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AFEKA TEL - AVIV ACADEMIC COLLEGE OF ENGINEERING

# Afeka Journal of Engineering and Science

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# Editors’ Preface

Dear readers,

We are pleased to present to you the first issue of the Afeka Journal of Engineering and Science.

The technological revolution that has started a few decades ago places the engineering profession at the center of human life. Engineers around the world affect every aspect of the society we live in, and the examples are countless: our concept of time has been shortened miraculously since we got used to getting Google's answers in milliseconds, our perception of space has changed since "Waze" steers us to our destinations, apps shape the relationships that we have, our money changes its value in a “bit”, and even family ties are extended and strengthened with the help of WhatsApp. The concept of "life" also takes on new meanings within the discourse between humanism and posthumanism.

A look at the papers in the issue shows that Afeka is a journal that seeks to be a platform for the interdisciplinary connections that engineering has with the various content worlds of our time. As a result, in the following pages you will find papers on a wide range of topics between which engineering is the link. We introduce to the readers, among other things, thoughts on digital culture, analysis of economic justice theories, examination of ethics for engineers, and a case study in the world of aviation.

In addition, because Afeka is a journal of a college of engineering that trains undergraduate and graduate students in the various engineering fields, we have a special interest in engineering training questions. These questions, of course, concern the academic content and teaching methodologies, but also the image of the engineer that forms before our eyes and that requires us to create a cutting-edge academic space enabling the acquisition of the necessary skills. This issue features a paper that presents a conversation between David Goldberg, author of *A Whole New Engineer*, and the college's president, Prof. Ami Moyal. You will also find in the pages below a paper discussing the importance of English studies in the academic training process of Israeli engineering students.

Here the use of the term "science" appearing in the journal's name must be explained. Questions about the essence of this concept are at the core of the philosophy of science, and the answers given throughout the history of ideas in this context were formulated within a view of the work of natural-science scholars as a model for defining science. For example, Karl Popper, who lived in the twentieth century, wrote his position against the scientific content of Adlerian psychology, while looking to physics as a field of scientific research, in which the researcher comes up with hypotheses and attempts to refute them. As a result, courses in the philosophy of science, which are currently being studied mostly in the humanities faculties, require a physical-mathematical orientation to delve deeper into the content they teach.

For too long, the social sciences have been looking into what is happening in the natural sciences as a model of scientific practice. For several decades, the circles that comprise the field of humanities in Israel have been mulling over the role of the term "science" on the sign at the entrance to the faculty. Even an apology is sometimes discerned in the words of those who wish to explain that the term "humanities" in Hebrew was born under the influence of the German language (Geisteswissenschaften) on those who founded the first humanities schools in the nascent Israeli academy.

The journal's editors do not consider such a concept of science as exclusive to research fields characterized by mathematical formalism in their construction of scientific theories, and by strict adherence to quantitative methods for scientific examination. We regard the concept of science as an attempt to expand the human mind, and in doing so, we recognize the importance of qualitative research methods and their scientific status, equal to that of quantitative research methods; this is, of course, while matching the method of research to the subject under study, and to the properties on which we seek to shed light.

Our final words relate to the nature of the journal against the backdrop of common trends in the world of scientific publications. First, academia all over the world is replete with content the publication of which is motivated by the promotion-and-reward system used in universities. Too few articles are published with the intention to inform the academic community of discoveries in the various fields of research. Second, academic papers evidently are becoming tediously longer, for reasons that are not necessarily essential, and thus the efficiency of informing the readers is diminished. Third, we live in an era of blurred boundaries and there are many non-academics who wish to read, be educated, and gain insights from those who devote their time to research. These three points lead us to try to propose a model of an academic journal in which short essays of approximately 2500 words will be published, written in a language that may be accessible to the curious reader, alongside papers of traditional length as is widely accepted in the various fields of science. The Information Revolution, spurred by the technological revolution, allows anyone interested to continue exploring and finding their way in the network's new expanse.

We hope your reading will be enlightening,


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# Engineering Education in the Academy

I am proud and excited to open the first issue of the journal of Afeka – the Tel Aviv Academic College of Engineering. The new journal was created with the understanding that the engineering profession is currently at the center of human existence, and that it has a direct and paramount impact on many different aspects of our lives. Given this, the question of the academic training of engineers must receive primary consideration, and so Afeka College started, three years ago, a conference on national human capital training in engineering. The conference, and to a large extent also the journal, is intended to provide information and tools to practitioners in the field; their main role, however, is to serve as a platform for the discourse about the change required in the training of engineers in the academy, and the need to collaborate across all systems on the educational continuum, and in particular, three systems that feed one another: the education system, academia and industry.

These opening remarks focus on the key issues concerning the change required in the way the engineers are trained in the academy. Most of them are insights gained from the process of change we have made at Afeka College in recent years, from the dialogue with other academic institutions around the world and the mutual visits we make, from the connection with the industry in Israel and from various international reports on the field.

The need to realize change in the way engineers are trained in the academy stems from two major changes that have occurred in the other two systems on the educational continuum: the profile of the education system graduate who enters the academy and the profile of the graduate engineer required by the industry.

The new student generation attending the academy has different characteristics from those of the previous generation. Students are technology oriented and are able to handle multitasking; they study differently, and it seems that in an age of accessible information, a class lecture is less suitable for them. The question of the relevance of academic studies occupies them in deeply, especially in the practical context of finding a profitable job.

Alongside this, the accelerated technological development in the world is leading to real changes in all areas of life, including the job market. Academic graduates, who integrate into the job market in an ever-changing age of knowledge, require broad and deep professional knowledge, but also essential skills for their success, such as multi-disciplinary teamwork, effective communication, self-learning, critical thinking and creativity (hereafter "essential skills").

One of the main functions of the academy is to train human capital for the benefit of society. Considering the changes described above both in the image of the engineer and that of the student, the question arises – is a change required in the process of training engineers in the academy? And if so, what is the change needed?

A report by Dr. Ruth Graham for MIT University, titled The Global State of the Art in Engineering Education,1 shows that the field of engineering education has undergone considerable changes in recent years. The report outlined two groups of leading academic institutions in the field of engineering: the world's leading academic institutions today, and the academic institutions that will become leaders in the foreseeable future. The main characteristics of the two groups are interesting, and they will be briefly discussed below.

1. Graham, R. (2018). *The Global State of the Art in Engineering Education*. Cambridge, MA: MIT School of Engineering.

The characteristics of the academic institutions in what is considered today the leading group, according to the report, are:

1. Established academic reputation consistent with international rankings;
2. Academic excellence of a particular department or excellence expressed in a particular curriculum;
3. International network for strategic collaborations;
4. An educational approach, the main components of which are studying alongside practical experience within the curriculum; a close link between research and teaching; a wide range of extracurricular activities; development of entrepreneurial capabilities and social responsibility; and collaborations with industry in research and during curriculum updates.

The characteristics of the academic institutions that are considered to be leaders in the foreseeable future, according to the report, are:

1. A cross-institutional educational conception that is motivated by a vision of prominence;
2. New institutions or institutions that have undergone extensive transformation in all engineering programs;
3. A development that is usually spurred by national needs or constraints such as economic development, lack of engineers or social gaps;
4. An educational approach, the main components of which are non-standard admission conditions or processes; integration of online and experimental learning on campus; innovative activities outside the curriculum led by students; focus on engineering planning and self-reflection; work-based learning.

In a recent Afeka College survey of more than 100 Israeli high-tech companies,[2] the question was asked, what are the five skills you find important for engineers? The qualifications are listed below in the order of importance defined by the respondents: working in a multidisciplinary team; solving engineering problems; creativity; effective communication; use of modern engineering tools; system design according to needs; lifelong learning; wider education; emotional intelligence; international orientation and English language knowledge; critical thinking; professional and ethical responsibilities; design, execution and analysis of experiments; mental resilience; up-to-date knowledge; application of knowledge in mathematics, science and engineering. So, in addition to knowledge, the list features conspicuously many essential skills.

The discussion of the change required in the training of engineers in the academy focuses, in part, on the question whether acquiring essential skills should be done during the academic studies. It seems that most senior functionaries in academic institutions agree that essential skills are needed for an engineer to succeed in the industry, but opinions are divided about how they are integrated into the engineers' training. In this regard, there are several main approaches:

1. The role of academic institutions is to impart scientific and engineering knowledge, while the essential skills are acquired during work in the industry;

2. Collaboration between the academy and industry in the form of curriculum programs is required, which will enable students to work in the industry during their studies and acquire essential skills;

3. The essential skills will be acquired in academia but in activities outside the curriculum;

4. The essential skills will be taught in the academy as part of the curriculum.

The group of institutions employing the fourth approach is faced with the question of whether acquiring the

2. Internal Survey, Afeka Academic College of Engineering, Tel Aviv, Jan. 2019.

essential skills should be done "at the expense" of acquiring knowledge, and if so – what knowledge should be given up in favor of acquiring the essential skills?

In addition, the very decision to impart essential skills within the curriculum requires tackling complex challenges, including defining the learning outcomes in courses with reference to the acquisition of essential skills; changing the pedagogy to impart these skills within the courses; and creating assessment measures to evaluate the acquisition of the various skills during the education process.

The questions presented here are not simple ones; in my opinion, however, every academic institution engaged in the training of engineers must deal with them and develop the appropriate solution for their students.

Afeka College is in the midst of a multi-year change process; the process began with the decision to train engineers according to the needs of the industry, and continued to define the image of the Afeka graduate engineer – an ethical person with scientific knowledge, engineering knowledge, proficient in languages and possessing broad education, with essential skills and engineering skills. The essence of change is the transition from defining our role as an academic institution that trains engineers to an institution that educates engineers, and to perceiving engineering studies as an educational process in which, in addition to knowledge, we impart values, skills and qualifications. The list of skills required for the engineer has been endorsed by the industry, and now change is made in the entire education process: in the curriculum, in the nature of the extracurricular activity, in classroom pedagogy and the supporting infrastructure (such as campus spaces for study and work, computing systems, labs and technology-based processes). Change rests on creating an organizational culture to contain and support it; faculty members are given support in the form of training, appropriate infrastructure for realizing the change and the understanding that the process will also include actions that will may fail, but from which lessons can be learnt. This is not a simple process, but in my view, it is mandated by reality; I am certain that the quality of Afeka alumni is better every year, and the results are already reflected in the various evaluations we do – and especially in the roles that Afeka graduates play in the industry.

I wish you a pleasant reading,


Prof. Ami Moyal

President

Afeka – Tel Aviv Academic College of Engineering

# The Power of Engineering Ethics

Hisham Abdulhalim

Hisham Abdulhalim has a B.Sc and a M.Sc. in software Engineering, a M.A. in the philosophy of science, and is now studying toward a Ph.D. in Ben Gurion University. His research focuses on professional ethics in software engineering. Hisham works at PayPal Israel as a senior analytical-product manager, and he volunteers as a technology correspondent at *Forbes Magazine*. In 2019, he was included in the list of Israel's Promising Young People.

**The way technology shapes our daily lives challenges the basic philosophy of human existence, were cutting-edge software replaces abilities of human interactions. There have been multiple debates about the ethical support of such technologies the and moral standards when using such products. Software development and ethics interface when developers make professional decisions about software products during the design, development, testing or maintenance phases. These decisions can affect people's lives both in the public and private sphere. Since technical judgments can impact human values, these technical decisions, which are closely linked to software ethics, are an implicit source of power in organizations.**

Even for traditional professions such as medicine, law, psychotherapy and engineering, the word "professional" is hard to define, mainly since different societies and cultures treat the term differently. However, broadly speaking, there is agreement on common characteristics shared by all professions, for example, Oxford's dictionary defines "professional" as “A person engaged or qualified in a profession”. The expertise of professionals, and the domains over which they exercise that expertise, grants them power to improve people's wellbeing, or to cause significant harm.

Quality has a huge impact on how products and services shape our daily lives. Errors in product design take on many forms. Production failure is all around us; it happens to even the most successful businesses, e.g. Toyota's unintended acceleration. This by itself highlights how crucial it is for engineers to take their professional duties seriously. Since engineers are mostly self-regulated, individual engineers may design different solutions to the same problems, leading to insufficient results. The problem starts with the fact that quality represents different meanings to different people. Some define quality as meeting a certain goal, reflected in customer satisfaction, while Weinberg defined quality as the value that something brings to a group of people, and ISO 9126 discussed quality as the features of a product that can satisfy specific needs. It is obvious that quality is therefore an inconclusive term.

Ethical considerations in engineering are principal to the solution to design problems, the devoted core of engineering, and is likely the major one among them. No design problem necessitates a particular solution since the gap between a problem and a solution is contingent in most cases and determined by the engineer. This gap means that ethical tools must enter into the core of engineering in the earlier phases of the design and planning. Think about the possibility of an engineer implementing a solution that might cause unnecessary harm without any initial intent. Yet ethical tools require attention. When it comes to solving a design obstacle, rationally, engineers tend to use their expert knowledge and skills to address issues. This knowledge is usually gained from past experience in solving problems that is not standardized or certified. Adding to that, past experience is not always relevant to all cases, due to new technological challenges and required technical skills, and due care. However, in taking due care, if only to avoid causing unpredicted harm, engineers make ethical judgments. In that way, ethical tools enter the core of engineering (NSPE, 2007).

Engineers are trained to think analytically and base their technical decisions on relevant facts and research. However, engineers encounter many situations involving ethical questions during their day to day work activity. Researchers in engineering disciplines have come up with various codes and guidelines to inform educators and professional bodies about what ethics are and, most importantly, to emphasize the value they bring in the actual process of engineering (Gottenbarn, 2002). "Ethics", as approached here, refers to intentional human acts that impact the lives and values of others. The connection between engineers and ethics can be described as occurring when engineers make professional decisions about products, during design, development, testing or maintenance phases. These decisions affect people's lives; this is how technical judgments impact human values and are linked to product quality. When faced with an ethical dilemma, a professional must be able to make rational and well-motivated decisions.

Today, AI technologies are in a rapid phase of advancement and adoption, following developments in mathematics and computer science, computing power, and the ability to capture and store large amounts of data. Artificial Intelligence (AI) is based on statistical relationships that are detected using large amounts of data, supplemented by algorithmic rules of reasoning and learning or self-correction, and then applied accurately, reliably, and uniformly in making a decision. We use AI in our everyday lives even without thinking about it, e.g. Waze-GPS navigation, spam detection in our email inbox, getting relevant search results and even relevant ads on Google or Facebook, or personalized recommendations on Netflix or Amazon. Even as customers, we don't stop to think about how companies use our data. AI is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence. AI is not just a new technology that requires regulation, it is a powerful force that is reshaping daily practices, personal and professional interactions, and environments. For the well-being of humanity, it is crucial that this power be used as a force for good.

Software development and ethics interface when developers make professional decisions about software products during the design, development, testing or maintenance phase. These decisions can affect people's lives both in the public and private sphere. Since technical judgments can impact human values, these technical decisions, which are closely linked to software ethics, are an implicit source of power in organizations.

Ethics plays a key role in this process. Consequently, some have argued that adherence to ethical principles can ensure the ethical harnessing of AI and can also mitigate AI's risks (Cowls & Floridi, 2018). The Machine Intelligence Garage Ethics Committee has created an Ethical Framework accompanied by corresponding questions intended to provide guidelines as to how these principles might be applied in practice (Machine Intelligence Garage Ethics Committee, 2018). Supposedly, these questions can be employed in project planning sessions prior to the initiation of a development process, in order to address ethical dilemmas.  But the issue is more complex and requires substantial social and ethical answers. Consider, for example, a policing AI system that targets young, black men. Even if such a system proves itself to be very efficient in reducing crime, it is based on biases that must be addressed from a socio-ethical perspective and not just in terms of technological efficiency.

Another example, turning to the realm of finance, financial processes that have traditionally required human decision-making are increasingly being replaced or supported by AI, mostly when it comes to approving or declining financial transactions, fraud detection and prevention and general risk management. Innovative technology developments and the data driven approach many financial companies are taking are contributing to the rise of AI in the field (Crawford & Calo, 2016). However, as Crawford & Calo argue:

*"AI will not necessarily be worse than human-operated systems at making predictions and guiding decisions. However, while engineers are optimistic that AI can help to detect and reduce human bias and prejudice, studies indicate that in some current contexts biased AI systems disproportionately affect groups that are already disadvantaged by factors such as race, gender and socio-economic background".*

These false positive results are likely to result in financial losses for both parties and low-quality service experience.

