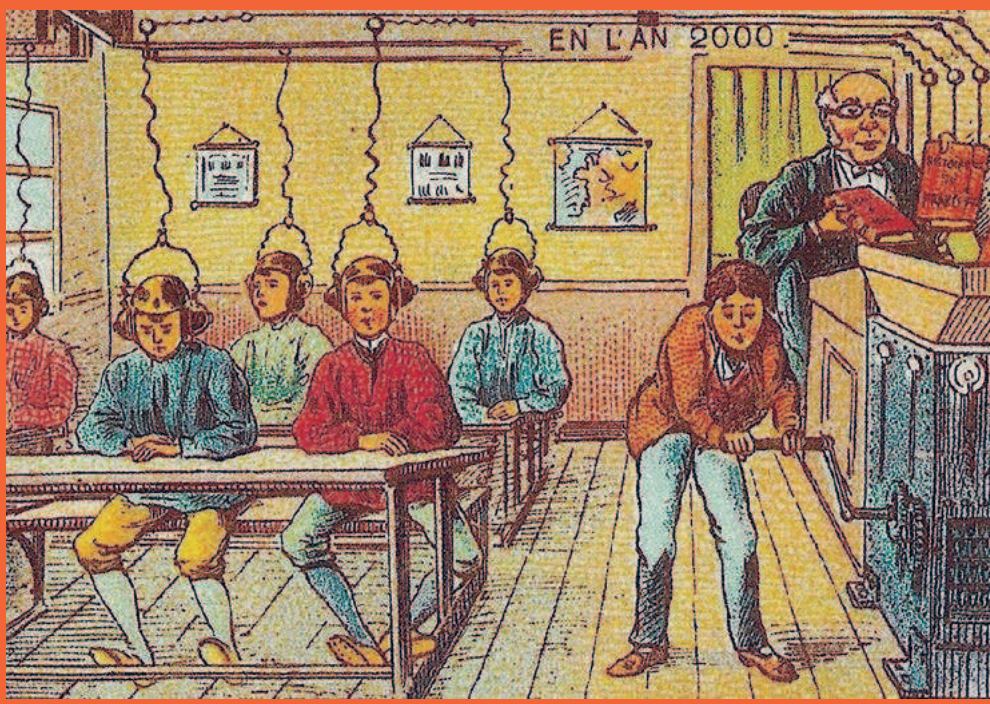
The use of media such as video or podcasts as part of the learning experience has increased exponentially over the past decade. Students google for the best YouTube explanation of concepts they need to understand for their exams. Teachers develop media clips to share with students as part of a new trend of active and flipped classrooms and a new set of online platforms have started to monetize online curated materials where top scholars from top universities share their knowledge through online courses which consists of video clips, animations, podcasts and online exams and discussion fora.

The ability to create, edit and manipulate voice and video media will enable teachers to create more and better lecture materials for their students. As the fields of speech editing tools and facial manipulation tools are maturing, teachers will be in a position to write their texts and bring them to life in a video and podcast, without them ever having to sit in front of a camera in languages that they do not themselves speak.

This is not totally science fiction; the software prototypes already exist. Voice editing can be done with Adobe Voco[5]. After recording about 40 minutes of your speech the system has enough information to be able to say something in your own voice without you ever having said it or to edit parts of something you have said. Meanwhile researchers at the George Washington University in Seattle and Facebook are developing facial editing and manipulating software[6], which could be linked to this system. They are able to map facial expressions of one person onto another, creating the possibility to deliver a lecture in different languages and it would look natural or just write a book which is then translated into a lecture automatically[7]. This could create more opportunities for a more inclusive learning experience.

The question remains as to how powerful can AI become as it enters the Higher education sector. Stuart Armstrong, in his short but very insightful book on the topic, stated: *"Looking at the skills of our current computers. Once they have mastered a skill, they generally become phenomenally good at it, extending it far beyond human ability."* As these systems improve, a lot of knowledge will be imparted by AI and will not require 'human interaction'. If all of this turns out to be correct, then new developments will not only challenge the role of the brick-and-mortar utility of a university as being the ultimate place for knowledge transfer, but they will also generate a growing appreciation for alternative spaces for knowledge creation and social interaction. —

[5] Presentation of Adobe Voco: https://www.youtube.com/watch?v=I3l4XLZ59iw
[6] http://grail.cs.washington.edu/malkovich/
[7] This was discussed in a RadioLab podcast http://www.radiolab.org/story/breaking-news/ with Ira Kemelmacher-Shlizerman from George Washington University in Seattle
[8] Smarter than Us, the rise of machine intelligence, Stuard Armstrong, MIRI, 2014. Pp. 13



A PICTURE FROM 1900 WHICH GIVES A VIEW ON HOW EDUCATION WOULD LOOK LIKE IN 2000.

CREATE
EDIT
MANIPULATE

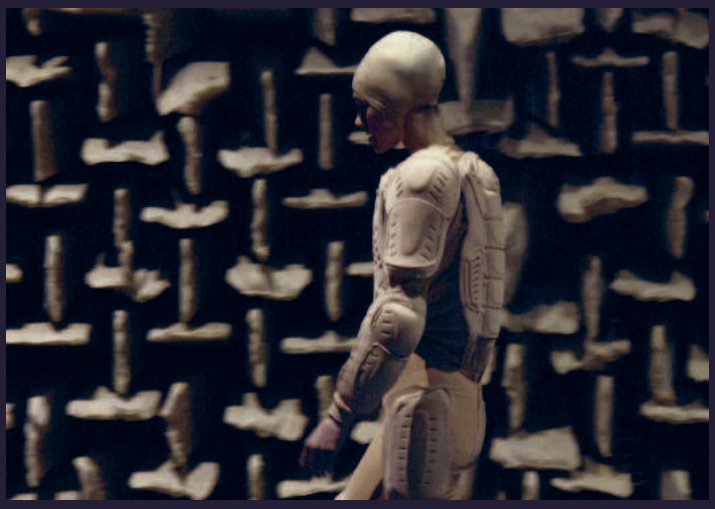
LUCY MCRAE: WE ARE GOING TO HAVE A REVOLUTION OF WHAT IT MEANS TO BE HUMAN

MAKE YOUR MAKER.

LUCY MCRAE

is a sci-fi artist, film director, TED Fellow and body architect, placing the human body in complex, futuristic scenarios that confound the boundaries between the natural and artificial; inventing iconic artworks that take people beyond the expectations of themselves. Trained in classical ballet and interior design, her approach is to influence culture by exploring scientific breakthroughs relating to health and the human body, while providing a feminine point of view on emerging technology.

MAKE YOUR MAKER.



INSTITUTE OF ISOLATION - ANEHOIC CHAMBER AT UNIVERSITY SOUTH-HAMPTON.

INSTITUTE OF ISOLATION

Through her project, The Institute of Isolation, Lucy McRae explores the body beyond Earth's edge. She tests the effects that extreme experience could have on evolving human capacity.
From the microgravity trainer that conditions the body for a possible life in space, to time spent in an anechoic chamber exploring the psychoacoustics of silence, a series of sensory chambers simultaneously challenge her body and brain on her plight to adapt.
The project is based on the premise that we are in a different phase of evolution - driven not just by nature, but human intent. Lucy contemplates if isolation could be designed to augment fundamental aspects of human resilience.