Historically, engineering roles brought up only engineering skills, e.g. developing maintainable code and proving the best technical solutions to any tech challenges the organization faces. Facing external customers was only required by either business or customer support interfaces, in addition to the public interest that was only derived from the organization's beliefs and strategy. Nowadays, the expectation is that software engineers bring their own perspective on business values by having a customer orientation rather than only acting as technical experts. Ethics can support professionals by offering tools and methods helpful in such situations.

# Science and technology

Joseph Agassi

Prof. Joseph Agassi is a philosopher. He edited about ten books and published twenty books and about 600 scientific papers: http://www.tau.ac.il/~agass/.

**In the West, the traditional view of technology has not been negative: only the scientific revolution had interest in practice, but even then mainly from a scientific, rather than practical, point of view. The view of technology as a mere efficient tool is that of disdain felt by a person who claims to be valuing only cultural products. The scientific world, however, has prided itself on the practical value of science. Many thinkers are misanthropes, who regard comfort and pleasure as negative. They even distance themselves from culture and art and accept them only in dull forms. Tradition demanded of the individual to give them up for the sake of the collective. Technology lessens this demand by assuming that every boring work should be disposed of and science and technology should be seen as interesting challenges that improve the individual's as well as society's quality of life.**

## Preface

It is customary to view science and technology as two facets of one function. Indeed, in the last few decades, the term "science" was replaced in many contexts by the term "science and technology", or "technoscience". And indeed, it is hard to imagine a scientist who disregards technology, and it is impossible to imagine modern technology without the support of science. One speaks then about science-based technology. This, however, cannot conceal what is clear to all: that the purpose of science is different from the purpose of technology, and that therefore the interest in science as a technological instrument radically differs from the interest in science per se, which in this context is called pure science. Pure science uses highly-developed technologies, but in such cases, technology serves science rather than the other way around. We must keep in mind that technology is a tool and therefore has varied and increasing aims; whereas science has one sole purpose, and that is to search for the truth. Indeed, most thinkers who claim that truth is not accessible to humans, claim that there is no pure science, since the field known as science is but a part of applied mathematics. This approach is known as instrumentalism – claiming science is nothing but an instrument. The opposite to instrumentalism is realism, which argues science describes the world as it is. In this context, Einstein, Russell and Popper hold the most progressive views, contending that the purpose of science is the truth, but its achievements are merely approximations to the truth and no more than that.

Nevertheless, thinkers sought a general purpose for technology, to mirror that which truth serves for science. They found it in an aspect that to me seems fictitious, which is the aspect of utility. Technology that contributes more to utility is preferable to technology that contributes to it less. If we assume that there is such a thing as utility, we could say that the fruit of any effort contributes to utility, while the effort itself is negative utility, for small investments are preferable to big investments if they yield the same yield. We could therefore generalize and say that thought contributes to spiritual culture and technology contributes to material culture, that is to say, products that bring pleasure. Hence, the big question is how much effort should we invest in culture and how much in utility? And of course, is mass culture indeed culture or mere pleasure? These are difficult questions that rest upon unclear suppositions, and it is hard to say what is required of those who discuss them.

For example, work is considered an investment, namely negative utility, and therefore the invention of robots has a large positive utility. But many thinkers attribute positive value to work; many of them, including several Jewish traditions and including the famous novelist Lev Tolstoy and Theodor Herzl, the herald of Zionism, explicitly reject the search for utility as a negative pursuit. This attitude goes hand in hand with a contempt for technology as something that contributes to mere comfort, lacking any cultural value. Excelling among them is the Nazi philosopher Martin Heidegger, whose chit chat is taught in respected universities, in all seriousness. It appears to me that we unjustly underestimate the extent to which such philosophers' venom is detrimental to the quality of modern life.

## I. The Integration of Science and Technology

The tendency to combine science and technology was already manifested in the ancient world. The clearest expression of this was the question "how is it possible to combine the instructive with the pleasurable?" The Roman poet Horace set this as his goal. It was also broadly recognized in the 18th century, when scientific research was all in the hands of amateurs, before the universities took over the monopoly over research and dried it to dust.

We need not turn to the Roman poets for the concept of the union between the instructive and the pleasurable. This is purported by Jewish tradition as the expertise of the Talmud – the study of Jewish law. In the language of the Talmud, the study of the Torah entails a reward in this world and in the next world, combined; it is among "…the things for which a man enjoys the fruits in this world, while the principle remains for him in the world to come…And the study of the Torah is equal to them all". Nevertheless, when the Hassidic movement hailed that one should worship the Lord with joy, it raised enormous objections on the side of the puritans amongst the Jews. There are trends in Jewish tradition that encourage pleasure and trends that oppose it, and the Talmud abounds in quotations advocating this way and the other.

The peak of puritanism is the position that it is best to refrain from any pleasure; not only from the pleasures of the flesh. The ultimate puritan does not restrain or abstain from pleasures, he is indifferent to them, perhaps even repelled by them. The puritan eats without pleasure, by mere recognition of the necessity to eat. The puritans even recommend making art without pleasure. Since the puritans reject the pleasure of good food, they also reject gourmet cooking. There is logic in this. If so, why do they not oppose art per se? Because it is a part of culture, and culture must be defended, especially if it is boring.

The non-puritan finds it difficult to understand how it is possible to study art without enjoying art. But this is the reality: Many of those who study art prefer art without pleasure. This is manifested in the hostility towards cheap art; in the demand that the interest in and engagement with cheap art be removed and replaced by serious – however uninteresting – activities. Indeed, traditional education aims for the prevention of pleasure, because pleasure is valueless. Therefore, one must learn to behave well regardless to remuneration; and therefore, it is no coincidence that many musicians in orchestras do not like music, for example.

Nowadays, a movement among performing artists tries to change this situation by developing new democratic modes of orchestra conduction. But of course, it will be long before we are released from indifference to art, for it will take many generations before parents will learn not to send their children to teachers who are pedants, who render art loathsome for their students. Even discussions on art can make people dislike it, for instance, by training people to appreciate only works of art that are difficult to understand, that demand great effort to follow like tedious medieval poetry, complicated church music and deep deliberations on the meaning of every word in difficult pieces by Shakespeare. I hope we will be able to see that even complicated church music can appeal to our sense of beauty and thus give us joy. I hope that art, as well as art history, will bring us pleasure. There are different pleasures, and one must learn to partake in as many of them as possible.

Perhaps saying it is a pleasure to study would have been unnecessary, were it not for a very strong undercurrent whose purpose is to make any study painful. In all my years in university – where indeed I have spent most of my life – I have tried to spread the idea that good study should generate immediate pleasure. Generally, I have failed: merely expressing this notion in the academic lecture halls spreads nervousness and anxiety among the audience. I find it easier and more gratifying to lecture outside the university for an audience that comes to enjoy listening to a lecture.

The puritan attitude towards life permeated deep into our culture and is not easy to get rid of: One must monitor its influence and try to neutralize it. I will bring here one example so that it will be clear that my lecture on pleasure is not mere social chat, but of important, far-reaching consequences. The puritan attitude to life contributed to the division of the individual's time to three parts: work, study and entertainment. First work – work is a burden, "Yet man is born unto trouble". Secondly study – study is meant as preparation for work, and therefore must be taken seriously and be rendered as laborious as possible. Study to has to be boring, there is no choice. Thirdly – entertainment. It is clear, that the purpose of entertainment is to rejuvenate a tired body so that it could return to work afresh. Therefore, entertainment must be limited to this framework as much as possible. It should be ascertained that one does not enjoy leisure too much, otherwise its temptation will grow. The inclination to be entertained causes idleness, and idleness is the mother of all sin. This is a puritan idea. Puritanism has no taste; it is accepted only because it is an excuse for misanthropy. The idea that some people enjoy life brings suffering to misanthropes. Even if one enjoys good deeds, it is a fault.

The poet Friedrich Schiller, who was also a professor of philosophy, criticized the theory of ethics of his friend and colleague, Immanuel Kant: According to Kant, said Schiller, a good deed is performed uncomfortably, because if you do a good deed out of a sense of friendship and it brings joy, then it stems not from good will, but sought after for pleasure.

Kant saw in ethics a whip that coerces people to behave themselves` he therefore contended that when people learn that it is better to behave, there will be no need for ethics anymore. This is an erroneous misanthropic idea which is easily refutable, because ethics instruct friendship and is therefore friendly. It is widely accepted that the good deed must be altruistic. This is a misanthropic idea, because the good is a combination of the egoist and the altruist, hence, teaching people to enjoy art is a good deed.

In order to facilitate this conclusion, it is vital to see value in every effort to blur the lines between the three domains – work, study and entertainment. This is a pioneering idea that characterizes the sociology of work and the movement for the improvement of the working life from the second half of the twentieth century – which must be implemented in the present century. The movement for the improvement of working life promotes it by disputing the silly notion that work must be painful. Indeed, Adam was cursed with the need to work with the sweat of his brow, but the curse may be lifted.

Allow me to conclude this point with an important note from the philosophy of science: Thomas Kuhn, the celebrated historian and philosopher of science, owes his fame to his development of the concept of normal science (to be precise, it should be emphasized that normal science is not science, but technoscience and technology). His idea is quite simple: Normal science is boring research, research that does not deal in principles but concerns the application of principles. This may not appeal to the normal scientist, but he has no choice; in order to make a living he must take his instructions from the scientific leadership. Kuhn was accused of hiding the fact that his theory in fact recommends imposing upon the normal scientist the ideas of science's leadership. Kuhn protested, claiming he never concealed this fact and even emphasized it, adding that this is not against the principles of democracy, because no one is forced to remain a scientist. Thus, he made clear that his discussion was about professional science one engages in for a living, that is to say, science-based technology. He was right: democracy does not forbid misanthropy, and employers, whether in the field of science-based technology or not, have the right to employ their workers in boring work. Hence the demand of the movement for the improvement of working life to forbid such employment, which met with some success in enlightened countries such as Sweden, where there are laws against employing workers in assembly lines. Recently, some members of this movement began expressing their objection to Thomas Kuhn's ideas. Certainly, we must oppose misanthropy in art, and there is much to do in this respect. Blurring the sharp lines that separate work and study, as well as work and entertainment, are inherent to the success of the movement for the improvement of the working life.

## II. Study Per Se and Study as Preparation for Work

The Movement's demand to blur the distinction between work and study is very important. In this lecture, I choose to discuss its call to blur the distinction between study and entertainment, advocated as early as the 19th century by Friedrich Fröbel and Maria Montessori, who introduced educational toys into the educational system: Fröbel in kindergartens and Montessori in the school system that is named after her. Both their ideas aroused tremendous objection, and both succeeded only marginally, as their impact was limited to toddlers and children with learning difficulties. I admire them, but I am not a fan of their ideas. They advocated, for instance, the notion of naturalness, which to me seems primitive. We don't know what is natural and what is not. And the deviation from the natural comes to all of us shortly after birth. Those who disagree must yet agree that in a sense, anything we consume is natural, but mostly it is both natural and processed, developed, improved. And why should it not be so?

Another of Fröbel and Montessori's ideas is that learning is a bitter pill that is better sugar coated. It is reasonable, of course, to sugar-coat a bitter pill; but study is not a bitter pill. Many conclusions that follow from the misanthropic, puritanical idea are accepted without criticism even among the secular public, which is far from puritanism and misanthropy. One such idea holds that there is an essential difference between art and science; that art belongs to the heart and science to the brain. It is said that scientific truth is not given to controversy and that it develops in clear steps, according to an internal logic that renders it impossible to skip scientific stages when sought to be understood. This is not the case of art: the different artistic styles are disputed, and there is no logical link between the stages of its development. Therefore, it is quite possible to discover a beautiful work of art at the heart of a pyramid in the desert, or in a lost attic in a ruin, and then wipe the dust off it and present it in a museum. Whereas an unpublished scientific idea from the past – even if it were valuable in its time – is antiquated, and the loss of its delayed publication is irretrievable.

This approach is rooted in the puritan notion that is in principle misanthropic. The discourse on the uniqueness of science stresses the role of the scientist who discovers scientific novelties. Very few scientists discover natural laws or register an important patent. Most of us are not professional scientists but consumers of science. Misanthropes stress the necessity of scientific education, preferring the boring scientific education attained through standard scientific textbooks. Whereas the truth is that science is an impressive commodity which is no less breathtaking than the best paintings and sculptures. Indeed, this is how science is portrayed on the science television channel, which students do not watch. But the misanthrope is interested not in the truth but in causing damage to his students. The standard discussion about the difference between science and art as represented here portrays science as a race for publication. The most famous sociologist of my time, Robert K. Merton, spoke accordingly. He took the race for the patent on the telephone as his paradigm for scientific discovery: Two people registered the patent in the course a few hours, one won fame and glory; the other lost it all. And the moral of the story is that the researcher must work as hard as possible, so as not to lose primacy.

Of course, the basic idea about the difference between science and art is easily refuted. There is no sense in the fundamental notion that science is all thought and art is all feeling. This notion underlines the fatality of the criticism that denounces an artwork as too brainy, too intellectual. Any piece of art declared brainy is thereby disqualified. It was said of the work of the great composer, Ludwig van Beethoven, and he took it as a compliment. The famous poet, Edgar Allan Poe, tried to present his work as brainy. Jabotinsky wrote an article criticizing Edgar Allan Poe, and very interestingly showed that Po's analysis of his own artwork is an artwork and nothing compelling.

It's no coincidence that the fundamental difference between art and science is presented from the viewpoint of the creator, of the worker, the artist, or the creative scientist, not from the viewpoint of the consumer, the individual who enjoys both art and science.

Who enjoys science today? Unfortunately, we forget that for thousands of years science was mainly a luxury, like art. Until the scientific revolution (1660), technology was alien to science. The fact that Archimedes' discoveries had important applications made them unusual and drew attention because Archimedes thus helped save his city from siege – and that, too, only after he was asked to help. Even the use of chemistry in technology began only at the outset of the 19th century, revolutionizing the Royal Society and transforming it from an amateur organization to a professional scientific organization in 1830. It is difficult to ignore the fact that technologists were looked down on, and that this ceased only when it became evident that nuclear chemistry called for significant scientific knowledge and bestowed much respect, as nuclear chemists were now able to kill millions with but one bomb.

I apologize for giving a belligerent example rather than a peaceful one, such as the cinema and the internet may provide. However, this is linked to misanthropy. The misanthropists hate pleasure, even if it is pleasure from something they appreciate. Thus, it was said that the important historian of the early 19th century, Thomas Babington Macaulay, was not a serious historian, because he wrote well and engagingly, and so his readership were not professional historians but amateurs who enjoyed his works. This is nonsense, of course. The great but hostile composer Arnold Schoenberg deemed only two popular composers as serious: Johann Strauss Junior and Jacques Offenbach. Later, he conceded also to add George Gershwin to this list. This distinction between high and low art is of course groundless and misanthropic.

Let me note briefly that it is hard to tell whether medieval art, for instance, is high or low. Beyond this silly distinction between high and low art, is the deeper distinction between practical art and pure art, or art for art's sake. Classical, 18th century literature differentiates between art types: the free arts, known today as academic education; the fine arts that nowadays are known as art; and the mechanical arts that today are known as technology.

Great misanthropic artists such as the philosopher Plato and the author Lev Tolstoy viciously attacked art for art's sake, favoring only applied arts, and only to the extent that it is applied. Perhaps they allowed for applied art only because it was too popular to be extinguished. For any art, any artifact, including our furniture, this room and our clothing, are applied art. There is no doubt that there is excellence in applied art, as there is excellence in pure art. But the very distinction, that high art is good and popular art is poor, however silly, is taken for granted. For instance, recruited art is neither art per se nor applied art. It is not quite pure art because it makes use of social and political ideas for its own means, it is neither applied art: it is not made for the purpose of propaganda. The entirety of socialist art is such, and all the east European nationalist music of the late 19th century art is such as well.

Israelis who have no knowledge of the new testament find it difficult to understand important western art works which serve as illustrations of religious texts. The great art historian, Sir Ernst Hans Josef Gombrich, explained that to a large extent, medieval art is an illustration of religious texts for an illiterate public, something like the modern comics. Of course, the modern observer must be made to understand the connection between an artwork and its religious background. Not only religious works, but also many secular works or art refer to definite background information, such as Greek ancient texts and pagan texts. While it is possible, of course, to enjoy a work of art without knowledge of its background details, and the demand for knowledge may even spoil the fun.

The question remains: how much background knowledge is needed to understand and enjoy a work of art? There is no doubt that the lack of background knowledge prevents non-westerners from understanding western music and vice versa. It is certain that art may be enjoyed and appreciated without learning, though learning is helpful, and it is interesting to know to what extent. Most importantly it is interesting to learn about the relation between art theory and technology.

The theory of art is an ancient field called aesthetics. The most important book on aesthetics is Plato's Symposium, which is justly considered one of the most beautiful and profound books in world literature.

There is no question of its significance and greatness, both as an artwork and as a piece of philosophy; nevertheless, it is easy to understand the argument that denounces aesthetics as a backward field, for there are grounds to this complaint. The question is how does a field mature. What shapes a marginal field into a serious field of research? The accepted opinion is that an anthology of empirical scientific information is necessary. But as the field of aesthetics deals with works of art, there is by no means want of aesthetic information. On the contrary, there is an enormous wealth of information of art works, and it is hard to know where to begin. It is customary to begin with Renaissance art, but it is unclear why. If we take the demand for factual information seriously, we may point to numerous sub-fields of aesthetics that received the respectable status that was prevented from aesthetics itself.

Let me mention the scientific study of the psychology of art; or the enormous collections of folk art, whether paintings or sculptures; or the practical art of ceramics, and here I could not avoid mentioning the beautiful pavilion of glass artifacts at the Israel Museum, as well as the writings of Martin Buber on Hasidism which have tremendous, multi-dimensional value, and also the important ethno-musicological collections of Béla Bartók and of Israelis who contributed much to this young and respected sub-field of aesthetics. Will I violate good taste if I refer here to the aesthetics of the design of motor cars? Of course. Is this subject taught in schools of engineering? I think only in schools of architecture and that is a pity.

Of course, there are those who are willing to see the study of car design as the aesthetics of motor cars. This mostly results in contempt for aesthetics. It does not occur to them to debate the aesthetics of cars. To me this understanding is limited, as there is hardly anything as beautiful and as impressive as a gang of young boys and girls who take a jalopy and try to bring it to life. This may be an expression of my own prejudice that education has to be pleasant in order to achieve its ends, not as a bitter pill to be sugar coated, but as pleasure derived from tasty food, where in one dish science comes together with technology; science joins art and the joy of art as a supreme value.

## III Scientific Research as Creative Work

How did so many sub-fields of aesthetics achieve their rightful status, whereas the status of aesthetics is still inferior? Is this just? I confess I think it is: I would not recommend reading most of the articles I have read about aesthetics. This refutes the theory that for a field to be considered worthy and mature it must accumulate information. The alternative theory is that in order to attain status, a field must develop ideas. At times this notion seems wise, and at times it seems silly. In such cases it is clear that the idea was only partially expressed: the requirement is not to develop ideas, but to develop good ideas. However, this does not help us much. For what makes a good idea? How may we develop a good idea rather than a banal one? This question is asked by artists, scientists and even startupists. Thomas Kuhn tried to circumvent this notion in his theory of the paradigm. The paradigm is a “chief example”; para is top, or chief, and dogma is example, meaning: here is an example, try to emulate it. When an important scientist develops a new idea, it becomes a paradigm. Then others imitate it and try to adopt its style. This is interesting, because it points to what science shares with art, despite Kuhn’s efforts to avoid this question, and indeed, the ideas Kuhn published were taken from Michael Polanyi, who stressed what is common to science and art, or rather to the influence of a great artist and to that of a great scientist. Polanyi was a serious philosopher, and it will be regrettable that when Kuhn’s reputation declines, his will decline as well. Polanyi did not attempt to go around what makes an artist and a scientist great. He claimed that this question is impossible to answer.

The great artist and the great scientist have followers. The aesthetic experience is famously complicated. Clearly it has sociological moments and diverse cultural moments. It is noteworthy that Schrödinger clung to his famous equation of the electron although he thought it invalid because it didn't fit the paradigm – because he found it beautiful. Many thought it irrational, however this is a recurrent phenomenon. I was present in a lecture at the Physics Department in Boston University, where I taught for a while, given by Physicist Paul Dirac whose equation replaced Schrödinger's equation for the electron. He recounted before us how he had discovered his celebrated equation and was reprimanded by the chairman who said: this is not the way to make science.

What do they teach in technology courses? In my studies in Jerusalem during the early days after WWII, there were no courses in technology, but there were courses in applied mathematics, which I took. It is hard to say to what extend they dealt with technology. Nowadays we no longer speak about technology without reference to the computer. It is much easier to use a computer rather than mere pencil and paper for this activity, especially when one uses the Wolfram computer programs. There are very few courses in the Technion that deal with aesthetics, mostly in the faculty of architecture. Is aesthetics important for machine engineers? It looks as if the answer is bluntly negative. In courses in mechanical engineering one learns a lot of physics. Here, the difference between science and technology is in the detail. The fundamental equations of astronomy are employed equally in science and in technology, but the way one uses them differs in the observatory and in the navy. In the navy they used to teach approximations of Newton's equations which were easy to apply. Today this is not so. The computer and diverse computer programs for finding one's way around the earth (Global Positioning Software) freed navigators from this task. Instead, navigators are now taught how to use navigation and GPS systems and what to do when such systems break down.

In technology courses they also teach marketing theory. This is less striking, because students have a harder time studying the mathematics of astronomy or of the strength of morphing materials than the mathematics of marketing theories. Even though the relatively simple marketing systems' analysis requires knowledge of economics, statistics and social psychology. However, it is clear that any discussion on marketing involves some discussion on fashion, which, in one way or another leads to aesthetics. This was rejected for generations, since the consumer's search for pleasure was unacknowledged. Misanthropy's bad influence on the study of medicine, for example, was revealed only in the last few decades, when it became evident that the study of women's diseases was lagging behind the study of men's diseases.

All this, it seems to me, encourages us to look with new eyes on research and academic teaching, in whose framework pleasure is not something to look down at or a necessary evil. On the contrary, there is enough suffering in God's world. We have to see to it that we don't add to it but detract from it. One of the most accepted assertions in philosophy today is that brought forth in Herbert Marcuse's book, One-Dimensional Man, which expresses contempt for the modern consumer who consumes needless commodities like aesthetics. Marcuse's students speak against the mobile phone, claiming that it reduces communication. They prove this by pointing to the fact that we see people in cafés sitting together at the same table, talking with their mobile phones rather than with each other. Many of my acquaintances take this as a very convincing argument. Anybody who sees this argument as convincing should take stock of his ways of thinking and mend them. In order to consider the weight of this argument the average amount of communication that common citizens partook in before and after the use of the mobile phone should be compared. For example, did people in cafés talk more with each other when they did not have mobile phones? Did past generations talk about their interests, or about football and the weather? These are difficult questions on which we do not have information. The discussion about loneliness in the big cities is important. We must seek to overcome it. The commonly accepted assertion is that before the industrial revolution, there was less loneliness in the villages than in the cities. To me this seems a blatant lie, but I do not have enough information about it.

Does technology improve our situation or not? This is disputed. Nowadays most philosophers think the answer is negative. If so, perhaps it's not advisable to open colleges of technology. I think this question is not at all practical, because under the present conditions one cannot stop the progress of technology. But there is a need to look for technology that will reduce the damages of technological progress. This is a subject I discussed in another book.

# A Cup of Hemlock: Actualism and the End of Science

Zev Bechler

By now we realize that we are caught in a frightening cultural tsunami which would be best named "Trump". But we should also be aware that this tsunami is quite old, being in fact the continuation of the struggle over the true nature of human reason as what defines the essence of our species. This paper claims to pick out four crucial turning points in this long dispute over the nature of explanation as employed in our best thinking, namely, science. The story starts with Socrates and his notion of science as an indubitable knowledge, and with Aristotle and his detailing of this notion that eventually led to the end of informativity in the best science of our day. Two thousand years later it was presented in its first modern form by Spinoza, who adopted the Aristotelian view and was willing to pay the price of losing thereby any pretense of ethics of life and society by deducing from this the inevitable truth of the theory of the violent supreme ruler. We then turn to Newton as the heroic continuation of Plato's vision of science as an uncertain but informative explanatory effort. However, Spinoza's idea of a non-informative science was to bypass all the Newtonian blaze by being continued in Kant's critical attacks on the possibility of science and of ethics and of aesthetics. But the best-ever show of the destructive power of the Socratic-Aristotelian program became painfully visible only with the explosion of Einstein's work on relativity, which announced the beginning of the most terrible and disastrous century ever.

## 1. How is a cause of beauty? Socrates

A quarter of an hour before gulping his evening cup of hemlock, Socrates completed quietly laying a time-bomb which in a few years would jump-start the first scientific revolution in Greece and which after 2405 years will bear the Einsteinian revolution and the whole terrible 20th century with its wonders and its un-believable disasters. And these were his words:

> I cannot understand these … theories of causation. If someone tells me that the reason why this object is beautiful is that it has a gorgeous color or shape or any other such attribute, … <u>I find it all confusing</u> and I cling simply and no doubt foolishly, to the explanation that the only thing that makes that object beautiful is beauty. …. It is by beauty that beautiful things are beautiful. This I feel is the safest answer, i.e., that it is by beauty that the beautiful things are beautiful. (Phaedo :100)

He declared here a position the like of which the world has not met yet, namely, that causal explanations are meaningless and must be given up completely. He brought forth just one reason for this thesis, namely that in the real world there simply is no real cause which brings forth this concrete event here and now, since this event would not have occurred had not this cause been accompanied by an infinite number of collateral causes we call "necessary conditions".

> Fancy being unable to distinguish between the cause of a thing, and the condition without which it could not be a cause! But it is this latter, that most people, groping in the dark, call a cause. (Phaedo: 99)

If causal speech demands a separation, inside such an infinity of collateral conditions, between those which are merely necessary, and those which are sufficient (even though only together with the necessary), it follows that causal explanation will necessarily be "confused" (and therefore all the causal explanations "only confused me", Phaedo 100) devoid of any certainty and so always arbitrary and lacks any certainty because it is always possible to choose between the two groups (the necessary and the sufficient) in another way.

## 2. How Is an Explanation? – Aristotle

So were born two theories of scientific explanation that were destined to rule scientific thought and consequently all canonic thought and speech of Western civilization to our times. The one argues that the beautiful is caused by beauty, in the manner that the particular is explained by the general: This flower is beautiful because it belongs to the class of beautiful things. The explanation is logical, not causal. Whereas the other holds that the particular is to be explained by another particular only. Thus, this fire here explains that heat over there, i.e., physically. Let's assign them these names: the physical, causal explanation is "informative", and the logical explanation is "non-informative". Plato held that philosophy, i.e., science and knowledge, must prefer "the confusing" informative explanation, whereas Aristotle, his pupil, decided like the rebel he was, for non-informativity as the paradigm of scientific explanation because, following the dying Socrates, only this would not be "confusing" (or question begging, probably), but on the contrary, be certain and clear and final.

We`ll say that only the physical explanation is informative whereas the logical explanation is un-informative so that Plato held that philosophy or science must prefer the informative and confusing and uncertain mode of explanation. His rebellious student Aristotle decided for the uninformative mode as the paradigm of scientific knowledge since only as such would be science able to attain certainty and clarity and finality of a kind as real knowledge should. In his predication theory he used the formula " saying one thing of another thing" and we now adopt it to say that informative-talk is saying one thing of another thing, whereas un-informative talk is saying one thing of itself. To attain scientific status then, the scientist must explain everything strictly by saying one thing of itself even when it does not look like that. Uninformativity is the key to science just as Socrates discovered.

Plato, in the course of a detailed argument, offered that knowledge of mathematics is possible for us only because our soul during its transmigration phase after death, resides closely to the territory of the Ideas, and because of some kind of "kinship" with them, the soul comes to know them directly. These Ideas are pure pieces of information, and therefore after being reborn our soul has "recollections" of them as pieces of pure informative knowledge embedded in it, and this re-collection we call learning (by experience, or by books, or by teachers, or by research, etc.).

Since the Ideas of mathematics were embedded in us by direct recognition, our mathematical knowledge is almost certain.

Almost, for though it is pure information it got mixed up with the human soul, and this mixture causes recollection to be faulty because our soul is impure, being mixed up with matter, and so the mathematics acquired by recollection or learning suffers of some doubts, e.g. as to its axioms. Since Information is logically doubtful, this implied that science as an informative explanation would never obtain certainty.

Plato illustrated, in some astonishing detail, how scientific explanation of the world is to be the reduction of all its phenomena to four basic mathematical Ideas (the point, the line, and the two basic equilateral triangles), such a reduction being the informative causal science of the world. By presenting this program as a story (mythos) Plato clarified that it has all claim of informativity but none of certainty and explained, in some detail, that science of nature does not, and can not, aim for more than being "a probable story".

Aristotle rebelled against this notion of science as a myth and argued that it was all nonsense starting with strange notion of the separation of ideas from the soul and of the soul from its body. As against Plato's employment of Ideas, he argued that these are mere potentialities for actuality and, as all potentialities, have no reality at all.

He therefore formulated the first actualistic solution to the wonder of mathematics. He constructed it around the thesis that all general concepts are neither real entities nor causal nor contain any information at all. They are merely the names of some mental operations of our intellect and imagination, so that they have no reality beyond and separate from words and thoughts. Concluding his critique with the words "so bye bye ideas", he constructed a theory of these operations of the soul, which he called "abstraction" and "division" or "cutting" and more.

Those Ideas are just our mental activities or operations upon things given to us by our senses, like abstracting some of their qualities, and grouping together such abstracted qualities, and dividing up such groups into other groups according to some similarity rule, and mapping of the groups according to their relations of containment and exclusion and such other activities. The outcome of these operations we call concepts. These operations came to be systematized in his lectures on logic and the wonder of mathematics was solved by reducing it to the mental activity of addition and subtraction of such operations of thought which, at the end, are the concepts we call "numbers" and "shapes" or "forms" "numbers" of geometry and its propositions and their proofs.

These two modes of explanation were constructed by Plato and Aristotle as explanations of the fact of Nature and of the wonder of its scientific explanation. Plato's mode was based on the hypothetic reality of unobservable entities, the Ideas, as the causal forces molding matter according to some major plan. Thus, e.g., the Idea of Beauty causes particular material things to be beautiful by "participation" in these happy things, Socrates' slogan getting thus an informative, causal, reading, i.e., the beautiful was caused by beauty, but at the cost of hypothetically, ending in mere "probable story".

I chose the title potentialism for this mode of solving the wonder of the fact of mathematics and science on account of its decision to employ unobservables and so merely possible, merely potentially real to us, agencies in the body of science. The other mode, established by Aristotle, will get the name Actualism, well known among Hegelians since circa 1920 when coined by a leading Fascist philosopher in Mussolini's regime.

As we saw, for the actualist any knowledge must be certain and therefore non-informative and therefore employ only observable entities and agencies in its theory and explanations. Science thus turned into one infinite chain of logically necessary proposition explaining all and only actual reality. Aristotle indeed took this step as well, by denying the notion of the creation of the world and along with it the notion of a prime mover or cause. He expressed this by converting the god into an inactive non-causal entity separate from Nature, serving only as a "final cause" towards which the world of matter longs. However, Aristotle added explicitly that all so-called final causality in the world is non-dynamic, i.e., "the final cause does not act". This clarified that the god has no role whatsoever in directing the world and the conclusion was that nothing created the world, and nothing moves it, rather it exists "by itself" and moves itself "by itself" and is completely independent of anything "outside itself". The world is thus completely autonomous and starting from this Aristotelian actualism, the world seemed more and more like the god itself, self-caused and self-created and self moved. Spinoza, the pinnacle of Aristotle's studentship some 2000 years later, will name therefore, the world "substance" and identify it with God.

The idea or program, of the autonomy of nature and motion trickled from Aristotle's speaking mode about nature or the world down to speech about existence and motion of the parts and "elements" of nature, i.e., the five basic kinds of matter which compose all of nature. These move themselves by themselves, towards their natural resting places, without any agent acting on them from outside or inside, and they constitute all the things of nature. It followed that in saying that a natural thing moves by its own power, the word power or force (dunamis in Greek, potentia in Latin, kuat in Arabic) does not signify in actualistic lingo anything real in the world, so when the actualist says that a thing has the power to act so and so, the word "power" does not signify any reality. It rather signifies that, on the contrary, something does not have any reality right now but only a "possibility" or "ability" and is therefore a mere potential and nothing in actuality. Thus, the long attack that Aristotle conducted against Plato's theory of Ideas was the actualists' argument that these "Ideas" are mere creatures of the mind and exist only potentially but not in reality.

The actualist will say that events of nature are logically and non-dynamically necessary, meaning they are necessitated but not enforced by any forces or any physical coercion, and consequently any dynamical explanation of nature is a systematic distortion and error.

Just like forces, so did "laws of nature" become yet more hidden and superstitious entities, thus determining what became the essential characteristic of any possible science of nature. In order to be certain, science of nature must be dealing with strictly sensually actual things, so that the only necessity in action in nature is logical, not in need of any forces and laws and any of the rest of actual agencies. Such a science of nature, which we named actualistic is to be not merely a-dynamic but also a-nomic, i.e., containing no forces and no laws, as hidden entities directing or enforcing the phenomena. We will call such a scientist actualist and he will in good time be the origin of the idea of post-truth and fake-everything.