MAKE YOUR MAKER

Make Your Maker takes genetic engineering to the extreme, depicting a world where technology is liquid and the human body is cloned to the point of a food source.
Food and Body Inseparable – Make Your Maker takes the concept of genetic manipulation to extreme; where gender and ego are blended like a chef makes a cake and human edible clones are consumed for sensory enhancement. The deliberate modification of life led Lucy to question her own genetic makeup; "What if we could choose our own human traits; or if our parents could choose what they give us?" Assembling the body from scratch in the kitchen where technology and biology merge, may seem absurd – But it's important to hover the imagination and discuss how scientific breakthroughs are slowly reconstructing the body. Lucy (the protagonist) moves through a series of sensory chambers spending time in an anechoic chamber examining the psychoacoustics of silence or in a self–invented microgravity trainer conditioning the body for possible life in space. These fictional locations explore whether the design of isolation into buildings could play a role in advancing human biology on an evolutionary scale.

MAKE YOUR MAKER.

INSTITUTE OF ISOLATION - MICROGRAVITY TRAINER.

INSTITUTE OF ISOLATION - MICROGRAVITY TRAINER.

TECHNOLYMPICS: HOW HUMANS WILL BECOME AWARE OF THE CYBORG EVOLUTION

WEARABLE ROBOT.

KRISTIAN ESSER

is entrepreneur at Mr. Harder. He studied at the European Institute of Design in Milano as well as the HKU and has been driven by creativity throughout his life, devoting his talents to understand and illustrate the opportunities new technologies bring. He describes himself as a 'tour guide to the future' and leads innovation projects working for both small companies as well as multinationals.

It looks like the world is accelerating because of the influence of technology. Biological time is shifting to computing time and the time available to react to emerging problems is becoming obsolete. Once the problem exists, it could be too late.

This thought has bugged my mind since I read the book 'de grens van de mens' written in 2010 by Peter Paul Verbeek, Dutch philosopher for technology, at the University of Twente. Humankind is not that good at anticipating behaviour, we normally fix the problem once it arrives. Concentrating thoughts and awareness on a future event seems to be more difficult and less important to us. Of course you can argue about the generic aspect of this observation but if you take the whole of humanity at stake, the collective neglect of environmental problems provides the right benchmark.

But how can we anticipate time, how can we make sure humanity becomes more aware of the problem arising in technology, specifically in cyborgs?

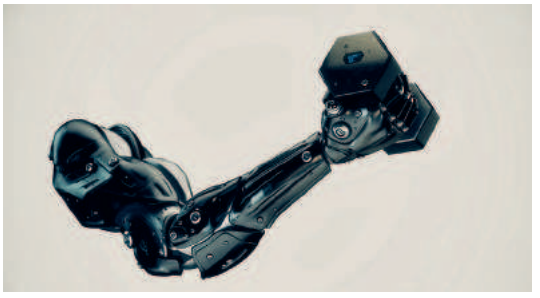
As Yuval Noah Harari describes in his book Sapiens, humans have the incredible ability of being able to illustrate myths in order to convince large numbers of people to work for the same end. He describes it as the ability to create 'myths'. This is often combined with the illustration of future scenarios. We need to 'see' what will happen in order to understand the consequences.

Reading this book confirmed an idea I had some years ago for creating a possible solution.

The idea is to add a new category to the Olympic Games called Technolympics. This category will coexist with the Paralympics and the regular Olympics. By doing so, we create a perfect and global podium for illustrating the evolution of cyborgs every other year.

Why perfect? There is a very legitimate reason why the Olympics should embrace this idea. Sooner or later they will have to provide an answer to this question. The day will come when one person with a technological body-part will knock at their door to apply for the games. And to be specific, when I refer to cyborgs I mean anyone using technology to enhance their possibility starting from a normal health position without any disability.

ADAM JENSEN ARM, AN AUGMENTATION INSPIRED BY DEUS EX.



A LEGO CYBORG ARM.

Why global? Because the Olympics are and there needs to be global awareness.

But why do we need this? Why not meet the need with a set of rules? Ethical discussion about the issue is essential. We can't expect the huge number of developers in the industry to work according to a set of rules but they need a deep level of awareness in their minds. Rules will follow.

Technolympics is starting its journey by gathering exponents from the science, enterprise and political spectrum. We are organizing the discussion about cyborgs on- and offline and creating a platform that, once filled with valuable power, will be ready to step up to the IOC and help them by collaborating on this solution.

Just follow us and join if you think you can add value. —

WE CREATE A PERFECT AND GLOBAL PODIUM FOR ILLUSTRATING THE EVOLUTION OF CYBORGS EVERY OTHER YEAR.

THE RENAISSANCE OF HUMANS

CYBORGS NEIL HARBISSON AND MOON RIBAS.

NEIL HARBISSON

is a contemporary artist and cyborg activist, best known for having an antenna implanted in his skull and for being officially recognized as a cyborg by a government. The antenna on his head allows him to perceive visible and invisible colors such as infrareds and ultraviolets via sound waves. In 2010 he co-founded the Cyborg Foundation, an international organization that aims to help humans become cyborgs, defend cyborg rights and promote cyborgism as a social and artistic movement.

Taking an active part in our own biological evolution is no longer a theory, but an option. If we want to survive as a species we have to either change the environment or change ourselves. Becoming a cyborg, becoming technology, instead of using or wearing technology, opens up the possibility of having additional organs and senses that could extend our perception of reality and increase our survival possibilities. We might be witnessing the start of our species' renaissance, a transformation that will help us explore our reality in depth and maybe even survive outside this planet.

The word *"cyborg"* was first coined in 1960 in an article called *"Cyborgs and Space"*. It proposes solutions to the challenges faced by space travel and space survival. Some of the suggested solutions are no longer hypothetical but a possibility brought by new technological advances. Nowadays, hundreds of people around the world have implanted electronic devices in their bodies to enhance their natural abilities. We call them cyborgs and I am one of them.

I AM TECHNOLOGY

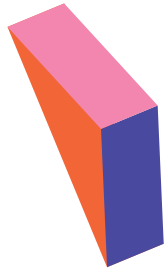
I have a chip in my skull that allows me to perceive colours like infrareds and ultraviolets that lie beyond the human visual spectrum. The antenna – which is surgically implanted in my skull - picks up visible and invisible light waves and transforms them into audible vibrations that travel through my skull. To me, colour perception is independent from the sense of sight or the sense of hearing, colour is an entire new sense.

My head also has internet connection, which allows me to receive images or sounds directly into my skull from other parts of the world. Selected people – one from each continent - can send images or sounds to my head by using their mobile phone cameras or microphones. This separation of my body and my senses makes me feel as if I have an eye and ear in each continent. Sometimes I might be facing a boring brick wall yet be perceiving a beautiful sunset from my Australian eye. Or I might be having an extremely boring conversation with someone yet be receiving extremely funny jokes from my American ear.

"The antenna is a new body part and the chip an extension of my brain. I don't feel I'm using technology, I don't' feel I'm wearing technology, I feel I am technology. I feel I'm a cyborg."

The word cyborg comes from the union between two words: *"cybernetics"* and *"organism"* so depending on how we define the word *"cybernetics"*, the word *"organism"* and the word *"union"* we can end up with endless definitions of the word cyborg. I feel that I can define myself as a cyborg in three different ways: I can define myself as a biological cyborg, someone whose body has physically changed due to cybernetics (I have a chip and an antenna surgically implanted in my head).

I can define myself as a neurological cyborg, someone whose brain has changed due to cybernetics. A new sense has been created in my brain due to the union between cybernetics and my body. And I can also define myself as a psychological cyborg, someone whose sense of identity has changed due to cybernetics. I identify myself as a cyborg.



I FEEL I AM TECHNOLOGY. I FEEL I'M A CYBORG.

CYBORG TRANSVESTITES

Psychological cyborgs don't necessarily need to be biological cyborgs. Someone might have no implants, no neurological modification and maybe even no contact whatsoever with technology yet identify oneself as a cyborg. In the same way that you might have the biological body of a man yet identify yourself as a woman. People who feel cyborg and want to become biological cyborgs are today facing problems similar to the ones transsexuals were facing in the 1950s. Back then bioethical committees did not allow sex change operations because (1) they thought the procedure was unnecessary (2) they thought it could be dangerous and (3) cause they were worried about public opinion: *"What would people think if someone came in our hospital as a man and came out as a woman"*.

Right now the reasons why many bioethical committees do not accept cyborg surgeries are exactly the same (1) they find it unnecessary (2) they think it might be dangerous and (3) in my case they were worried

about what will people think if I came out of the hospital with an antenna sticking out of my head. My surgery was not accepted by the bioethical committee and had to be done underground.

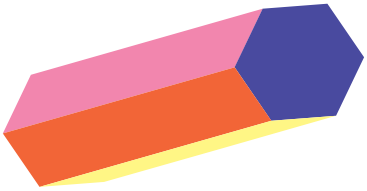
Little by little more and more people will be facing this problem. Cause the amount of people that want to become technology is growing. In a way we are ALL consciously or unconsciously in transition of becoming biological cyborgs. You can notice it in language. Before, one would say *"my mobile phone is running out of battery"* now most people would say *"I'm running out of battery"* or *"I have no reception"* instead of *"My mobile has no reception"*. We are already talking about technology as if we were technology. And the fact that most people here today are wearing technology is also a clear sign of transition. In the same way that if I wanted to be a woman I would probably start by wearing women's clothes and then I would have surgery, some of the people who wear technology will eventually have surgery. You are all cyborg transvestites.

SPACE TRAVEL

Some people fear that becoming a cyborg will make us less human but I believe the opposite. Becoming a cyborg will make us feel more human, it will make us feel closer to nature and to other animal species. Perceiving ultraviolet and infrared makes me feel closer to animals that can sense these colours, having an antenna makes me feel closer to insects that have antennas too, and perceiving space makes me feel closer to nature and to the universe. There are many senses in nature that we could benefit from: electroreception, magnetoreception, night vision, echolocation... Sharks can feel where the north is, we could be like them by having a small compass implanted in our leg that vibrates every time you face north.

But the fact of having internet connection in my head, the use of internet as a sense, allows me to go beyond colour. I can also connect my head to Satellites and to telescopes and perceive and extend my senses to space. Which is what is happening right now. I'm now here but my head is connected to NASA's International Space Station's live stream. So my body is here but my sense of colour is in space.

Our senses no longer need to be where our bodies are. I believe the next stage of human exploration, of the renaissance of our species, is to explore the disconnection between body and senses and to start travelling without our bodies. If we want to survive outside this planet, instead of going through the uncomfortable pain of traveling many lightyears, we could send our senses to space, 3D print ourselves at other planets and explore. We could become mindstronauts, while lying in bed. What better space ship than a comfortable bed? —



OUR SENSES NO LONGER
NEED TO BE WHERE OUR BODIES ARE

LETTER TO HUMANITY

ALTHOUGH YOU ARE FUNDAMENTALLY A SPECIES OF ANIMAL, THERE'S SOMETHING ENTIRELY UNIQUE ABOUT YOU.

KOERT VAN MENSVOORT

is an artist and philosopher best known for his work on the philosophical concept of Next Nature, which revolves around the idea that our technological environment has become so complex, omnipresent and autonomous that it is best perceived as a nature of its own. It is his aim to better understand our co-evolutionary relationship with technology and help set out a track towards a future that is rewarding for both humankind and the planet at large.

Dear Humanity,

It feels strange writing you a letter, I admit. Letters are generally addressed to an individual or a limited group of people. It's unusual to write to humanity as a whole. You don't even have a postal address, and I doubt you get much correspondence. Still, I thought it was time I wrote.

Obviously, I realise I can't possibly reach you completely – if only because humanity not only consists of every person who's alive right now but also of everyone who's ever lived. That's an estimated 107 billion people. And then there are all the others who haven't been born yet – hopefully there will be a great many of them. I'll return to that later, but before we talk about the future, I'd like to look back.

No other animal has shaped its surroundings as thoroughly as you have. It started sometime around 200,000 years ago. Back then, there was no Nobel Prize for coming up with the brilliant idea of using animal skins to keep warm, or controlling fire, or inventing the spear or the shoe. All those were exceptionally clever inventions that not only enabled you to survive in your unruly original natural habitat but allowed you to shape it to your will and to dominate it.

Human beings weren't always so powerful. With no more control over your environment than gorillas, butterflies or jellyfish. You stayed alive mainly by gathering plants, catching insects, stalking small animals and eating carcasses left behind by much stronger predators, of which you lived in constant fear.

Researchers believe this is because human beings once nearly became extinct and today's entire global population descends from a few survivors. This fact compels us to be modest. Actually, it's a miracle we're here at all.

Physically, compared to many animals, human beings are surprisingly fragile creatures. What other animal enters the world naked, screaming and relatively helpless, easy prey for any predator that comes along? A newborn lamb can walk within a few hours; it takes a human child about a year to stand on its own two feet. Other animals have specific senses, organs and reflexes that enable them to survive in specific environments, but you aren't naturally equipped for any habitat in particular. Yet this apparent weakness has also proved to be a strength, enabling you to spread from the savannah to the North Pole, the ocean floor and the moon! That's a unique achievement.

In itself, that's a fine idea, if only to prevent your being wiped out someday when a massive meteorite hits the planet. That would be a shame. To be honest, though, I think it's a bit early for you to seek refuge on other worlds. Because it has to be said that your presence on earth has caused problems: global warming, deforestation, plastic in the oceans, ionising radiation, declining biodiversity. It's enough to make a person depressed. It sometimes seems as if you do more harm than good!

I often encounter people who believe the planet would be better off if you weren't here at all. I hope I won't offend you by saying this, dear humanity, but I feel obliged to tell you that there are those among us who mistrust you, look down on you with scorn, or simply dislike you because they think you're ruining the planet. I hasten to add that I'm not one of them myself. I've always had trouble understanding such misanthropy, because ultimately it's a form of self-hatred.

On further investigation, I discovered that those infected with it have a particular image of humanity that is, to my mind, completely incorrect: they see it as an anti-natural species that doesn't truly belong in romantic, beautiful, harmonic nature. I believe this is a naive prejudice that won't help us to move forward, and we should get rid of it as soon as possible. To understand this idea, we need to start at the beginning.

The earth came into being more than 4.5 billion years ago. At first, it was no more than a lonely rock in space, and it

took more than a billion years before the planet's biosphere began to form. After that, it took about 2 billion more years for the first multicellular plants to evolve. Another billion years later, during the Cambrian explosion, an entirely new kind of life form appeared on the planet: animals.