## 3. Actuality the Measure of Justice: Spinoza

Spinoza enters the story as the first modern Aristotelian actualist. Spinoza's Ethics was published ten years before Newton's Principia and so these two works became the modern symbols of the two great philosophies of science governing us today.

Spinoza's actualism can be reduced to the following three world turning consequences:

1. Nature is whole and independent and has no prime moving cause or last end, since it exists of itself and moves itself. The whole world is its own cause, and if you wish you may call it God.
2. And exactly as God, so has nature no laws which determine its steps. There are no "Laws of nature" and so there are no "forces" in nature which coerce things of nature to move according to "laws".
3. All the causes and necessity and laws and forces of nature, exactly as its ends, are superstitions of the multitude. They are potential things only, and therefore they have no reality or actuality.

Now, among the examples of "all the concepts and superstitions of the multitude" he included "good and bad", "merit and wrong-doing" "praise and blame" "right and wrong" "order and disorder" "beauty and ugliness", along with the notion that "the gods directed everything for the good of humans" or the beliefs that "God acts for an end". All these are mere superstitions of the multitude.

It is important to notice that he argued all along Ethics that order and disorder in nature are nothing but creatures of imagination which our mind creates for itself and which have no reality whatsoever in the actual world. Spinoza did not soften this abolition of the "order in things" and did not qualify it by any suggestion about another kind of order. On the contrary, he went on to clarify that the concept of order in nature cannot refer to anything "in things" and separate from the mind, "as if order was something real in nature beyond its origin in our imagination".

And after having explained that the common teleology too is a belief in some kind of order, which refers to the intentions of God's will and imagination, he continued and expanded his argument to all the other concepts he mentioned, i.e., there is no difference between "the good and the bad", "the beautiful and the ugly", on the one hand, and between "the sweet and the sour" on the other hand.

The ethics implied by these principles was thus an ethics without values or ends just as the physics implied by it was without laws or forces. The gimmick was that the world without forces is also a world without violence, without good but also without evil. They will be replaced by "a nature" and "the natural" and the "just by itself" and so it will turn out that all man's actions are enacted within complete freedom because they are always done "by themselves", and Spinoza grafted this ethics into the definitions of Part One, i.e., directly into his language and grammar:

> Definition 7: That thing is said to be free, which exists by the mere necessity of its own nature and is determined to act by itself alone. That thing is said to be necessary, or rather compelled, which is determined by something else to exist and act in a certain fixed and determinate way.

But just as a separate creator-god is by now merely a superstition of the ignorant, so also is his creation and his law-making and his enforcement and ruling over nature. Spinoza used to mock teleology as a major superstition, but he did apply the concept of necessity to nature's phenomena. But this means that natural necessity and natural forces are just so many more superstitions and the only meaning of necessity that remained available for his use was logical necessity as the only enforcing agency in nature. Thus, nature became a self-ruling entity needing no enforcing and no forces at all and so all forces became not only superstitions but methodologically superfluous as well. Exactly as was the case with Aristotle, so was it with Spinoza: the world is lawless, forceless, self-moving and self-managing entity exactly as it appears to us phenomenally, a visible, lawless, free, god.

Just like his world so also his actualistic ethics will contain no good or evil and no forces and so also no violence and no ends to long for or beginnings to worship. Hanna Arendt would have called it the ethics of banality: not only has the actualist been from the start the grand source of "banality-speak", but also his theory of state and society would be adopted by all the tyrants of the world and all destroyers of nations who were fed on this "banality-speak".

This should have been clear to readers of the Political Treatise, the last work he wrote in total freedom, knowing it would not be published in his life, ill as he was. It was here that he unfolded the full political consequences of his actualistic ontology, in which "law of nature" cannot possibly mean law at all since there is no law-maker god to create it or enforce it on nature.

### 3.1 "Only the higher authorities have the right to decide what is good and what is bad"

Since there are no forces there is no violence, and the notion of the action of force is now to be taken as the action of nature and so "of itself" and "by nature". All crime is now mere natural motion of ownership-transfer happening by reason of the fruition of all the necessary conditions and thus by strictly logical necessity. All talk about violence is to be replaced by talk about ownership-change, so conquering other nations will be change of land-ownership, and similarly about all extortion and abduction and the rest of the infinity of variations upon this theme. Orwell comes to mind since he was indeed the first to realize that the reality of actualism is already here and now, unfolding before our eyes, language, logic and all.

At the focus of Spinoza's image of the ruler, is the fact of the ruler's ownership over the law, because his citizens transferred to him all their power, and so they are unable to make him keep the contract, and therefore it is in his power, and therefore his natural right, to deny any obligation to any law which is in his ownership, and to proceed just as he wants. This matter of ownership over the state through the taking possession of its laws and its powers, he made clear in this last, posthumously published, work:

> The right of the highest authorities is defined by its power and is based on it [...] and therefore only the higher authorities have the right to decide what is good and what is bad, what is just and what is unjust, [...] only the higher authorities have the right to legislate laws. (TP iv, I). It could never be the case that the ruler of the state is obliged to the laws or that he can do any wrong. (TP iv,5)

Moreover, the ruler is the only owner of the law because he is the only one who created it out of nothing, and he keeps re-creating it incessantly by enforcing its daily application by his citizens. So, he is also the only allowed interpreter of his laws, and this uniqueness of his law-making and interpretation and execution, is itself also one of his laws:

> The laws of the state depend only on the state's decision and in order to stay free the state is not obliged to obey anyone but itself and is not obliged to justify or blame anything but what it decides to be good or bad for itself. (TP iv,5)

Moreover, by this same power, there ensues also the ruler's right to break and cancel his laws, and replace them by others, exactly as he wills any time:

> and therefore, not only has the ruler the right to defend himself, to legislate laws and interpret them, but also to cancel them, and by his supreme power to forgive any crime. [...] only he who has the rule, and no one else, can decide anything in this matter (i.e., whether a given breaking of the law is good for all or not). It follows that according to the rule of the state only he who owns the rule remains

> the interpreter of the laws. Except for him no one can justly defend them and therefore, they do not actually oblige the ruler. (Tp iv,6)

Spinoza exempted the ruler in such an absolute manner because the ruler's aim in his law-making is just the increase of his power to maintain the fear-balance against his citizens, but fear-increasing is a law of nature and happens by itself.

He explained that justice and all principles of reason (i.e., utility) including the principles of grace and fairness, received their power only by means of the ruler's right (TTP19), i.e., from his powers to enforce his laws. From here Spinoza proceeded to infer that the citizens' obedience to the ruler's laws must be absolute, and this is the situation no matter how the ruler achieved his kingdom and created his laws, and therefore justice can never be a justification of rebellion against the ruler:

> and only after thus showing the basis and right of the ruler, can we determine easily what is the private right of the citizen, what is evil, what is just and unjust in the citizen status. For as a private citizen right (in statu civili) we cannot understand but the freedom of each one to maintain oneself in its own state (in suo statu conservatum) i.e., a freedom determined by commands (edictis) of the high authority and safe by it alone. (TTP 16 196 [168])

The contract cannot by now define the rebel and the traitor and the criminal except as a regular citizen whereas the ruler can never be indicted of treason. The private freedom of the citizen of the state, is not his own right at all but merely a command determined by the ruler in virtue of his supreme power (suma potestas) and this command only is what creates and eliminates the citizen's right to freedom.

Such is the case not merely regarding freedom but rather, every other right that he has now is not an eigen-right of the citizen, because in view of his contract with the ruler, the citizen gave up all his power and thereby all his rights and he is now devoid of any natural eigen-right:

> He who transferred to another his right, which is determined by his power, to live his life as he sees fit, i.e., he who transferred to another his right and power to defend himself, is obliged to live by the other's wisdom alone, and defend himself by the defense of the other alone. (*Ibid.*)

### 3.2 "There are no crimes in reality"

Thereby Spinoza prepared the philosophical basis for a complete justification of the phenomenon that became at present the most actual and real threat to the possibility of open society - the overtaking of the state by institutional crime, to such a measure that today's society leans more and more, trial by trial, to agree that indeed there are no crimes in actuality and therefore the world is at each moment perfect, as one of Spinoza's readers wrote to him:

> If this is the only measure of perfection, and there are no mistakes in reality, then there are no crimes in reality, and everything which exists contains this or that essence as God gave him and being what it is, it is always perfect. Letters [22]

But the situation is even more extreme than this, because Spinoza's argument pointed clearly at the natural family kinship of rulers as such, and crime, in the fact that both live and act by Spinoza's actualistic principle, that the law and therefore all contract and agreement, do not oblige anyone who has the power to break it, but only the weak who has not.

The natural aim of the ruler is to gather power of one kind, and the aim of crime is to gather power of another kind. But what unifies them and is even stronger, namely, the fact that both live above and beyond any law at all. Spinoza explained that the ruler cannot break the law because he is its owner, and the criminal cannot break the law not only because he is not a party to the contract at all, but mainly because he acts according to his eigen-nature only and therefore by strictly logical necessity. It follows that such family kinship between the ruler and crime will lead to the result that instead of fighting each other they will combine their powers in order to vanquish their common enemy i.e., the citizens standing in their way and disturbing their natural way of being.

It is therefor reasonable that the natural history of rulers will end up in their unification to crime into one natural and homogeneous unit, which will be the true and real leadership of the state. Obviously, this will be an unobservable process, to be hidden by the laws which the ruler would make for this specific end, and by his interpretation-mercenaries.

This is the main reason why the weak try to exclude the right of legislation completely out of the ruler's power and hand it to separate and independent authority. And as we know today, the principle of the separation of powers whose aim was exactly this, is unable to face up to much less than the power of the ruler. The only stage in the evolution of the state that might effectively limit the ruler's legislative voracity may turn out to be only as a power openly hostile to the ruler, chosen specifically for that reason and function according to the constitution.

### 3.3. "The ruler has the right to complete violence and to kill his citizens, just for any reason at all"

Spinoza presented his theory of toleration only in two tiny places - under the title of the TTP and in its short introduction. This title declared that the aim of this tractate is "to show that freedom of philosophical research not only can be given without any harm to fear of god and peace of state, but, on the contrary, that it is impossible to eliminate it without eliminating with it also the peace of state and the fear of god".

This thesis, that the freedom of scientific research is a necessary condition for the peace of the state re-appeared in the introduction with the addition that "this is the main point that I aim to prove in this work" (TTP itro:3.) But what actually happened was that "this proof" aimed to show also that the source of all suppression of freedom is superstitious beliefs, these being always supported by the monarchic states and the established religion. "The proof " became a disquisition into "the main prejudices of religion and matters of authority of the higher rulers (sumarum potentatum jus)" (TTP 3,4), and so the proof of the thesis about toleration disappeared in the turnings and re-turnings of the research of the Jewish case of superstitions. Only the last chapter of the book will return to the freedom of thought and this only after the three previous chapters analyzed the nature of right and the nature of state. Only at the last chapter did he announce, "that it is time now to return to the matter of freedom of thought in the state" and so this chapter became the only document that Spinoza wrote about the possibility of toleration in the state. And from its first step it was quite alarming:

> We cannot deny that it is possible for the rulers to be hurt by words just as by deeds. Therefore, just as it is impossible to deny this freedom from the citizens, so it is a great peril to give it (the freedom of speech) to them unlimited, and

> therefore we must check here the limits of giving each one this freedom without damaging the peace of the state and the rights of the high authorities. And this, as I said in the introduction to part 17, is my main aim here. (TTP 20)

What remained now of this collision between the right of the ruler to limit the freedom of speech of his citizens and the right of the citizens to complete freedom of speech, was determined, of course, just by what each of them has power or is capable of doing.

Now, it so happens that nature itself limits the power of the ruler since "he will never be able to prevent people from judging by their opinions about any given matter" (TTP 210). The reason or cause of this limitation of the rulers' right to rule over the thought of his citizens is the biological fact that the brain-organ of the human species is surrounded by a protective bone layer opaque to light, such that the mechanism of thinking is unobservable. Spinoza did not hesitate and added that the power of the ruler is limited not only by this accidental "fact of the scull", but also by a variety of utility calculations. And he concluded that since the power of the ruler is limited in these two senses, the fact of the scull, and doubts about utility, his right to limit his citizen's thoughts is in fact limited as well:

> It follows that the authorities do not have absolute power to do such things and their likes, and therefore they have no absolute right, for we showed that the right of the authorities is determined by what they have the power to do. (TTP 20)

"Such things and their like" are what he described as "preventing people from judging by their opinion any things whatever" and preventing them from "being acted upon by such things or the like", that is, prevent influencing their thoughts by "things like" books and learning and various arts. But though the ruler has no absolute power and therefore no right over his citizens' thoughts, he has absolute power and so the right to mark them, i.e., according to their friends and posture, and so to mark them as his enemies, and by this alone he does have absolute right to destroy them. Spinoza himself has undergone such a treatment by his community twenty years earlier, and since then he never revolted against this right of the ruler to mark his citizens and then to do with them whatever in his power:

> Indeed, it is true that the ruler has the right to mark as enemies all those who do not agree with him completely, but we are not dealing now with his right but with its utility. For I admit that the ruler has the right to rule <u>by complete violence and to kill citizens for whatever reason</u>. (*Ibid.*)

It is of importance to note that these are Spinoza's words in the course of his defense of the citizens' right to their freedom of thought and speech: since the world is of such nature that the ruler has the power and so the natural right to execute his citizens for the slightest reason, it follows that the citizens have no right to any freedom at all. Their only real right is to live in constant fear of everything in their world coming to it end at the next 4 o'clock in the morning.

## 4. How to Absolute Time and Space? – Newton

The scientific revolution created by Newton ,was essentially the creation of mathematically detailed informativity in scientific theory ,i.e ,.obeying the demand that all propositions in physics must consists in" saying one thing about another thing ."The" phusika "that was created according to this demand ,declared that in the actual world there is no motion according to" physis "but only motions against the" physis "of bodies ,i.e ,.all motions in nature are strictly forced motions ,and so need always an informative explanation :every state of motion or rest of every body in every condition is caused by something different and separate from the body and is called force ,and so alongside matter and motion there are forces which are non-material things ,separate from matter and invisible to human observation ,but which act upon matter and force it to move .This was therefore the revolt against actualistic physics and a transit to a potentialistic physics saturated with separate forces .This was accompanied ,therefore ,by a transit from a non-informativistic philosophy of explanation to an informativistic philosophy of explanation ,and this was the essence of the scientific revolution of the17th century.

The third definition “in the Principia explains that the inner force” (“vis insita”) is the “force of resistance” which “sits inside” every material thing, and that “by this force” “the thing persists in its present state, be it a state of rest or of uniform motion along one direction”. And the explanation following this definition says that “it is a force proportional always to the thing whose force it is, and another way of understanding it is as the power of inactivity of the mass”, and therefore “this inner force may be named a very significant name, the force of inertia i.e., the force of inactivity”.

The rest of the explanation adds a crucial fact regarding the nature of the force of inertia: though it is a force of inactivity i.e. acting only for the preservation of existing state, sometimes it becomes a force “acting in order to change the state”. Thus, if some external forces act to change the state of the given thing, this thing’s force of inertia suddenly transforms into an external force, which acts in reaction on the other thing and accelerates it, changing its state just like any regular external force.

Newton took, in the explanation of the “third definition”, the crucial step in the ontology of forces within which his theory of gravitation was to be formed: Even the force of inertia, which is almost indistinguishable from the material mass itself, is in fact separate from this mass since it is able to transform sometimes (at a moment of collision, for example) from internal to external. And so, it becomes clear that in order to undergo such a transformation, it must be separate from the matter – since the matter does not change in nature during this collision and so, it is not the matter of the given thing that acts on the other thing but the force of inertia itself. Newton clarified that the matter itself has strictly a single property – impenetrability, and this property does not change during its whole existence. Therefore, what causes matter to persevere in its state, i.e., to resist a change in its state, and then to re-act upon another entity, is an entity other than the matter, separate from that matter, though attached to it and so accompanies it wherever it goes. And so, the world contains at least two kinds of things separate from each other: matter and forces. This is the first ontological message declared or rather implied by “the laws of motion”, “the definitions”, and “the explanation” which head the Principia:

Such separateness of forces from matter finds a rather explicit expression at times. Thus, Newton distinguished (in “definition 8”) between the different aspects of the centripetal force according to its source, the acceleration which it causes, and the direction of the motion which it causes. The centripetal force in regard of the acceleration he described thus:

> The accelerating force I relegate to the place of the accelerated body and regard it as a kind of ability radiating from the center and spreading in the places all around it, so that it moves bodies, which happen to be in these places. (Principia 5)

The power of gravitation, described here, is an example of the force which accelerates things, but is separate from the mass - because it “radiates” from one mass, “leaving” it and spreading in the space and resides in it, so that it acts on any other mass that happens to be in this place, and so it is separate from the two masses, the source mass and the target mass acted upon by that force.