The first animals emerged on the scene 500 million years ago. We don't know how plants, which had been around for a billion years already, felt about animals showing up. As you know, plants like to be left in peace; they don't move much and draw sustenance from the sun and soil. Now, I don't know what plants think, since I can't talk to them, but it doesn't seem impossible that they found it hectic and uncomfortable having to put up with animals all around them. Perhaps they even saw animals as unethical, not just because they were fundamentally rootless and lived at an unimaginably fast pace but more because they did something that in those days was completely new, unheard-of and abominable: animals ate plants.

All things considered, the arrival of animals couldn't have been much fun for plants. Though, and while an earth populated solely by plants was fine as far as it went, it was also a bit dull, or at least less exciting than one that contained animals too (I'll spare you a description of what it was like back when earth had no plants, only rocks, which was even more boring).

So, back to the role of humanity. Remember, you only just got here. Animals have been around more than 2,000 times as long as humans, and simple plant life more than 7,000 times as long. But I'm not saying that to compel you to modesty, because I think you're amazing.

Although you are fundamentally a species of animal, there's something entirely unique about you, which has less to do with your physical human build – which, as I said, is less than impressive – and more with your inherent tendency to use technology. While other industrious animal species transform their surroundings – think of beaver lodges and termite mounds – none of them does it as radically as you do. I'm using the word "technology" in the broadest sense: by "technology", I mean all the ways human thinking has an

impact on the world around us – clothing, tools and cars but also roads, cities, the alphabet, digital networks, and even multinational corporations and the financial system.

Ever since you came into being, you've been building technological systems to liberate yourself from the wilful forces of nature. It started with a roof over your head that protected you from a storm and has proceeded all the way to modern medicine for treating deadly diseases. You are technological by nature. But like the fish that doesn't know it's wet, you tend to underestimate how intimately your life is intertwined with technology and how much it's done for you. Look at life expectancy, for example. At the beginning of your existence, the average human couldn't expect to live much beyond the age of 30. Partly because of high child mortality rates, you could count yourself lucky if you stuck around long enough to reproduce. From Mother Nature's perspective, this is entirely normal. If you see a pair of ducks with a dozen ducklings swimming behind them in springtime, you shouldn't be surprised if there are only two, or with luck maybe three, left by the end of summer.

As bees collect nectar, they help flowers to reproduce by spreading their pollen. Human beings are dependent on technology, and vice versa. And humanity, what a huge help you've been on that score! Technology has become so omnipresent on our planet that it has ushered in a new environment, a new setting, that is transforming all life on earth. A technosphere – an ecology of interacting technologies that evolved after your arrival – has developed on top of the existing biosphere. Its impact on life on earth can hardly be underestimated and is comparable to, and perhaps even greater than, that of the emergence of animals 500 million years ago.

From an evolutionary perspective, all this is business as usual. Biology builds upon chemistry, cognition builds upon biology, calculation builds upon cognition. But from your point of view, it's exceptional. Breaking free of a DNA-, gene- and carbon-compound-based evolution billions of years old. Just as DNA evolved from RNA, your actions have made possible a leap to non-genetic evolution in new materials, such as silicon chips. Although this wasn't a conscious act, the consequences are no lesser for it. This is your

doing, but as yet, you barely seem to realise that, much less have you been able to take a clear position toward it.

Now, I understand that this is far from a simple task, if only because you, humanity, are not a single thinking being but a teeming mishmash of billions of individuals, all with their own thoughts, needs and desires, who aren't really biologically equipped to think on a large-scale planetary level. Nevertheless, it seems to me to be the most pressing issue of the moment. You are standing at a crossroads. And that's why I'm writing to you.

With respect to the future, I see two possible paths along which you might develop a co-evolutionary relationship with technology: the dream path and the nightmare one. Let's start with the nightmare. Parasitic relationships, in contrast to symbiotic ones, lack reciprocity. A leech, tapeworm or cuckoo gives nothing back to its host; it only takes. Could the tension we feel around technology have something to do with this? In spite of the fact that we've been using technology since time immemorial, because it serves us and extends our capabilities, human beings are in danger of ending up being the ones who serve technology, of becoming a means instead of an end, of becoming technology's hosts. An example can be seen in the pharmaceutical sphere. Medication is undoubtedly a life-saving technology, but when pharmaceutical companies try to maximise their own growth figures by convincing everyone who deviates from the statistical average in any way that he or she has a disorder and needs the appropriate drug, we have to ask whether they're truly serving humanity or just satisfying the needs of the industry and its shareholders.

The ultimate spectre is that you, humanity, ultimately become nothing more than the sex organ a larger technological organism requires in order to reproduce and spread. Life forms encapsulated within larger ones can be found elsewhere in nature: for instance, think of the intestinal flora that perform various useful tasks inside our bodies. Will we soon be no more than microbes in the belly of the technological beast? At that point, humanity will no longer be an end but a means. And I don't see that as desirable, because I'm a person, and I'm playing for team human.

Now for the dream.

Changes to come will allow you to be more human than ever before. What if we used technology to magnify our best human qualities and support us in our weaknesses?

We could call such technology humane, for lack of a better word. It would play to our strengths rather than rendering us superfluous. It would expand our senses rather than blunting them. It would be attuned to our instincts; it would feel natural. Humane technology would not only serve individuals but, first of all, humanity as a whole. And last but not least, it would realise the dreams we humans have about ourselves.

So what do you dream of? Flying like a bird? Living on the moon? Swimming like a dolphin? Communicating by sonar? Telepathy with loved ones? Equality between the sexes and races? Empathy as a sixth sense? A house that would grow with your family? Do you want to live longer? Maybe you could live forever.

Thanks to your inventiveness and creativity, you have raised yourself up out of the mud of the savannah. You have become an evolutionary catalyst that's transforming the face of the earth. This process is not complete. You are a hinge between the biosphere from which you sprang and the technosphere that arose after your arrival. Your behaviour affects not only your own future but the planet as a whole and all the other species who live on it. That's no small responsibility.

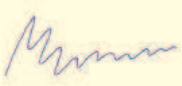
If you don't think you're equipped for this, you should have stayed in your cave. But that's not your style. You have been technological since the day you were born. The desire to get back to nature is as understandable as it is impossible. It would not only be cowardly in the face of the unknown, it would deny your humanity. You must move forward – even though you only just got here. You're a teenager, but it's time to grow up. It's the materialisation of human ingenuity in the physical world. Let's make it an artwork we can be proud of. Let's use technology to build a more natural world and map out a path to the future that works not only for humanity but for all the other species, the planet and ultimately the universe as a whole.
In closing, I'd like to ask you to do something. I'd like

to invite every one of you – living and not yet born, on earth and elsewhere – to ask one simple question of every technological change that appears in your life: does this increase my humanity?

The answer usually won't be black or white, yes or no. More often, it will be something like 60 percent yes, 40 percent no. And you'll sometimes disagree with other people and have to debate the matter before you can come to an agreement. But that's good. How? That remains to be seen. No one knows what human beings will be like in a million years, or whether there will even be human beings, and if so, whether I would recognise them as human. Will we accept implants? Reprogramme our DNA? Double the size of our brains? Communicate telepathically? Sprout wings? I don't and can't know. But my hope is that in a million years there will still be such a thing as humanity.

From the core of my humble, imperfect humanity, I wish you happiness, love and a long, exciting journey. In the anticipation that you will bring forth trillions more people,

all the best,



Koert van Mensvoort
Founder Next Nature Network

PS Note to the individual reader: After you read this letter, please pass it along to one of your fellow humans. If you'd like to do more, you can also copy, translate, reprint and further distribute it. Humanity is all of us.