Only as a consequence of this ontology it becomes possible from now on to view nature as an informative world: Each motion had to be explained now by separate forces acting on matter causing it to conserve its states or to change its states, alternatively. But, differently from matter, forces are not things appearing to our senses - we are able to sense only matter and its motions and only these signify the existence of forces. Moreover, not only are forces transparent entities to our senses because they are not material, but moreover they are also transparent for these same reasons to our imagination: We are unable to draw them on our imaginary internal and private video screen, in which we fantasize strange worlds as we wish. Eventually Kant will call this internal screen "the faculty of pure intuition" and the simple fact that forces are non-representable in intuition will become for him a major difficulty, which will demand not less than the creation of a completely new interpretation for Newton's Principia, contradicting everything Newton wrote as the guide to his own interpretation.

But for the scientific revolution as Newton essentialized it here, this was no difficulty at all. A complete understanding of the new theory of the world, and therefore of the world itself, does not depend on the power of imagination at all. All that was important in the new theory would be unimaginable, and this because it will be sometimes nonmaterial and sometimes it will demand accepting contradiction. The paradoxicalness of the world appears at the first moment the theory is presented with the third "definition" which describes the existence and transformation of the force of inertia as we saw, but then it is led into further demands on our credulity.

For since forces are separate from masses, it follows that there is an ontological difference between a mass in which a force of inertia maintains a constant velocity and between the same mass in which several opposing forces act on it to keep it moving at that same velocity.The difference between the two cases is between the number and kind and identity of the forces involved and thus it is an ontological difference. yet, in case the mass is rigid, (as an atom would be, Newton held,) there would be no phenomenal signs to differentiate them.

In potentialistic it would be said that such two ontologically district cases are absolutely distinct, irrespective of our evaluations and the reference frames we would use to measure them .But an absolute distinction implies absolute motions and velocities and absolute reference frames. And these were the absolute space and time which Newton had to introduce in his notorious Explanation:

> But because the parts of space, cannot be seen or distinguished from one another by our senses, therefore, in their stead we use sensible measures of them…and so, instead of absolute space and motions, we use relative ones. (Principia 8)
>
> Absolute, true and mathematical time, of itself, and from its own nature, flows equally without relation to anything external, and by another name is called duration.… Absolute space, in its own nature, without relation to anything external, remains always similar and immovable. (Principia 6)

These new entities and the explanation of their modes of existence are indeed loaded with paradoxicalness since our common language is not rich enough to contain a grammar of the absolute .Expressed in our common speaking we would get intense confusion and would have to forgo any understanding .But this is merely the price of informativity ,which the most rigid of the scientist community was and would always be willing to pay.

## 5. How to Legislate a Nature? – Kant

The Aristotle-Spinoza actualistic tradition took a fast bypass around Newton ,unleashing terrible side-fire on his potentialism ,which awakened Kant up from his slumbers .The scandal of Newtonian science became clear to him somewhat late in life ,only when he happened to read German translation of a scholar of the Scottish Enlightenment movement ,which flourished then in the leading Scottish universities) and thus ditched Latin as the universal language .Kant was converted overnight and formulated the essence of this Enlightenment thus:

How is synthetic a-priori knowledge possible? (Prolegomena §5)

Kant's great discovery was that all laws of science ,i.e .the laws of mathematics and the laws of Newtonian physics ,are certain simply because they are a-priori like all the creations of human mind .His immediate conclusion was that this intellectual pure synthesis of the physical world can not possibly be informative about any world since by strict actualistic reason it is impossible for there to be a-priori information .Since the a-priori is nothing beyond a product of our inborn intellectual constructive ability ,it is no information about anything at all .But since it is a-priori it is necessarily also a logical truth ,and so he declared:

> From the very notion of a-priori knowledge, it follows that man does not get the laws of nature from nature, but on the contrary, **man legislates to nature its laws**. (Prolegomena §36)
>
> Thus, the order and regularity in the appearances, which we entitle nature, we ourselves introduce. We could never find them in appearances had not we ourselves, or the nature of our mind, originally set them there. (A125)
>
> Thus, the understanding is something more than a power of formulating rules through comparison of appearances, **it is itself the law giver of nature**. Save through it, nature, would not exist at all. For appearance, as such cannot exist outside us. Nature as object of knowledge in an experience, with everything which it may contain, is only possible in the unity of apperception. (A127)

So that outside unified perception no physical world exists at all. Nature exists only within our sensual faculty, and outside this faculty there exist nothing. Again, in order to remove any doubt in my reader, nature would not have existed at all were it not for our mind, the phenomena do not exist outside us, and so without the mind there would not exist any nature and a world of phenomena at all. In this exact sense the law of nature exists only in our brain and to sum up his discovery “all laws of nature and therefore all the phenomena of nature are determined and exist only in our souls and its intellectual and sensual faculties. Any thing not determined by our soul and its faculties cannot be real for us and all that is real for us is determined by our soul and resides in it, and there is nothing outside it:

> However exaggerated and absurd it may sound to say that the understanding is itself the source of the laws of nature…such an assertion is none the less correct, and is in keeping with … experience. (CPR (=Critique of Pure Reason) A128)

It should be noted, reading these words, that Kant’s discovery was indeed his solution to the ancient twin wonders, the fact of mathematics and the fact of physics. In his days it was the wonder of Newtonian mathematics and Newtonian physics. We already saw that the wonder of mathematics was recognized and solved by Plato in his potentialistic mode and by Aristotle in his actualistic mode. Kant merely extended the Aristotelian actualistic solution, though in huge Prussian detail in order to fit it to the new wonder of his times, the Newtonian wonder. Thus, the explanation of the fact that these two new sciences of his time, the new mathematics and physics, are certain and necessary, is now that they are empty of all information, whether about the super-sensual world (since it is only imagined but not constructed at all), and whether about the one actual world, which is strictly the world of actual sensual things which are the phenomena present to human senses.

What Kant added to Aristotle's actualistic solution was what Aristotle only dared hint in a few words in his lectures on the soul, but never taken up by any of his followers before Spinoza and Kant. This was the notion that the scientific explanation for the fact of nature is the construction of this fact of nature from beginning to end. And so, the wonder of physics is explained now by the fact that not only science but also the whole of nature itself are strictly creatures of human soul and are real strictly by being present to human soul as two of its creations:

> Hitherto in has been assumed that all our knowledge must conform to objects. But all attempts to extend our knowledge of objects by establishing something in regard to them a priori, by means of concepts, have, on this assumption ended in failure. We must therefore make trial whether we may not have more success in the tasks of metaphysics, if we suppose that object must conform to our knowledge. This would agree better with what is desired, namely, that it should be possible to have knowledge of objects a priori, determining something in regard to them prior to their being given. (CRP, Bxvi)

By this conclusion Kant's "critique of understanding" became the most lethal critique which science now began to suffer starting in the middle of the 19th century, when a group of mathematicians and physicists (from Gauss, through Riemann and Helmholtz, to Poincaré and Duhem and Mach) got to digest this lethal implication of Kant as the thesis of the necessary fictiveness of all possible science. This critique never stopped since then, and one hundred year later it became toxic not only to science but to the possibility of thinking at all. With the beginning of world war II scientific thought started losing speedily its worth, its value and status, and this at the hands of scientists and historians and philosophers with a clear Kantian heritage.

This intellectual and scientific nihilism accompanied a parallel nihilism in ethics and aesthetics originating from the two later of Kant's critiques of ethics and aesthetic, constructed in parallel with his critique of science and obviously by the same reasoning. Since all of the concepts of actualistic ethics are strictly creatures of the mind, Kant made it clear, they have no content and do not refer to any real thing in our real world but are only some kind of lower grade mind-fictions which he named "ideas" and which he abolished to a fictive world he titled "the realm of ideas", which is said to be distinct from the realm of concepts of the intellect.

What characterized these ideas and distinguished them from intellectual concepts, Kant explained, was that our faculty of ideas is incapable of enforcing them upon sensual so as to construct anything in our sensual phenomena. Rather they serve only to give a general direction to these constructions in science and ethics and even then, not even to direct actions themselves.

## 6. The Construction of Total Destruction

Kant seemed to be oblivious to the harsh consequences that the picture of his special revolution would induce now over the phenomenon of scientific revolutions and the idea of intellectual progress at all. The first and harshest consequence would be that any conceptual revolution is nothing but the exchange of one conceptual form by another such form which the intellect forces upon a part of the world, but which is also no more than a creature of the mind. And in somewhat direct words, what happens in a conceptual revolution is that one fiction replaces another fiction but still both are merely conceptual and so none is truer that the other because the idea of a true conceptual form is devoid of any meaning in the actualistic world in which no reality is allowed to these forms at all. In such a world scientific knowledge is devoid of any information beyond the one that is provided by our raw sensations.

Indeed, the categorical imperative, the highest good, man as an end, action by duty only, the eternity of soul and punishment and grace by God - this is just a small collection of the ideas which reside in the realm of ideas and which do not designate therefore anything real in the world, serving us only as fictions and accessories in our practical life. Kant called such ideas "metaphysical foundation of ethics" and implied thereby that the principles of ethics contain no reality beyond mere rules of speaking in his contemporary society. Thus, he merely continued and expanded the continuous nihilistic stream flooding everything since Spinoza and Aristotle and Socrates.

Kant's big conclusion was that the informativity of our science is only apparent and this pseudo informativity he called from now "synthesis". The term included his solution to the wonder of the possibility of Newtonian science: this science is indeed certain because it is a-priori i.e. independent of sensual experience, but this is why it is merely synthetic, and contrary to informative, i.e., it merely synthesizes a world, i.e., it constructs it by concepts. He argued that the intellect or understanding forces its concepts on the output of our sensibility and this enforcement of concepts upon sensation is the synthetic creation of the world of phenomena, so that it is a constructed world and this construction is the scientific activity.

The principle of a-priori world-construction achieved the pinnacle of its power mainly through the French Academy after the second world war in the sixties, and from there it expanded like a plague throughout the world. Today, after two generations, we are already in the midst of towers of babel of thousands of cultures producing and inventing languages which synthesize an infinity of a-priori worlds, thereby getting locked within their particular, constructed, world which is already a part of their invented essence and genome. This genome already contains the principle of non-informativity as one of its essential genes because it gives laws a-priori, which are the foundations of every constructed world and of all the propositions they imply, which are only the consequences of the "synthesis" which the mind builds by its nature and through the materials it receives from the senses.

One example will suffice to illustrate this kind of lunacy, in which one of the creators of French post modernism, Jean Baudrillard, tells us that "The gulf war did not take place". This is the title of his little book and the name of the third of its chapters:"1. The Gulf War will not take place" "2. The Gulf War: is it really taking place?" "3. The Gulf War did not take place". Led by rigorous actualism, he argued that the only actuality of this war regarding us were television and newspapers reports and therefore this is the only reality for us, pictures and stories and no war at all.

The quotation I chose to represent this philosophical lunacy is the explanation of the fact that the state of Israel did not react to the missiles that hit it:

> This explains the tolerance of the Israelis: they have only been hit by abstract projectiles, namely missiles. The least live bombing attack on Israel would have provoked immediate retaliation. (p. 45)

"Abstract projectiles", because they are only pictures on some television screen, and you and I never really saw them as anything but such, since what does not explode right on me is an abstract explosion and creature of mind and imagination. This is the concrete and actual world of the French post-modernism which became a refuge from France's shameful history during the second world war, then south east Asia, then north Africa, and its shameful participation as executor in the SHOA. This apologetic construction says in effect that history is nothing but invention, intellectual construction, just as science is nothing but an imaginary construct, society is nothing but imaginary construct and so on. Hundreds of books with titles "The invention of the X" suddenly appeared in the academic market and the plague is in full swing, fed on a tradition going back continuously to its origin in Kant. But the most exciting figure, which acted as the first mover of our present actualistic paradigm of Kantian nihilism was Einstein, through his unique contribution to the destruction of language.

## 7. Legislating to Space and Time: Einstein

Every discussion of contemporary culture must open with a quotation of the introduction to the declaration of Einstein's 1905 revolution:

> These two principles we define thus
>
> 1. The laws by which the states of physical systems undergo change are not affected, whether this change of states be referred to the one or the other of two systems of coordinates in uniform translatory motion.
>
> 2. Every ray of light moves in the "stationary" system of coordinates with velocity C whether the ray be emitted by a stationary or by a moving body. Hence velocity=lightpath/time-interval, where time-interval is to be taken in the sense of the definition in §1. (*ibid*: 41)

Principle one Einstein named "the principle of relativity" and principle two he named "the principle of the constancy of the velocity of light". The principle of relativity is a necessary condition that every fact must obey for it to express a law of science. The principle of light says that the constancy of the velocity of light is such a fact. These two principles embodied the huge revolution not only in physics but also in the philosophy of physics, because both are false according to classical potentialism but are certain according to classical actualism.

However, the idea that there can be something physical moving at a constant velocity which is numerically the same velocity relative to every possible reference system was considered nonsensical in every physics created to that day. But the principle of light seems to be saying something similar, (with the difference that it is limited to inertial reference frames – which are frames moving at constant velocity and direction in relation to another and the other in relation to absolute space?) Einstein will leave this problematic concept in his theory without any further revelation, but the oddity remains: How is it possible for an object to move at a velocity A at the same time in reference to two distinct reference frames such that their relative velocity to each other is B?

If velocity means how many kilometers light covers in one second relatively to one frame, it seems that it would cover in the same second more kilometers relatively to the other frame, i.e., A+B kilometers. This is the classical concept of velocity as against Einstein's principle of light which says that we must give it up for a new concept of velocity.

And what is this new concept of velocity? The answer is that the new concept of velocity is just everything entailed by these two principles. These principles define, therefore, the concept "velocity" as all that would make them true, exactly as the axioms of geometry define all their basic concepts as everything that satisfies them and makes them true, and similarly also, the new concept of "law" which is the main subject of the principle of relativity.

Potentialism assumes the contrary: it expects that if a given linkage is a law of nature, then it would most certainly not be true relatively to every reference system. And there was a simple explanation for this: a law of nature binds two separate things such as, e.g., the trajectory in space and time, and the force that causes a body to move along it. Thus, e.g., the force of gravitation causes a body to move in an ellipse or a parabola or a circle and so on.

If force is an entity separate from motion, then its magnitude and direction are not dependent on the reference frame (they depend only on the mass, which is the source of the force. But the form of the trajectory, of course, depends completely on the reference frame in which it is measured (and therefore only after having been measured it relatively to the sun did Kepler discover that it was an ellipse).

And so there will be a variety of reference frames in which the same force would cause different types of trajectories. It can be expected therefore that generally an informative law of nature (e.g. the law of gravitation or Kepler's laws) would not remain true relatively to all reference frames, and not even to a sub class of them.

And on the contrary, if it becomes clear that if there is a law of nature which stays true in all inertial reference frames, the potentialist would explain that this is quite a wonderful and singular case and completely improbable. Thus, for example, Newton's three laws of motion are such but only because they happen to bind forces and masses to accelerations only: It so happen mathematically, that forces and masses remain constant in all changes of reference frames because they are separate and independent entities, and it is a mathematical fact that accelerations conserve their values under all changes of all reference systems so that all relations between them are conserved also. The law of gravitation and its consequences the Kepler laws, on the contrary, are not like these, because they bind forces to trajectories as well and not only to accelerations, and trajectories (geometrical forms) are not conserved under such changes. The informativity of a law of nature implies that its conservation under changes of reference frames will be a coincidence only. In general, information which depends on reference frames, like velocity, cannot be conserved under the change of such a frame. Einstein transformed the concept of law of nature into a new and strange concept, according to which such a conservation is the essence of law, and he did this by demanding that the principle of relativity be taken as an implicit definition of the new concept "law of nature".

In respect of this ontological change a new language hides a new ontology of substances, forces, and laws of nature, so that the two new principles entail a complete change of all the concepts in the Newtonian potentialistic language. Thus, the new concept of velocity implies a new concept of a law of nature, and these together entail that there is no meaning at all to separate space and time. Which is an example of the change in the concept of entities which were regarded as separate and therefore as substantial, but under the new language lose their entity-hood and become just one spacetime. But similarly, therefore, there is no more meaning in forces which are separate from masses, and consequently it is impossible now for laws of nature to be informative propositions, for only by losing any such informativity can the two principles become and remain true.