Find the online version of this letter on
http://lettertohumanity.org/english

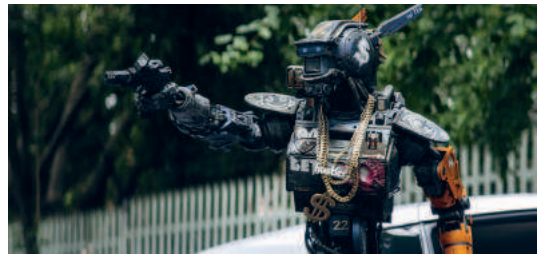
THE SCIENCE-FICTION OF THE HUMAN SELF

©MOON. DIR. DUNCAN JONES. A-FILM, 2009. FILM.

MASHYA BOON

is a Dutch Film Studies Scholar currently obtaining her PhD at Michigan State University, USA. For her doctoral work, she explores how the cultural imaginary of cinema has envisioned certain 'science-fictions of the self'. By analyzing a variety of fictional rheohuman figures in contemporary science-fiction – like the clone, the A.I. and the cyborg – she strives to formulate inclusive, supplementing, and adaptive alternatives of human subjectivity instead of exclusionary, segregating and rigid doctrines of identity.

Why am I the one I perceive myself to be? This might be the most pivotal question the field of the humanities can ask itself, for it allows an examination of what it means to be a human being. Is it because I am unique? Because I am embodied? Because I have a consciousness? Or because I have experienced what I have experienced? But what does it entail to be a unique, embodied, conscious and experiencing human being? The notion of the 'human' is an utterly capricious and culturally constructed concept in itself, yet simultaneously it retains a seemingly self-evident and naturalistic 'aura'. Within cultural discourses on human subjectivity a certain essentialistic view on the human sense of self has been dominant. This traditional Cartesian perception comprises an embodied subjectivity unified through the act of conscious awareness of the self and is deeply rooted in an almost 'sacred' uniqueness and singularity of the human subject. Although much critical work has been done to contest anthropocentric viewpoints, the implicit and normative cultural constructions underlying these hegemonic discourses on human subjectivity have *normally* remained uncontested. We have questioned if the human is essential to the core of existence, but we rarely question if the core of the human itself essentially exists at all. To critically interrogate this presupposed human core, I undertake philosophical 'thought-experiments' by analyzing how the cultural imaginary of cinema has envisioned certain 'science-fictions of the self' which radically stretch the normative boundaries of our conventional understanding of human identity. One could see the medium of film as functioning as a sort of 'prosthetic memory'; an arena where virtual yet affective experiences are disseminated across people's minds, a fictitious commonplace where actual memories are formed. This particular perception



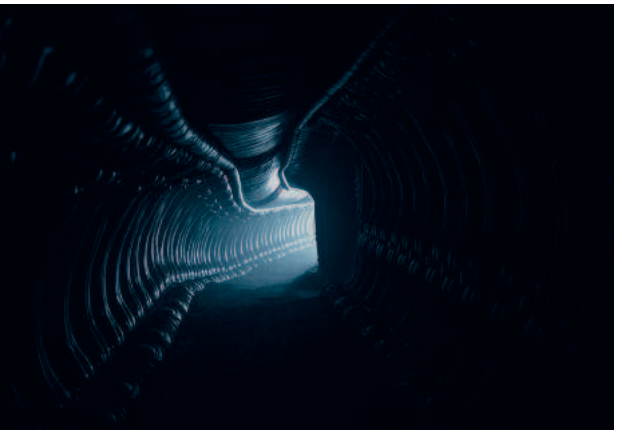
©CHAPPIE. DIR. NEILL BLOMKAMP. COLUMBIA PICTURES, 2015. FILM.

of cinema appeals to me intimately. However, cinema might even be considered as a certain mode of thinking, as a way of thought in itself. For a medium through which memories are formed, is in my opinion a medium that inherently enables an advancement of consciousness and therefore it is a medium through which we are productively able to think and thus philosophize. Simultaneously, film should be discerned as a kind of cultural imaginary, a cerebral terrain where a variety of discourses are continuously shaped and reshaped as they shape us as well. Each film presents us with its own distinct cinematic language; a particular ideologically laden vernacular which can invite us into a philosophical dialog. In this sense we might enter a film as a 'thought-experiment' and experience the cinematic site as an existential and ethical playground. Science-fiction in particular has long been recognized as a genre that is particularly apt for allowing philosophical ideas to roam freely through the fictional simulations it creates, and to reflect on existential questions rarely encountered elsewhere. Seen in this light, film itself becomes a discursive and reflective *topos* where we can venture into as an innate means to explore who we are – for we are formed by it as much as we form ourselves through it.

©MOON. DIR. DUNCAN JONES. A-FILM, 2009. FILM.

CINEMATIC CLONES, ILLUSIVE IDENTITIES & MERCURIAL MEMORIES

Imagine if you would encounter yourself today. A disquieting question arises: Who am I if I am already there? This scenario radically upsets the conventional conceptions of human subjectivity that exist in our society and form the basis of our sense of self. Can I consider you, this other person that is not myself, to be me? Do we experience life in the same way? Are your memories mine or my memories yours? Do we share a consciousness? Is your body my own or is my body yours? Am I still unique? Are we me or am I you? Asking



©ALIEN: COVENANT. DIR. RIDLEY SCOTT. TWENTIETH CENTURY FOX FILM CORPORATION, 2017. FILM.

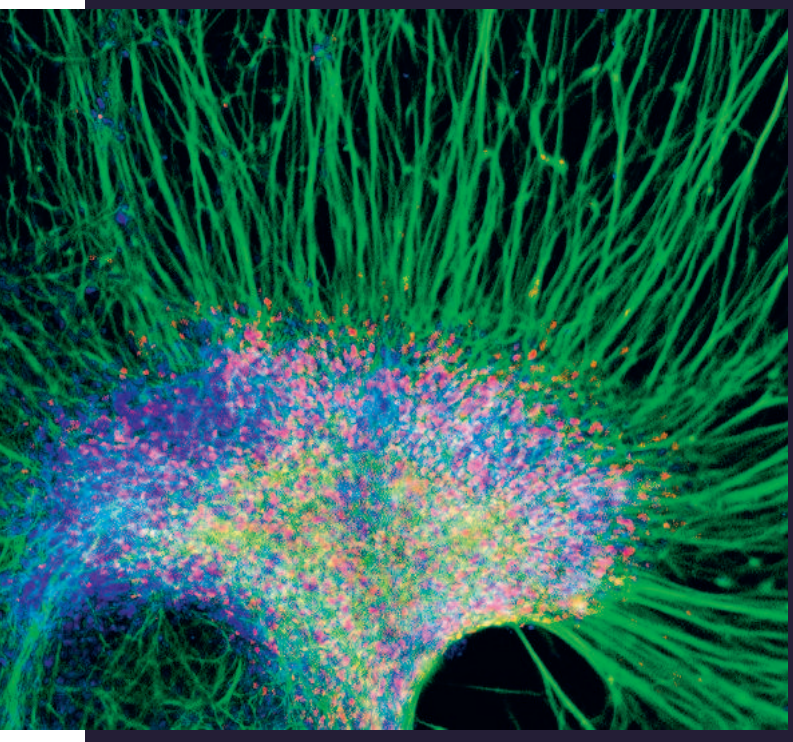
these kinds of existential questions is intriguing and important, for they allow an ontological exploration of human subjectivity. Within my prizewinning MA-thesis *Cinematic Clones, Illusive Identities & Mercurial Memories* I undertook such a philosophical thought-experiment by analyzing 'the cinematic figure of the human clone' within the filmic texts of *Moon* (Jones-2009), *Alien: Resurrection* (Jeunet-1997) and *The 6th Day* (Spottiswoode-2000). Although actual human cloning has not seen the light of day yet and all the possible answers to the questions posed above remain hypothetical to this particular instance, we are able to presently venture into this subjectivity-reshaping terrain on a more palpable level by exploring the manner in which human cloning has been envisioned in cinema – for the questions the very real prospect of human cloning evokes, are in fact readily being explored within the domain of science-fiction. In this sense the phenomenon of cloning is a cinematic as well as scientific *topos* within a specific cultural imaginary. This 'genetic imaginary' increasingly pervades our discourses on the self, memory, identity and humanity. The cloned protagonists of my three case-studies, are clones that possess the memories of the lived experiences of their 'original': clones that are endowed with a 'prosthetic memory'. This concept experiments with the idea that the memories and therefore the identity of an individual could be extracted and subsequently implanted into the next as a kind of prosthesis. However, the concept of memory in itself already comprises an extremely slippery phenomenon. The evocation of a prosthetic memory within a cloned subjectivity hence renders any conception of memory or self as inherently unstable and inessential, although memories in their precarious nature do very much structure the basis of our subjectivity. By interrogating this capricious connection between memory, cloning and subjectivity within the realm of cinema, I delineated different and novel ways a cloned sense of self might unfold. The coupling of the trope of human cloning with the concept prosthetic memory thus brings forth a number of severe consequences for maintaining the Cartesian sense of self on which our place in the world is based. However, if this thought-experiment ferociously revealed conventional subjectivity to be a mere fantasy of unique individuality, we should not cease to search for the self. Precisely because identity and memory have become so elusive and mercurial, a self-reflexive quest like this gains additional momentum. My research strives to radically stretch the normative boundaries of our conventional understanding of subjectivity, while I wish to deconstruct a certain discourse where a power struggle rages from within the dichotomies of original vs. copy, uniqueness vs. multiplicity, 'aura' vs. reproduction. In my opinion the discussion surrounding contemporary subjectivity-reshaping technologies, like genetic manipulation, human-robotic enhancement and artificial intelligence, is utterly trapped in a hegemonic deadlock where a kind of fascistic logic is deployed by inherently valorizing certain hegemonic categories above others. Therefore, my project emanates an almost politically driven goal: it aspires to update, enhance and break open the normative frameworks of thought concerning our notion of the human self. A paradigmatic shift in our frame of reference concerning human identity is much needed. Because in times like these, in which animals are cloned by the millions in China, in which organs can soon be printed from our own unique biological material, in which computer technology is progressing at such a rate that human thought pattern

could be made codifiable, it seems redundant to keep thinking within a restrictive discourse where the original, the singular and the unique are unequivocally and unquestionably conflated with 'the sacredness of human life' and all other forms of subjectivity are discarded as deviant and dangerous. In a time where anything can and will be artificially reproduced – not only the image, but also the body itself – it is counterproductive to assign a Benjaminian 'aura' to categories which are no longer the basis of life itself. Perhaps thinking in this vein seems like a giant leap when we are coming from actual practical, scientific questions of genetics that are being asked today and dive into elusive, philosophical questions of subjectivity that might or might not affect us in the future. Nonetheless, I think it is very important to ask these existential questions beforehand, for the time to address the ethical implications of these technologies of reproduction is before we actually apply them. So the time to address them, is right now.

THE FIGURE OF THE RHEOHUMAN

My project is undeniably rooted within posthuman theory, for it strives to radically stretch the normative boundaries of our conventional understanding of human subjectivity. However, in my opinion my research in its scope and aim transcends and overflows some of the rims this framework has demarcated. The term 'posthuman' literally means: an entity which is beyond the 'human' as we know it. Posthuman theory in accordance critically questions the perception of human nature as a universal and hegemonic state. Instead of contesting humanity's essentialism to the core of existence, I would like to deconstruct the seemingly self-evident but nevertheless culturally constructed and therefore 'fictitious' core the human self appears to possess. My project does not seek to annihilate conventional constructions of human subjectivity. However, it wishes to update, enhance and break open the normative frameworks of thought concerning our notion of the self in order to establish new ways in which we might imagine the human subject; novel modes of subjectivity that encompass inclusive, supplementing and adaptive alternatives of a human sense of self instead of exclusionary, segregating and rigid doctrines of identity. Posthumanism, in my opinion, restricts itself by still adhering to normative humanism. By imagining entities which are beyond the 'human' as we know it, the posthuman implicitly reaffirms and naturalizes the discourse of 'sacred' uniqueness and singularity of human identity by means of in- and exclusion within the very same discursive framework it seems to contest. It simultaneously places itself beyond the borders of the known, therefore obscuring the category of the 'posthuman' and casting it into the fringes of the unknown while keeping the category of the 'human' firmly within its hegemonic place, whereas I would like to reshape the 'human' as we know it to make it susceptible to more fluid and productive forms of subjectivity. Therefore, I would like to propose a certain perception on human subjectivity which encompasses both the 'old' (re-) and the 'new' (neo-) and incorporates a multifaceted human sense of self which *flows* across multiple embodiments and mentalities as water runs through multiple rivers and as life gushes through multiple forms: 'panta rhei' – everything flows. Therefore, I propose the figure of the *RheoHuman*, a subjectivity which is in a state of perpetual but constant change and contains a 'continuous consciousness' as well as a 'continuous corporeality' – a perception of a human sense of self in flux. In my MA-thesis I already started conceptualizing such subjectivities out of 'the science-fictions of the self' my three case-studies presented me with. What I found is that the very notion of a 'constant and invariable' self is intrinsically a fictional construction. According to philosopher David Hume we should view our subjectivity as a 'fiction of the self', one which is based on our ever-changing perceptions of our identity which on their part are based on the perceptions of our memories of our perceptions of ourselves: 'a bundle or collection of different perceptions, which succeed each other with an inconceivable rapidity, and are in a perpetual flux and movement'. In this vein subjectivity should be discerned as an imagined impression of *fictional* assemblages we carve out of our own illusive perceptions. In a way we could state that our hegemonic cultural construction of the self is just as 'real', or just as 'fictitious' as the cinematic constructions of subjectivity we find within the cultural imaginary of cinema. Therefore, I deem it very fruitful to investigate these science-fictions of the human self in order to shed a critical light on ourselves. So by analyzing a variety of fictional but nevertheless evocative RheoHuman figures in film – like the clone, the A.I. and the cyborg – we can critically interrogate conventional conceptions of human subjectivity. These figures all in their own right defy some of the implicit core values of what it means to be human. By closely looking at how these figures are structured by the filmic texts they reside in, we can begin to formulate different and deviant ways in which human subjectivity might be thought of.