## 8. What You See Is What There Is

Einstein's next step was to show what must be the laws of translation of distances and times from the language of one inertial reference-system to another ,so that the principle of light would be a law of nature .This is a simple calculation ,but it entailed that Newton's laws of motion are by now no laws of nature any more .These rules of translation do not conserve the laws of Newtonian physics ,unless it is assumed that the mass is not a constant value but depends on the reference frame .The reason is simple - acceleration is by now not a magnitude conserved between reference systems ,because distances and time intervals are not conserved any more :It follows from these two principles ,that a box measuring one meter relative to itself or in its own reference system ,will be measured shorter than a meter ,when measured by a reference system which moves relatively to it .That is to say ,box at rest ,of length one meter ,becomes shorter as it moves.

The same is true about time intervals - these lengthen: if my heart ticks once a second in my frame, in another frame it would turn out that the same heart ticks only once in two seconds, say, and the effect depends on the relative velocity of the measuring system. These two, shortening of length and lengthening of time, entail that accelerations by now are new entities which do not conserve their value relative to all inertial systems, and consequently Newton laws stop being true for all inertial systems. It is necessary, therefore, to correct them in order to re-instate their truth, and the correction is made by taking mass and force to be neither independent nor separate magnitudes so that they are from now on dependent on the measuring system. It turns out also, that Maxwell's electro magnetic field laws are not correct under these conditions, unless the electric force is also frame dependent and consequently is not a separate entity.

> We see that the electro-motive force plays in the developed theory merely the part of an auxiliary concept, which owes its introduction to the circumstance that electric and magnetic forces do not exist independently of the state of motion of the system of coordinates. (Einstein 1905: 55)

And by means of abolishing the separate status of forces and turning them into" auxiliary ideas," i.e ,.creatures of mind which depend on the reference system ,the problem of asymmetry ,which Einstein mentioned at the head of the paper ,and which wakened him up from his slumbers ,is solved as well ,and he added:

> Moreover, questions as to the "seat" of electro-motive ... now have no point. (*ibid.*:55)

The question disappears because electro dynamical and magnetic forces from now on do not reside anywhere at all - they pop up and disappear according to the reference system in which they are measured. So too are masses. Forces and masses become secondary qualities like sweetness and warmth, which are inseparate from sensing, with the difference that here they are inseparable from the reference frame and their measurement taken in this frame. This measurement replaced now the role of subjective sensing, and these physical magnitudes became now inseparable from their measurement.

The explanations the new science will provide will become strictly matters of language, and all hope of informativity disappears. Einstein created a language in which all physical concepts were redefined by the new principles and axioms, and its grammar redefined by laws of translation of measurements between reference systems.

As a result, the only possible explanation of phenomena now is strictly formal, a kind of grammatical (i.e. mathematical) proof, showing that in the new language, the translation from one reference system to another, produces the observed result.

All this could sound like a mere verbal exercise, were it not for the real wonder in all this strange revolution – the new language provides everything the old science had, and on top it also some new predictions of special phenomena at high velocities, all of which were verified. But here is the trouble - no one understands why, and this from the first moment, the moment in which Einstein declared the principle of light. From then on, we have no explanation and no understanding of how it is possible for anything to move at the same numerical "velocity" relatively to all reference systems (even of one kind, e.g., inertial).

And since this fact has no possible explanation within the theory of relativity (since it is not a fact at all but a principle, an axiom, a postulate) there is no possible explanation of its success, even though there is no doubt about it.

Except for one explanation, which is the actualistic explanation, saying that an uninformative language system will be true always and necessarily as long as its emptiness is strictly conserved, and the theory of relativity is such a language system. All its truths are necessary because they are strictly formal or lingual, exactly as happens in every well-constructed mathematical system.

We saw until now three remarkable things in the special theory of relativity, which can be taken as the symbols of the revolution. First, Einstein's choice of building it on definitions, and two postulates which are the synthetic a-priori of Kant. Secondly, the linguistic construction of physical reality. And third, the crucial role of the actualism on which the postulates were constructed.

Let us underline some of the terms in this plot. First, the idea that laws of nature are true in all inertial reference systems, can be meaningful only by the abolition of the old distinction between the subjective and the objective. And, only after such an abolition would it be possible that the conservation of such a truth is logically necessary. For since all the old physical properties, (length, time mass, force) became secondary and dependent upon reference systems, all primary qualities disappeared, and with them also the old concept of the objective thing, as something whose existence does not depend on any reference system or language, and only its appearance changes by such a change of reference system.

Secondly, thus disappeared, therefore, the distinction between what exists and what appears, and only therefore the fact that the length of the box is one meter in one reference system, and the fact that its length is two meters in another reference system, are both objective in the same measure. From now on, there is no distinction between the concept "size as measured and as appears" and the concept "the true and objective size", or, in the new language, there is no preferred reference system at all.

Thirdly, this is exactly why forces which appear and disappear with the change of a reference system, are actual objects and therefore are also real. Only thus are they real. Only thus it is possible for laws of nature to conserve not only their form, but also their content, under translation between different reference systems - they appear exactly as they exist, e.g. "they appear just as the velocity of light is C in all reference systems" is a law with the same exact content, i.e. the velocity C is numerically the same in all of them.

The new concept of objectivity is the converse, therefore, of the old concept of the objective thing in Newtonian physics, just as the law of nature, hides its objective properties, i.e., only its appearing form depends on the reference system.

It was only natural for the potentialist, that Maxwell's laws of field, which explicitly included the velocity of light C, would not be conserved under translation between reference systems, exactly because their truth is objective, and this was the reason why the search for the absolute motion of the earth, prior to Einstein's 1905 paper, were made by means of electro magnetic experiments - since in the period of the old language, because Maxwell's field-equations are objective laws, they were supposed to be true only relatively to absolute space, and therefore, on top a moving earth, they were supposed to be different, according to the absolute velocity which changes during its revolution around the sun.

Thus, the absolute velocity of light had to be different from C according to the different directions of light in absolute space, and the difference between them was expected to reflect and thus measure the absolute motion of earth.

The new concept of objectivity reflected by this principle of relativity was, therefore, a clear expression of Einstein's actualistic ontology. Only this ontology makes it possible to turn conservation in appearance (i.e. in measurement) in different reference systems into a necessary condition of objectivity, and only this ontology enables a clear and distinct meaning for this strange notion.

THE END

# Preparing Israeli Engineering Students to Engage in the International Arena in the 21st Century

Leor Cohen

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**The 21st century will be characterized by further specialization of the engineering disciplines, yet its projects will become more interdisciplinary and international. This inverse relationship will present communication challenges for engineering experts from various disciplines and countries when collaborating on the same projects. Therefore, focusing on communication skills is not only practical, it is also inevitable. Thus the outdated English as a Foreign Language courses must be re-envisioned in a performance-based collaborative pedagogy for the purposes of International Communication. This initiative will increase our students' value in the market place.**

The 21st century belongs to engineers. As we enter an age of implementation, engineers will be increasingly tasked with operationalizing the massive leaps in technology made in the previous half century. The application potential stemming from the growth of knowledge in medicine, artificial intelligence, brain sciences, and robotics (to name only a few) has yet to be fully realized. However, this operationalization will occur in an unprecedented global context of multinational corporations and cooperation. As discipline-specific knowledge increases in the depth of specification and specialization, the hard skills – discipline specific knowledge – will require increased expertise that can only be acquired through intense and narrowly-focused training. With further potentialities discovered in each field, the synergistic potential in blending across disciplines increases exponentially. And so, we are left with the problem of how to get highly-specialized experts to collaborate on complex, multi-disciplinary projects across national and linguistic boundaries. Only through intentional training in soft skills can the challenges described here be met head on and responsibly. The following brief articulation re-envisions the wider context and purpose of English as a Foreign Language (EFL) courses in hopes of better capitalizing on this opportunity to prepare our students for their future.

The soon-to-be-outdated stereotypical image of the engineer depicts a geek in the corner – hair frazzled, spectacles thick, pencils chewed – buzzing away at the computer, in isolated mathematical creativity, pocket protector and all. Given the complex global context portrayed above, this image will quickly find itself archived as an irrelevant cultural reference. In its place, coming into focus will be an image of expert engineer who is also a savvy communicator, a fluid team member and an effective negotiator. In the last century, educational institutions were singularly concerned with students' disciplinary knowledge acquisition. But knowledge acquisition needs not be only about knowing that; it can also be about knowing how. Knowing how does not simply include how to apply discipline-specific knowledge. It more broadly envisions knowing how to effectively pitch a new idea to a CEO or VC, knowing how to explain a discipline-specific problem to a non-expert-yet-integral team member, or knowing how to facilitate a discussion among international departments in a video-conference call. The global skills that are high on the 2018 QS survey (https://bit.ly/3oDwcIG), for example, are problem-solving, teamwork and communication. These skills, along with resilience, represent some of the widest gaps between the importance employers attribute to the skills and employer satisfaction (regarding employee performance) for those skills. Language-based communication skills are at the foundation of these and many other skills that employers in the 21st century will value. The following is the list of the top 15 skills that employers value in descending order of importance, as set in the above-linked 2018 report:

- Problem-solving
- Teamwork
- Communication
- Adaptability
- Interpersonal skills
- Data analysis
- Resilience
- Organization
- Technical
- Subject knowledge
- Creativity
- Leadership
- Language
- Negotiating
- Commercial awareness

Rather than focus on the fact that three of the top five skills are all communication based, it is much more telling that all the skills listed above require language to some degree or another in their performance and realization. For instance, resilience – a main ingredient in that most prototypically Western, Herculean plot, the form of which we all love to engage in regaling our own individually-attained victories – is much more likely to be attained through garnering the support of colleagues and maintaining interpersonal relationships. Similarly, skills like problem-solving, negotiating and creativity may have been envisioned in the past as projects of an isolated individual, but more and more these skills are facilitated by collaboration and community support.

Now, acquiring a language is not simply about growing one's grammar or vocabulary. Most people assume that communicating effectively is about selecting the right word, but research (in Linguistic Anthropology and Sociolinguistics) into the actual ways people speak within their communities shows that more importantly than what you say is how you say it. Everyone speaks differently in the office than they do in their own living rooms. Language is suffused with the contexts it accompanies (or creates), and this is why the most effective pedagogies in language acquisition construct communicative contexts simulating the type of language events students must be prepared to navigate successfully. This means that language pedagogies today should look to the contexts our students will face once they leave our classrooms.

This brings us to the EFL courses. In the Israeli context, students in academia are required to exhibit a particular level of skill in using the English language, for which they receive their English exemption – as English happens to be the lingua franca in this particular historical moment – and are given the go ahead to finish their degree. Traditionally, the curriculum was limited to purely reading comprehension. That was the original mandate given to the courses by the Council of Higher Education (CHE) for the purposes of preparing students to read the literatures in their content courses as part of their discipline-specific knowledge acquisition, but this is rather a missed opportunity. All this is about to change.

First of all, calling the courses "English courses" or even "EFL courses" does a disservice to the pedagogy. The courses, properly altered and adapted to meet 21st-century skills, are more and more being called English for International Communication (EIC) around the world. The courses should increase students' value in the marketplace. Now, if we are talking about engineering students, then we are talking about sky-high employability potential. What a success it would be for institutions of higher learning within the Startup Nation to produce engineers that can more smoothly communicate and sell their solutions on the global stage – ready to collaborate and fit right in anywhere with any team. Now add the academic skills – the ability to synthesize and review disciplinary-specific literature to analyze concepts across positionalities within a community of scholars – and graduates are ready to lead at the cutting edge of their respective fields.

This is the frame of mind that language educators are arriving at in their droves. For instance, in attempting to cope and manage widespread immigration, the Europeans have developed a tool called the CEFR (Common European Framework of Reference: https://rm.coe.int/cefr-companion-volume-with-new-descriptors-2018/1680787989) to aid in their effort to teach masses of foreigners the language of the host country. It is said that that the CEFR is now used from Chile to China, and it is important to note that its origins are not from within Academia, but from within state mechanisms like Absorption and Welfare Centers. The CEFR is based on communicative learning outcomes. For example at the A2 (Basic) level:

- Can use simple everyday polite forms of greeting and address.
- Can say when something is wrong, e.g. 'The food is cold' or 'There is no light in my room.'
- Can reply to an advertisement in writing and ask for further information on items which interest him/her.
- Can ask basic questions about the availability of a product or feature.
- Can indicate when he/she is following a discussion.

- Can recognize when speakers agree and disagree in a conversation conducted slowly and clearly.

These are not academic skills. They are basic communicative ones that allow a person to navigate smoothly within a community, be it a host country, a classroom or a project team. At the lower levels, students are given a wide base of not necessarily academic skills, but basic communicative skills, so that when they reach the higher levels their retention of the language skills better prepares them to engage with more challenging material. Thus, an academic curriculum can be inspired by the spirit of the CEFR and compose learning outcomes geared also to research – to literature reviews, economic reports, policy papers, etc. Such learning outcomes serve several purposes. One, they serve to scale the courses according to levels of difficulty as students move through pre-basic communication skills up to reasonably proficient ones. Two, they focus and inspire lesson planning, content development, and the creation of ever-new simulations adaptable to our ever-changing world.

At the Afeka College of Engineering, Tel-Aviv, the English program, or as it should now be called – English for International Communication – has undergone adaptations in the spirit conjured above. All EFL courses involve the four communication skills. In terms of productive academic skills, the most basic one is summary. Summary writing of a peer-reviewed article first occurs in the pre-exemption level course (Advanced 1 or Mitkadmim Aleph). Students present the summary of their article in a formal presentation in front of the class. Intertextual analysis is also introduced at this level; students are exposed to how authors compare and contrast across the positions or texts. Then students engage in comparing and contrasting two texts (not necessarily peer-reviewed). Admittedly, the above activities are not revolutionary; what is revolutionary here is that they are used to scaffold the curriculum of the subsequent level.

In the exemption level course, students develop a poster project that structures the whole course within a Project Based Learning (PBL) curriculum. The project is a literature-review-based-research-proposal, whereby students have the option of working in collaborative groups and selecting a peer-reviewed article of their own choosing. After having summarized their first article in a four-stage process of notetaking-linking notes-reducing-further reducing, students are taught to find another two articles that engage with the first in some form of discussion, and then they summarize those articles as well. With the three summaries, students are taught to synthesize the three articles by bringing them into discussion with one another, so that they can arrive at a logical future research proposal that stems from the literature. All this work is meant to provide the infrastructure for students to now begin working on their posters. Poster presentations occur in an exhibition style with 3-4 posters concurrently presented 3-4 times to smaller, more intimate peer audiences within the class.

Having completed this course, students are now better prepared to face future projects within their degree as well as within the industry. Just as in casual conversation among friends, it is important to know how to appropriately participate in discussion – turn-taking, interrupting, listening – for if a move is deemed inappropriate, interlocutors very often police offenders. This form of knowing how is called sociolinguistic competence, and it has to do with the level of adherence to the unwritten conventions of (in)appropriateness in discourse within particular communities. In order to know how to join an academic discussion thereby participating in the literature, it is absolutely necessary to know what is currently being discussed by a community of scholars with like research interests. These are soft skills not gained by completing that unfortunately too typical writing assignments that begin with choosing a thesis statement; choosing a thesis statement should only come in response to a literature review and not drummed up in a vacuum. The good ideas are found in those intertextual, liminal spaces; they are the insights and logical conclusions arrived at by pitting contrasting ideas against one another. If our students can do this in English by the end of our courses, then we have truly created impactful international communicators.

To conclude, too often past pedagogies have taken soft skills for granted, but educational institutions can no longer afford such a grave oversight. In today's increasingly complicated job market, fresh entrants must be prepared to package and showcase their skills, convey their ideas, and network effectively. The traditional English as a Foreign Language courses – in their traditional formats – are a missed opportunity, which should be capitalized on to provide students with a range of necessary skills that increase the students' value in the marketplace and hold the potential to unlock countless doors.