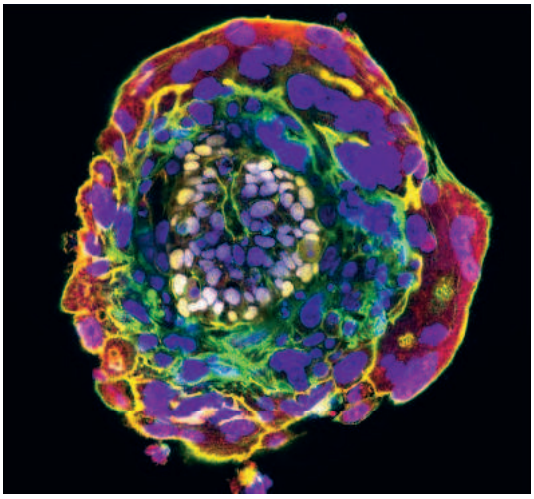
WHOSE IS THE HUMAN EMBRYO? THE DILEMMAS OF HUMAN ENHANCEMENT



CLUSTER OF NEURAL CELLS DERIVED FROM HUMAN EMBRYONIC STEM CELLS.

ROBERT ZWIJNENBERG

is professor of Art History in relation to the development of science and technology at Maastricht University and Leiden University. His research focuses on the impact of art on science and technology in contemporary culture, an example of which is Bio-art, where artists seek inspiration from science, while enriching the moral debates by visualizing the ambiguity of the issue.



MOLECULAR MARKERS DELINEATE DIFFERENT CELL TYPES WITHIN ATTACHED HUMAN EMBRYO.

In August 2017 a paper appeared in *Nature* describing how reproductive biologist Shoukhrat Mitalipov and his team had used genome editing (CRISPR/Cas9) to correct a gene that causes a potentially fatal heart condition in humans (hypertrophic cardiomyopathy). The article describes how they corrected – Mitalipov's choice of word – a disease-causing mutation in dozens of viable human embryos. Researchers in China and Sweden had previously attempted to alter human embryos genetically but no team had ever demonstrably succeeded in doing so in such a way that the embryo could develop to full term. Of the 58 embryos treated in this study, 48 were theoretically believed to be viable, though to be absolutely certain further research would be required. Nevertheless, Mitalipov's achievement is an important step towards fulfilling the great promise of CRISPR/Cas9, the revolutionary gene-editing technique enabling precise editing of faulty genes, including in the germline. With his technique we can alter the human genome in ways that are inheritable to subsequent generations, that is we can eradicate from the human species once and for all single gene disorders (such as Huntington's disease, cystic fibrosis and sickle-cell anaemia) and we can 'correct' disease-causing mutations in embryos.

The response to Mitalipov's research by ethicists, politicians and the public have nevertheless been cautious. Do we really want this as a society? What about the ethical implications? Or: are we trying to play God? The response from biotechnologists has been more enthusiastic, on the whole. The study is seen as a very important step in efforts to cure 'sick' embryos. If it is safe we should apply this technique, because this would allow us to correct heritable diseases before a child is born. It seems as if, to biotechnologists and doctors – and undoubtedly to many non-biotechnologists – eradicating lifelong suffering due to illness trumps any ethical and religious misgivings. And who could possibly be against this form of human enhancement, which is intended to give people a healthier and happier life?

What grates here, however – for me, at any rate – is the fact that the question of 'Whose is the embryo?' remains unaddressed. Beneath both the caution and the delight with which gene editing is received lies an assumption about who is allowed to decide what happens to an embryo. This is of course a philosophical, ethical and religious issue, but it is also an everyday issue. Conclusions as to what may or may not be done to an embryo always have practical implications that imply moral ownership.

This is made all too clear by the following two examples. In the debate on the relaxation of the Dutch Embryo Act, the Dutch Health Council has recommended that research on specially created embryos be made possible. This is not permitted under the Embryo Act in its current form. Biomedical scientists argue that it is vital that the creation of embryos in the lab be allowed in order for important progress to be made in biomedical research. They thus claim ownership of the embryos they would themselves create and the right to use this exclusive ownership to conduct research on the embryos as they see fit.

THE SECOND EXAMPLE CONCERNS A PAPER IN BIOETHICS

(February 2017) by Eric Mathison and Jeremy Davis. They argue that 'at some point in the future – perhaps within the next few decades – it will be possible for foetuses to develop completely outside the womb. Ectogenesis, as this technology is called, raises substantial issues for the abortion debate'. In the current legislation, a woman's right to abortion is weighed against the foetus's right to develop to full term. Abortion is permitted up to the point that the foetus is legally regarded as viable outside the mother's body, at 24 weeks' gestation. This limit has been determined by the biotechnological potential to allow a foetus to develop fully outside the womb. With ectogenesis it might become possible for

a woman to have an abortion, in the sense of having the foetus removed from her body, but for the foetus to be kept alive. What are the implications if we want to maintain both the woman's right to abortion and the right of the foetus to develop fully with the aid of ectogenesis? The question 'Whose is the embryo?' is vital here. Is the foetus in the artificial womb still the mother's, or is it the biotechnologists', the hospital's, society's?

The authors conclude that, according to current legal and ethical opinion, while there is a right to an abortion there are good reasons to doubt that the right to the death of the foetus exists. At the same time, they conclude that this practical issue, as they call it, deserves more philosophical consideration. And this is where they strike a nerve: our moral frameworks appear increasingly inadequate for addressing the ethical issues raised by the results of biotechnological research. As can be seen in the response of medics to Mitalipov's research, the dominant life science debate barely distinguishes between a risk assessment and an ethical assessment. In the legitimate call for strict safety regulations, ethical considerations are reduced to nothing more than the result of a risk assessment. Once patient safety and benefits are guaranteed, an application is almost by definition ethical as far as the medics are concerned. Politicians and also philosophers, ethicists and religious thinkers almost always fall back on their traditional moral frameworks, thereby encountering insoluble paradoxes.

To me, the question 'whose is the embryo?' is one raised by biotechnological innovations and the ethical issues associated with them.

It is a question that expresses a need, as I see it, for a radical rethinking of our traditional notions of nature, the human body and the concept of the human. For this to be possible, I believe we at any rate need a practice that subjects biotechnology to hands-on study and investigation, yet forms no part of it. One example of such a practice is bioart. Bioart is a contemporary art form in which artists make use of the techniques and media of biotechnology in their own research and artistic projects in a biotechnological lab, to construct an alternative understanding of the sociocultural, ethical and philosophical implications of biotechnology.

One of the leading bioartists of our age is Adam Zaretsky. The goal of one of his projects - his 'Initial Attempts at Embryonic Transplant Surgery' – 'was to cut the head off of one growing zebrafish embryo and transplant (paste) that head onto another "whole" zebrafish embryo. Done correctly, this might develop into a two-headed, fleshy and fashionable, "Mosaic Brut" designer zebrafish'. This project is part of his relentless quest for what he calls a transgenic aesthetic and an ethics that matches the opportunities of biotechnology. On his website he writes: 'This is an attempt at waking the sleeping dreams of personal beauty. Therefore, I am not shielded by the rhetoric of moral sanctity implicit in the public face of scientific rationalization'. The responsibility of bioart manifests itself in the fact that it is amoral and holds no prescriptive claims to how society should be. This way, bioartists simulate the forces that structure a biotechnological society and modulate them in the direction of an alternative system. Zaretsky's project almost automatically raises the question 'whose is the embryo?'. Or, more broadly,

'whose is life?'. What limits do we wish to impose on biotechnological innovation involving nature and the human body?

And what notion of being human and of nature are these limits based on?

Of course bioart cannot provide an answer to or enable us to circumvent the ethical and cultural paradoxes and ambiguities evoked by biotechnology. However, in the words of the bioethicist Joanna Zylinska: 'In its use of biotechnological media and tools, its tampering with life, bioart takes responsibility for life, without retreating to any pre-defined moralist positions about what life is and how it should be treated, contours for a new paradigm for an ethics of life in the biotech era are being drawn'. This suspension of a moral goal makes the hands-on practice of bioart specifically fit as a means of trying to work around the deadlock in the scholarly and public debate on biotechnology. Within the field of possibilities opened up by the artistic register, including inconsistencies, paradoxes, ambiguities or uncertainties, a bioartist can try out different and sometimes opposing avenues to explore the implications of re-designing life. My question 'Whose is the embryo?' is therefore above all a call to biotechnologists, ethicists, politicians and concerned citizens not to fall back on preconceived moral concepts but to surrender without fear to the confusing moral openness unleashed by a bioart project, as a first step towards escaping the deadlock. —

THE FUTURE OF HUMAN EVOLUTION

EVER EXPANDING BRAIN SIZE

MENNO SCHILTHUIZEN

is a Dutch biologist and researcher. He works as a senior scientist for Naturalis Biodiversity Center and holds a post as professor of evolutionary biology and biodiversity at Leiden University. His research on the evolution snails and insects takes him to jungles in Borneo and caves in the Balkans, but he also studies how animals and plants in cities adapt to the Anthropocene.

Humans have stopped evolving. Or haven't we? It may seem that in our modern day, natural selection has stopped. With improved health care and safety, most people these days live long and have children. And genes for diseases that we die from after we have reproduced cannot be touched by selection. But this also means that genes that make us more susceptible to disease which previously would be selected away by premature deaths, will be on the rise. And this is also a form of evolution. After all, evolution is just any change in allele frequency.

Of course, we have to remind ourselves that evolution does not have a goal. An evolutionary change is the result of selection in previous generations and since we cannot know what selection pressures the future will bring, we also cannot know in which direction evolution will take us. But we can still do some educated evolutionary speculation.

Modern genome research shows human evolution in action. The 150,000 British genomes that have been scanned in the UK Biobank project show an increase over the past half century in a nicotine receptor allele. People who carry this allele are more likely to take up smoking and to die young from smoking-related illnesses. But our smoking habits changed and declined compared to the 1950s and 1960s. Therefore, the selection on this gene has lessened (less people die with these allele) and it has increased over a time of just one or two generations.

EVER EXPANDING BRAIN SIZE?

What other evolutionary effects might we expect from our current thriving and expanding human population? One thing we could do is look for trends over long periods of time. Brain size, for example, has increased steadily in human evolution over the past few million years. Clearly, large brains have been universally beneficial for a long time. And it seems logical to expect that our brain size will increase even further.

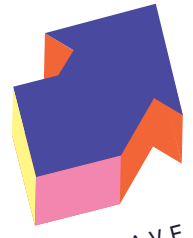
There could be limitations in brain growth, like the size of the birth canal in women. A big brain baby has a large head, and is perhaps unable to pass through its mother's pelvis. But there are several possible ways around this potential limitation. First, increased hip circumference in women could evolve as well. And sure enough in another British genome sequencing project called UK 10K, researchers found evidence that genes for larger hip size in women have been selected over the past few millennia. The second possible way around the limitation, would be our unique human ability of developing technology. Caesarean sections are still rising. And they could be the key to allowing big-brained babies that otherwise would have died, to be born.

Another possible obstacle to further increase of our brain size is lack of genetic variation. If there are no genes floating around in the human gene pool that code for bigger brains, then evolution will come to a halt. But we have to remember that the chance on the right mutation depends on population size. The more people, the more mutants. Since most steps in our brain evolution have been taken when the human population was still very small, it is unlikely that the current 7 billion persons do not contain the right mutations.

SEXUAL SELECTION

There's a more general reason why the current huge population size may be very important for our evolution: sexual selection. Many researchers believe that eye color and hair color and pattern, but also personality traits, such as creativity and perhaps brain size itself, have evolved via sexual selection. The strength of sexual selection depends on population density. The more potential partners you meet, the more possibility there is for selecting favorite characteristics. In our past when people lived in sparse, small groups, most people only met a few potential partners during their lifetime. Today, in the dense cities that most people live in, we meet hundreds of potential mates each day.

We have not stopped evolving. Our behavior, our technology and our population size, along with the increased likelihood of new mutations rising, may mean that rather than at a dead point in our evolution, we may actually be on the brink of a new evolutionary stage of the human species. —



WE HAVE NOT STOPPED EVOLVING

HIREC: Human-induced rapid evolutionary change

Darwin thought evolution was a very slow process. We see nothing of these slow changes in progress, he wrote, until the hand of time has marked the lapse of ages. But even while he was writing this, natural selection was darkening the wing color of the now famous peppered moth via improved camouflage against the soot covered bark of trees in Industrial Age England. In just 40 years, the second half of the 19th century, all the peppered moths in England had changed from white to black. So after legalization put an end to air pollution in the 1950s, it took another 40 years for them to change back. The peppered moth evolution is the first example of what we now call HIREC, Human Induced Rapid Evolutionary Change.

No other agent is changing the environment as fast and drastically as humans are. We pollute air, soil, and water. We fish and hunt, we dam rivers, change the climate, and light up the night. We introduce exotic species and pets into the environment. In areas that are strongly influenced by humans, and by the middle of this century that will be almost anywhere on Earth, wild animals and plants will need to either adapt or go extinct.

Besides the peppered moth, we now have a whole list of organisms that display HIREC. Sometimes this even leads to so-called speciation, the evolution of two species where first there was just one. Speciation is what creates splits in the branches of the evolutionary tree of life. And normally it is a slow process, but when humans are involved, it can happen much faster. Evolution can go very, very quickly if the selection pressure is strong. And human action creates such strong selection pressures. This means that humans are influencing the evolution of life on this planet in irreversible ways. But it also means that some species may be able to survive environmental change by evolving adaptations, a kind of evolutionary rescue.

Novel ecosystems

So, rapid evolutionary change can take place if there is a strong selection pressure, a strong need to adapt. By the mid-21st century, three quarters of all humans will live in cities, more than half of the land mass of the planet is urbanized. And much of the rest covered by human shaped farms, pasture, and plantations. Altogether, a set of entirely new habitats, the likes of which the natural world has not seen before. So how will the ecosystems of the future look like if HIREC became the overwhelming evolutionary force in our world?

Until the middle of the 19th century, blackbirds were reclusive forest birds. They were never seen in cities. But since 1850 or so blackbirds began colonizing cities. First in Germany, then in other cities all over Europe. What happened then is that the city black birds began to evolve. They lost their tendency to migrate, their body shape changed, their breeding time shifted and they began singing at a different pitch. We know that some of these changes are genetic, from looking at the bird's DNA.

The same DNA studies also showed something even more remarkable. Namely that the city blackbirds had not colonized cities by first evolving in one place and then leapfrogging from city to city. No, instead, each city blackbird population had evolved independently from the local forest population. Even in China, the Chinese blackbird, which is a different species, spawned an urban offshoot independently. So the urban blackbird is an example of parallel evolution, the same evolutionary changes taking place independently in different places or different times. Such parallel evolution is likely to happen in urban evolution. After all, unlike the natural ecosystem, the city ecosystem is regulated by human interactions. And because of our long distance communication, the same habitat changes are taking place at the same time in different cities.

So, for the future we may expect that urban ecosystems will dominate the planet and that human technology transfer lets changes happen simultaneously across the world. And as cities expand, changes will happen more and more quickly. This means that only those species that can evolve fast enough to keep up with the changes will survive.