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# Engineering’s Role and Proper Place in Dealing with Climate Crisis

Itai Eliav

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**This paper examines the field of geoengineering as a possible path for dealing with the challenge of global warming. Its main contention is that in the context of geoengineering, there is no room for the technological optimism that characterizes the field of engineering, and that research and development through which engineering should focus its endeavor to cope with the climate crisis are to be subjected to a conception of sustainability.**

Global warming is one of the most worrying and troubling issues facing humanity today. As human activity continues to entail massive emissions of greenhouse gases into the atmosphere and does not drastically reduce these emissions, this will have devastating effects on the future of humanity, nature and its ecosystems. Also, failure to cut emissions will reduce the chance of stopping the warming process before passing the point of non-return. From this point onwards, even emissions reduction would not prevent serious disaster scenarios, and the situation will only be exacerbated. Therefore, there is broad international consensus on the urgent need to reduce greenhouse-gas emissions. This is both a scientific consensus, as expressed in the Intergovernmental Panel on Climate Change reports,[1] and a political consensus, as expressed in the Paris Agreement, signed in December 2015 by 197 countries.[2] In this agreement, the states have pledged to reduce their greenhouse gas emissions, and to work to increase reductions under the mechanism set out in the agreement. Recently (October 2018), the Intergovernmental Panel on Climate Change has published a report addressing more ambitious mitigation targets than those that have been at the center of international discussion in the past.[3]

While the main route of dealing with global warming is reducing emissions, humanity today seems to have not yet embarked on a path that could lead it to successfully meet its required reduction targets. In practice, the global carbon dioxide emissions into the atmosphere in 2018 increased by 2% over 2017.[4] The scheme of reduction goals to which countries have committed in the Paris Agreement does not lead to the

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1 The Intergovernmental Panel on Climate Change was established in 1988 by the United Nations Environmental Program (UNEP) and by the World Meteorological Organization (WMO). Thousands of scientists from all over the world work on its reports.

2 As of July 28th 2019, 187 countries out of the 197 signatories have ratified the agreement. See: https://unfccc.int/process/the-paris-agreement/status-of-ratification.

3 First, P. J. (2018). *Global Warming of 1.5 ⁰C: An IPCC Special Report on the impacts of global warming of 1.5 ⁰C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* The report can be read at: https://www.ipcc.ch/sr15.

4 British Petroleum (2018). *Renewable Energy–BP Statistical Review of World Energy 2019*, 68th edition, British Petroleum: London, UK.

required extent of global reduction, and it is doubtful that, in implementing the agreement in the future, those countries increase their commitments to emissions reduction sufficiently before it is too late. This is especially so after the US announced its withdrawal from the agreement in June 2017. It appears that we, our children and future generations will be exposed to global warming and its dangerous climatic outcomes, including loss of ice mass at the poles, intensification of drought and storm events, desertification etc., all of which are likely to worsen over time. These will cause human beings unprecedented damage, harsher living conditions, water and food shortages, disease spread, destruction caused by storms, dealing with long and extreme heat waves, damage to agriculture, rising sea levels and flooding of inhabited coastal areas and more. All these will bring about the deterioration of the quality of life, casualties, countless fatalities and sicknesses, a significant increase in climate-refugee numbers and enormous economic damages.

In this state of affairs, the idea of climate engineering (geoengineering or climate engineering) is more often debated than before. Climate engineering is a field that has to do with developing ways of intentionally interfering with man's natural systems on a global scale to stop global warming. Until the beginning of the 21st century, the occupation with this engineering field was relatively limited. Climate engineering was considered presumptuous and dangerous, an expression of unprecedented, and even immoral, hubris. The idea of a global "fiddling" with the atmosphere to optimize it to human needs was seen by many as a dangerous megalomania, and thus there was a kind of "taboo" on engaging in this field.

This situation changed following a paper by Paul Crutzen, who won the Nobel Prize in chemistry, in 2006.[5] In his article, he called for the development of sulfur particle injection into the stratosphere (one of the methods of climate engineering).[6] Since then, climate engineering has become very legitimate for many, and has evolved significantly. Countless papers and big-budget studies have been published in the field, and what used to be regarded as science fiction with little bearing on reality has gradually evolved into methods and means some of which support start-up projects and attract investments, patent registrations and more.[7] However, the methods developed in this field are not yet ripe for implementation, and it is difficult to predict what their potential for coping with global warming in the future will be, if any, but various scenarios thought up by the Intergovernmental Panel on Climate Change (IPCC) for coping with global warming assume that climate engineering methods may fill an important place role among potential courses for dealing with the warming trend.[8]

It can be stated in general that the implementation of climate engineering methods on a global scale involves side effects inflicted on the climate system and ecosystems. The uncertainty about the implications is huge, and this field encompasses many risks. This is especially true of methods for reflecting solar radiation from Earth into space – a set of methods known as Solar Radiation Management (SRM). However, it cannot be ruled out that the advancement of science and engineering could introduce more viable and safer climate engineering schemes in the future. Such a goal, however, seems very futuristic, and may be reached only in the very distant future, while we must address the climate crisis effectively right now, and urgently.

5 Crutzen studies the atmosphere and won the prize in 1995 for his study on the ozone layer.

6 Crutzen, P.J. (2006). "Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma?". *Climatic Change*, 77(3), 211-220.

7 Hamilton, C. (2013). *Earthmasters: The Dawn of the Age of Climate Engineering*. New Haven & London: Yale University Press, 74-76, 79-82.

8 Clarke, L., Jiang, K., Akimoto, K., Babiker, M., Blanford, G., Fisher-Vanden, B., ... & van Vuuren, D.P. (2014). "Assessing Transformation Pathways". In: O. Edenhofer et al., (Eds.), *Climate Change 2014: Mitigation of Climate Change*. Contribution of Working Group III to the 5th Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, pp. 484-489.

Moreover, even if the development of research in this field can offer usable schemes in a safe way (which seems to be merely a theoretical idea at the moment), humanity will have to reach international accords on how they are implemented, managed, regulated and so on. Since the implementation of climate engineering schemes globally will not affect the climate homogeneously, it will be very difficult to impossible to reach an overall international agreement on the manner of its implementation.

Thus, for example, a climate engineering method that proposes to inject sulfur into the stratosphere to increase the reflection of solar radiation into space is likely to weaken the global hydrological cycle. This weakening will result from various effects of sulfur on microphysical processes such as nucleation, condensation, evaporation etc.[9] This means a decrease in precipitation levels such that millions of people will be affected. Among other things, researchers expect changes in monsoon frequency in India and the rest of Southeast Asia.[10] If so, why would countries in the affected areas agree to this?

The expected difficulty in formulating agreements on how climate engineering is to be implemented should be seen in the face of international difficulties and disputes regarding the drafting of a global emissions-reduction agreement. These disputes essentially revolve around the ethical question – how to divide the burden of greenhouse-gas emissions between the countries of the world in a fair and just manner, and in relation to the emissions history of each country. A controversy surrounding this matter led to the failure of the Copenhagen Climate Conference in 2009 – a conference that ended without a global agreement to reduce emissions despite the great expectations of the international community on the eve of the conference. This failure has led to the realization that it will be difficult or even impossible to reach an international agreement on how the various countries divide the total amount of emissions that must be reduced for climate stabilization. Therefore, for the purpose of formulating the Paris Agreement in 2015 and for preventing another failure like that of the Copenhagen Conference, the countries were asked to declare the amount of emissions reduction that each of them would be willing to undertake. Unfortunately, the total amount of reductions that were summed from the voluntary declarations of the various countries is insufficient, so that even if the countries do meet their declared reductions, the climate crisis solution is still not in sight. To the extent that the international community fails to reach agreements on the total emission reduction quota – a relatively simple matter – how it can reach agreements on the implementation of climate engineering, which is a far more complex matter that involves countless options, methods, and method combinations, where different countries have opposing interests with regard to the different alternatives?

Moreover, as humanity turns to climate engineering technologies in the future without drastically reducing greenhouse-gas emissions, the implementation of climate engineering methods will have to be very long-term, and from the current perspective – unlimited. This will intensify the problem of the effects of climate engineering on the earth's natural systems and its accompanying risks. On top of that, constant human management of the atmosphere will be required. Such dependence on human management is inherently dangerous. After all, it will be highly sensitive to any event that could bring it to a halt, and cease the application of climate engineering in general, or render humanity incapable of sustaining it. This

9 Hamilton (2013), 63, 61.

10 Hamilton (2013), 63; Bala, G., Duffy, P., & Taylor, K. (2008). "Impact of Geoengineering Schemes on the Global Hydrological Cycle". *Proceedings of the National Academy of Sciences*, 105(22), 7664-7669; Rasch, P.J., Tilmes, S., Turco, R.P., Robock, A., Oman, L., Chen, C.C.J. & Garcia, R. R. (2008). "An Overview of Geoengineering of Climate Using Stratospheric Sulphate Aerosols". *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, 366(1882), 4007-4037.

can happen, for example, in situations of international disagreement about how to continue implementation, geopolitical tensions or wars, natural disasters, or economic crises that could dry up funding for its implementation. As some factors or other bring about the termination of climate engineering, a rapid, powerful, and very dangerous climate warming will occur – due to the accumulation of carbon dioxide in the atmosphere resulting from continued emissions over the years, concurrently with artificial climate "management".

In the context of climate engineering, therefore, I think there is no room for technological optimism that usually characterizes the engineering field. Developing climate engineering is not the desired course of action for dealing with the climate crisis, and certainly not in the immediate time frame. It is appropriate to maintain humility and not get carried away with dreams, bordering hubris, about human management of the atmosphere. The directions of research and development in which efforts should be concentrated are to be subject to the concept of sustainability. As part of such a concept, human intervention in the atmosphere should be reduced by limiting greenhouse-gas emissions in the hope that the climate system stabilizes. Accordingly, engineering should be developed and used to reduce greenhouse-gas emissions, to allow full transition (100% or as close as possible) to green energies in industry, transport and electricity generation. The methods that would enable such an energetic transition must be further refined, efficiency levels must be increased, and their costs should be lowered. Recently, we have witnessed the decline in solar energy production prices, the development of electricity storage and storage solutions and so on. This is a welcome direction.

In the Israeli context, it should be noted that on July 29th 2018, Government Resolution No. 4079 was passed, titled: "Preparing Israel for Adaptation to Climate Change: Implementing Government Recommendations for Strategy and National Action Plan". As the title shows, the decision is focused on preparing Israel for adaptation to climate change. Of course, preparation is crucial, and engineering plays an important role in this. This field can develop technological and engineering measures to help us, and the State of Israel, deal with extreme events, climatic emergencies and climate hazards.

However, the decision does not address Israel's emissions-reduction targets. As of 2016, green energy in Israel was only about 2% of general consumption.[11] The goal of the State of Israel is to reduce electricity consumption from non-renewable sources by at least 17% by 2030 and to reach electricity generation from renewable energy by at least the same rate in 2030 – all this in contrast to the business-as-usual scenario.[12] This is an insufficient target, especially in view of the demographic trend of population growth in Israel, and in relation to the goals of other Western countries. These goals must be corrected and improved, and the engineering community in various institutions of higher education in Israel and abroad can play an important role in this. They can combine forces to conduct research to examine the feasibility and potential of substituting fossil fuel-based energy with green energy alternatives in Israel and offer a "roadmap" for a significant energy transition, tailored to this country. Such a roadmap should serve as a basis for an ambitious plan to transition to 100% (or as close as possible) green energy in the electricity and industrial sectors in Israel, and should present to the professional echelons in government ministries and political

11 Tal, Alon (2017). *And the Country was Replete: Coping with Population Explosion in Israel.* Tel Aviv: HaKibbutz Hame'uhad Publishing, p. 40 [in Hebrew].

12 Proactor, Gill (2017). *Reducing Greenhouse Gas Emissions in Israel: Annual Report Monitoring the Implementation of the National Plan and Goals of Emissions Reduction,* Ministry of Environmental Protection, p. 3.

decision-makers evidence and calculations that would show that developing a viable plan in light of the roadmap is possible. The state should not be allowed to drag its feet and leave the low emission reduction targets as they are without professional response from the citizens – response from various engineering and adjacent and additional fields, which will show the state authorities responsible for this issue how to dramatically improve emissions reduction goals, and which will shine a critical light on the state's plans and goals in the area of emissions reduction. If the state does not act, or if it claims it is impossible to act, civil society must prove to it that ambitious goals are indeed possible.

Israel, which is lagging behind other countries currently and is even did not succeed to fully exploit the sun's abundance in our region, must become a global leader in technological solutions to the climate crisis and to emissions reduction, and set an example and be a "Light unto the Nations" when it comes to ambitious transition to renewable energy. The contribution of engineers to dealing with the climate crisis is a vital and necessary, albeit insufficient, condition for a successful resolution of the climate crisis. As the engineering community introduces a "roadmap" for energy transition, or a professional, viable proposal that is very ambitious for moving into green energies, civil society organizations and the citizenry in general will be able to apply pressure on the state and its political decision-makers to examine and consider adopting the roadmap or plan. The engineering community has a moral responsibility to do so. After all, it turns out that the engineering developments, which led to the industrial revolution and radically improved the welfare, quality of life and health that we enjoy, have eventually led to disaster in the form of the climate crisis. The engineering field that "got us into this mess" must now play an important role in bailing us out, offering a feasible vision for decision makers of a complete (or almost complete) transition to green energies that can be realized relatively quickly – and the sooner the better.

# Are We Prisoners or Masters of Technology?

Noa Gedi

Dr. Noa Gedi is a lecturer and multidisciplinary scholar. Her subjects of interest include various fields of philosophy (epistemology, ethics, aesthetics and phenomenology), social theory, cultural theory and theory of digital culture.

**Creating and developing tools is a core characteristic of human civilization, from its very beginnings to present-day intelligent information technologies. Technology is a testament to human inventiveness and imagination, and it is an important factor in the cultural power of every society, at every age. The digital revolution is a cultural revolution in the sense of generating a complete system overhaul in every aspect of life, in every field of human activity, in our thinking patterns in in our everyday practices. Therefore, it beckons a philosophical-cultural discussion on its various meanings and implications for knowledge, society and ethics, and on the fate of the human subject, whose technology threatens to transform from a useful tool to an end in its own right. This paper invites the readers to such a discussion.**

*"The Matrix is all around us… It is the world that has been pulled over your eyes to blind you from the truth… That you are a slave, Neo. Like everyone else you were born into bondage. Into a prison that you cannot taste or see or touch. A prison for your mind" (Morpheus, The Matrix 1, 1999)*

The status of The Matrix 1 (the first of the Wachowski sisters' trilogy) in the world of cinema is analogous to René Descartes' status in the world of philosophy. They both became cultural icons of their respective times – a definite symbol of the Zeitgeist. The first Matrix turned the attention of the general public who came to watch a futuristic action movie to one of the most troubling, fundamental problems of philosophy that baffle it to this day, which is the problem of skepticism. In the seventeenth century, Descartes, one of the pioneers of modern philosophy, gave this problem its most famous formulation by two very quoted arguments, which echo in the first encounter between Morpheus, the free rebel leader of Zion, and Neo, a prisoner of the "Matrix" illusion, who already began to question the true nature of the reality surrounding him.

The first question that came to the viewer's mind, after exiting the movie theater in 1999, was: "Is it possible that we are now inside the Matrix (and we have no idea)?" Are we – like Neo who works for a high-tech company and is a hacker at night, and convinced that this is the reality of his life – also managed by a super-intelligence that feeds us with the simulation that it runs, all without our knowledge? Could we imagine that in the first place, if we were held captive by a "Matrix"-like computerized construction? If our sensory experience during sleep is the same as while being awake, or the experience in a dream or in virtual reality the same as in physical reality – how do we know in which of the situations we are right now? Descartes, as mentioned, made two skeptical arguments about the ability of the human mind to reach true knowledge of the world: the dream argument and the deceptive demon argument. In the dream argument, Descartes insisted that our experience of dream and wakefulness is the same in both content and sensation: the things we dream about are familiar to us from reality, and only the combinations or situations are surprising or farfetched compared to our sensory experience in reality. Also, as long as we are in the dream, things feel "real" and concrete. Hence, the senses cannot be relied upon as a credible source of knowledge, not even as a distinguishing feature of wakefulness from sleep. We shall name this argument first-degree skepticism.

In the deceptive demon argument, Descartes raised the possibility that there is a cunning and malicious supernatural entity that makes him believe in things that do not exist, while, in fact, there is no physical reality and Descartes does not even have a body. This argument is equivalent to the Matrix hypothesis – to the assumption that the brain responds to fabricated stimuli and produces mental content accordingly – and shall call it second-degree skepticism. It means that we have no ability to even know if we know, because all of the supposed content in consciousness is "implanted" content, the product of total external manipulation.[1] Suppose the entire world is "collective hallucination" and the brain-in-a-vat story is true, "could we, if we were brains in vats, say or think that we are?" According to Hillary Putnam, the only problem with this assumption, which does not violate any physical law, is that it simply does not make sense because "even though people in this possible world [where sentient beings are brains in a vat] can think and say every word we can think or say, they cannot relate to what we can relate to. Specifically, they cannot think or say that they are brains in a vat" (Putnam, 1981, 7-8). In other words, our words and concepts must have real objects, unless we have completely withdrawn from the realistic position (according to which the world is real, and objects exist independently of our perception of them or of our ability to recognize them correctly) to a solipsistic position that is only committed to a bubble-world of conceptions within our head, without analogous objects that correspond to them.

The question "What is the Matrix?" is not a scientific or theological question, neither about bodies nor about final ends; it is a metaphysical question regarding the relation between cognition and reality. This is a question that requires clarification that is beyond the immediate phenomena. Neo, like Descartes, is driven by the question that leads to a philosophical exploration of the world. The question of whether we (in the "Matrix" language) are "inside or outside" has great significance epistemically and ethically; these are questions that the movie's heroes also face, even though the human-cultural world they once knew is extinct, even though they live in the age of machines that control the body and mind of all humanity. Neo finds it hard to break away from the basic beliefs and assumptions that he held and was guided by within the Chicago simulation in favor of the truth about the "Desert of the Real" that Morpheus reveals to him. He finds it hard to believe that his fate was not determined by him but rather dictated by a super-software that controls every thought and physical act he allegedly committed himself. He finds it hard to believe that he can jump from one roof of a building to another because he is bound, in his head, to the laws of physics,

1 In its 21st-century version, the Cartesian argument became the "brain in a vat" argument, where instead of the deceptive demon we have an evil scientist who feeds by computer a brain that floats in a vat of liquid with all its current experiences. Since the brain in the vat has no way to distinguish its own experience from that of something that is not a brain in a vat and given that the evil scientist succeeds in what he does – such a brain cannot possibly know that it is not a brain in a vat (Dancy, 1985).

which in effect are not valid in the fictitious world of the “Matrix". The "cause" of Neo’s near "crash" the first time he tries to jump is not related to the objective conditions of reality – since there is really no body or buildings or gravity within the "Matrix" – but rather to a cognitive-psychological conditioning to which he is subject, because in his consciousness, in his cognitive structure, Neo is still human. Neo, like all of us, believes in causality, whether it has a real bearing on the world of phenomena or is merely a characteristic of our organizing consciousness (as Emmanuel Kant has shown). Even if the skeptical critique of the empiricist philosopher David Hume is valid, and the concept of cause is nothing but the "habit of the mind" to link two consecutive events, one of which always preceding the other, only in a fictitious world of virtual reality can one free oneself from this causal fixation and stop bullets midair instead of dodging them, as Neo does when he finally acknowledges his superhero abilities.

The Matrix does bear the guilt of vulgarizing the philosophical issues that it brings up, but it certainly succeeded, perhaps more than any other movie (apart from Stanley Kubrick's 2001: Space Odyssey), not only to illustrate visually and dramatically key philosophical ideas on the nature of the human subject and the nature of the reality this subject is dealing with, but also effectively to demonstrate their relevance in the era of "smart" technologies. In particular, The Matrix managed to induce in the viewer to the tension between the real and the virtual, the organic and the biological, the human and the mechanized, and the blurring of boundaries between them, as well as the implications this has for questions that accompany us every day, consciously or unconsciously – questions concerning truth and knowledge, ethics and society, our perception of ourselves and of our existence in the world.

Is The Matrix (as a metaphor) a metaphysical hypothesis about the hidden reality, or is it a socio-ethical parable of the human condition? Whether it is the primary, physical reality of blood, sweat and tears, or a virtual reality, free of the bonds of body and matter and all the pain and worry they create (though not free of values), it is the same consciousness that wonders at the meaning of all this.[2] The emergence of virtual reality should not be serve as an escapist or hedonistic refuge from the primary reality we are still rooted in, on the contrary – the computer is a quintessential "metaphysical machine" (Heim, 1993), which requires us to think seriously about the very concept of "reality" and the meaning of the human subject’s existence in the cosmic and cultural drama of which we are part, as we face its challenges and rebel against the limitations it places on us. If we had the opportunity to "retire" into a virtual reality world where we could reshape our character and experiences – much like the deal that treacherous Cypher makes with Agent Smith (the personification of the Matrix software) in exchange for turning Morpheus' over to the latter – would we do it? Would we voluntarily give up on the spontaneous course of life or free choice (with all its possible consequences), and entrust our fate with a librarian-software that would choose for us a biography that is the realization of every dream or wish we ever had? And suppose we could get into and out of such an "experience machine" (Nozick, 1974), as many times as we want, each time to a different exciting software program – would we exchange our real existence with an amorphous existence within a virtual space? What for? What would be the meaning of our actions inside the machine? Does this choice not void the concept of free choice, and annuls the ability to change and influence things – to "make a difference"?

The technology of virtual reality and artificial intelligence has only increased the interest of philosophers and cultural scholars in metaphysical, ethical and social questions. The academic preoccupation with the

2 Just as Mouse in the movie wonders how the “Matrix” knows the flavor of wheat, and how he, having never tasted wheat, can possibly know that this is indeed its flavor.

digital world has become established during the 1990s, based on the striking realization that the invention of the computer and the Internet was not just a technological revolution in the field of communication, but a real cultural revolution. Like the Industrial Revolution, which began as a revolution of mechanization in agricultural production and gave rise to a series of economic, social and mental processes, the result of which is the urban lifestyle that has characterized and defined modern culture to date – digital technology has also created a new cultural space: cyberspace. Telecommunication’s tentacles reached well beyond the iron and steel pipes and the rapid sea, air and land transport vehicles; material freedom from the bonds of space-time in a kinetic, elastic and ever-changing space has allowed the "new pipes" (Mitchell, 1999) to expand and dominate every known sphere in every level and aspect of human behavior in the daily life of individuals and groups, of societies and states, and to radically change their patterns of behavior "from within".

The cultural significance of digitalization (like that of the industrialization before it, but on an unprecedented scale) goes far beyond digitization and automation, beyond the mechanisms of information dissemination and global communication and interactive platforms. It is an ontological and conceptual turn that requires us to re-examine our position as human subjects in the cyber world that we created in parallel to the material world, and the conceptual definitions that are used to describe it and render meaning to it. Most importantly, the digital turn requires us to make decisions about trends of development and applications, which, as correctly identified by the father of cybernetics Norbert Weiner (1964), are tied to our moral responsibility, as the decision makers. Will we adopt the mentality of the slave – who prefers to pierce his ear and entrust the responsibility for his fate to his master – and give in to the algorithmic logic of an artificial super-intelligence, or will we preserve our autonomy of intelligence? Will we give up the vague ambiguity of our language for the universal functionality of computer language? Although human intelligence is limited and sometimes disappointing, it is self-conscious, reflexive intelligence, capable of attributing and understanding meanings, intentions and values. It is an intelligence that has creative imagination that is the only thing, in the words of British mathematician and programming pioneer Ada Byron Lovelace (Toole, 1992), that can reveal to us invisible worlds and relationships beyond the senses, and mentally introduces them into our consciousness. It is the imagination that has been responsible for inventing, developing and perfecting tools since the dawn of humanity, from the first modern homo (homo sapiens) to the modern one of our time. It originates in the human brain capable of fabricating scenarios and outlining events autonomously, of establishing an entire world of symbols and representations – from natural forces to mental powers – in response not only to the world around it but also to itself. This world of representations is self-aware and finds expression in the human language, a language we try to impart to the wise robot so that it can communicate naturally with us and "behave" in a way that makes it easier for us to have a social-like, even emotional relationship with it. The kind of self-awareness that accompanies every human experience and experience is irrelevant in the case of artificial intelligence; a semblance of intelligent behavior and compelling conversational skills suffices (just as the famous Turing test determined).

The controversial question is, should we, human beings, also undergo transformation and adaptation to the technological world of smart machines? If neurological stimulation is enough to manipulate consciousness that can then run itself on imagined, virtual objects, such as in the Matrix scenario or in a dream or a hallucination, then may consciousness itself be a fiction, and a human brain can ultimately be tuned and wired like the e-brain created in its image? The fantasy of artificial intelligence, the tendency to assimilate in the spectacular technology we created and fall for the magic of the words that describe it – according John Lenier, a musician, computer scientist and influential VR-technology developer – rests on the expectation that this technology will henceforth control us through such God-science (software that it will code by itself, that no human brain can code). "Cybernetic Totalism" (Lenier, 2000) – the notion that computerized information patterns are the best means of understanding reality, that humans are essentially such a collection of such information patterns, that biology and physics will eventually merge with computer science so that life on earth will cease to be human in a sense familiar to us, and the age of singularity will begin (Kurzweil, 2012) – is a reminder of Norbert Wiener's initial insight, that the true master of technology is man.

In this sense, there is no escaping the subjectivity of human consciousness, the anthropocentric perspective, even though the computer seems to be "more advanced" because its capabilities are more sophisticated in some ways. Ultimately, human synthetic thinking capacities, and specifically the planning and evaluation ability, are what gives humans control over the entire decision-making process. Wiener believed that the most important task of cybernetics, as long as there is life on Earth, is the reduction of entropy in "a world whose general tendency is to run down". Until the inevitable demise of our planet, "we may succeed in framing our values so that this temporary accident of living existence, and this much more temporary accident of human existence, may be taken as all-important positive values, notwithstanding their fugitive character".[3] Therefore, in an important and fundamental sense, which devotees of digital technology and various kinds of futurists tend to ignore or repress, if we do not completely vanish from this planet – no matter what digital spectacles or ionic prostheses we wear, and what electronic chips transplant in our bodies – existential, epistemological and ethical dilemmas will continue to occupy us and be relevant to our continued human existence.

## Bibliography:

Dancy, Jonathan (1985). *Introduction to Contemporary Epistemology*. New York: Blackwell Basil.

Descartes, René (1993). *Discourse on Method and Meditations on First Philosophy*. Indianapolis: Hackett Pub.

Heim, Michael (1993). *The Metaphysics of Virtual Reality*. New York: Oxford University Press.

Hume, David (1969). *A Treatise of Human Nature*. Harmondsworth: Penguin.

Kurzweil, Ray (2005). *The Singularity Is Near: When Humans Transcend Biology*. New York: Viking.

Lenier, Jaron (2000). "One-Half of a Manifesto". In *Wired* 8.12 December, http://www.wired.com/wired/archive/8.12/lanier_pr.html

Mitchell, J. William (1999). *E-topia: "Urban life, Jim - But Not as We Know It"*. Cambridge, MA: MIT.

Nozick, Robert (1974). *Anarchy, State, and Utopia*. New York: Basic Books.

Putnam, Hilary (1981). "Brains in a Vat". In *Reason, Truth and History,* New York: Cambridge University Press, 1-21.

Toole, Alexandra Betty (ed.) (1992). *Ada, the Enchantress of Numbers: A Selection from the Letters of Lord Byron's Daughter and Her Description of the First Computer.* Mill Valley, CA: Strawberry Press.

Wiener, Norbert (1950). *The Human Use of Human Beings.* Boston: Houghton Mifflin Harcourt.

3 Wiener, Norbert (1950). *The Human Use of Human Beings.* Boston: Houghton Mifflin Harcourt.

# Afeka College: A Case Study in Higher Education Change Leadership

David E. Goldberg

Prof. David E. Goldberg was a distinguished professor at the University of Illinois. In 2010 he resigned to undergo training in leadership coaching, and today he is president of ThreeJoy Associates, a change leadership, training and consulting firm in Douglas, MI.

**An interview with Prof. Ami Moyal, president of Afeka College, describes the effort of a visionary, who arrived from the industry, to effect deep change in the educational conception of a rising academic technological institution. This reform is analyzed according to the principles presented in the book *A Whole New Engineer*, and which are implemented in the work of ThreeJoy Associates. These constitute the engine of change in the educational environment of the new engineer in the 21st century. What was known before as "soft skills" becomes, in the ThreeJoy world, "shift skills".**

## David, Goliath & the Writing of *A Whole New Engineer*

In 2014, Mark Somerville and I published a book entitled *A Whole New Engineer* or WNE (Goldberg & Somerville, 2014). That book has been used by engineering educators and other educators of professionals as a roadmap to bring about change in many different schools around the globe. Part of the attraction of the book was the David-and-Goliath nature of the two main narratives running through the text. Olin College was, at the time, a relatively unknown, scrappy startup trying to bring about a new kind of engineering education, and the University of Illinois was a traditional research powerhouse trying to reclaim its undergraduate mojo, and many of the particular practices of the two schools did not transfer well. However, at the level of motivation (emotion), culture, and change leadership, Mark and I found common ground to understand key factors of what was happening at these two very different schools during periods of rapid and effective change.

Since leaving the University of Illinois in 2010 and the writing of WNE, I have had the challenge and pleasure of trying to better understand the principles of emotion, culture, and change in many different contexts around the globe. From the relatively unemotional culture of Singapore to the on-the-shirtsleeve emotions of Brazil, from a startup tech-liberal arts college in the Netherlands to a polytechnic on the Midwestern plains of the United States, and points in between, I've worked at the university, college, department, faculty, and student levels, one-on-one and in small and large groups, with the aim of bringing about effective change.

## *A Whole New Engineer* Goes to Tel Aviv

Recently, I was pleased to have a conversation with Professor Ami Moyal, president of a rising engineering college in Israel, Afeka College, and it struck me that many of the practices I have been advocating since my earliest writings in engineering education (Goldberg, 1996) and those advocated in WNE were present in our conversation. To be clear, Afeka has not been following WNE in its work; it only recently became aware of the text, and to use a biological metaphor, this is a case of parallel evolution, the same or similar systemic results achieved through different evolutionary pathways. Nonetheless, I thought it might be useful to highlight key elements of my conversation with President Moyal as an aid to those seeking effective change leadership practices in the academy. Additionally, toward the end of the article, I highlight some of the recent advances in accelerating change at schools like Afeka that are ready to take the next step inside the curriculum.

## Conversation with a Startup Leader in Academic Wonderland

One of the remarkable things about my conversation with President Moyal is his background. Israel is the per-capita leader in entrepreneurial startups—so much so, that the country has been called Start-up Nation by a book of the eponymous title (Senor & Singer, 2009). Following his straight-through achievement of a BSc, MSc, and PhD in Electrical and Computer Engineering at Ben Gurion University, Moyal went onto a career in analytical speech recognition in the Israeli hi-tech industry, starting as a research engineer, and completing his career as CEO of NSC. He then rose through the academic ranks at Afeka as a faculty member, research center director, department head, and now President.

Needless to say, this is an unusual background for a college president. Many come up through the ranks of academic administration, and even the use of the term "administrator" tells an important story. In coaching practice, the distinction between administrator, manager, and leader is the difference between yesterday, today, and tomorrow. Administrators make yesterday happen today. Leaders bring about a new tomorrow.

In the next few sections, we'll highlight key points of a stimulating conversation between an experienced startup CEO trying to make change in traditional engineering education.

## Introduction to Ami & Afeka: A CEO "Changing the Adventure"

A key way leaders lead is by changing the story of their organizations. This showed up early in the conversation when Ami spoke of "changing the adventure."

> Dave: Ami, thanks for making the time to talk about Afeka and Israeli engineering education, more generally. For people who are less familiar with your school, what are the most important things for someone to know about Afeka College of Engineering?
>
> Ami: OK, first of all, as a general sentiment, I like to think of Afeka as an academic college of engineering with the spirit of Israeli hi-tech. We are an academic college with a little more than 3,000 students in most of the engineering programs. We are implementing a major and deep change in our program in order to reflect the needs of the industry with regard to the vital

[“soft”] skills for the new generation of students, which has a different approach to learning. In other words, we are changing the adventure the student is facing in the four years he or she is with us, inside the classroom, outside the classroom, and on the campus itself. We make these changes so our graduates will have the knowledge and skills they need in the real world.

## What’s a Nice Startup CEO Doing in a Place Like This?

CEOs often stay CEOs, but an interest in doing something different and meaningful led to Ami’s evolution from industry to academia as we see in the following excerpt.

Dave: What’s a nice startup CEO like you doing in a place like this?

Ami: First, I spent 15 years in the hi-tech industry in Israel in various positions from a research engineer, team leader, and vice president of research and development to finally a CEO. And that has shaped my view of what’s needed in engineering education.

Dave: I walk around the planet talking to college of engineering deans and university presidents, and it's a little unusual to have someone with your experience at the helm of an engineering school. And you were a hard-core electrical engineer (EE), a speech recognition guy. So more seriously, how does an EE with such a nice career in the C-suite end up as the president of a college of engineering?

Ami: I was a CEO of a company that was acquired by the major shareholder. And then I had a question mark, ”What would be my next step?” Obviously, I would be able to continue as a CEO of another hi-tech company, but I felt it would be more of the same.

Dave: That makes sense, but why the move to engineering education?

Ami: I felt an urge to come back to academia with a clear agenda on several issues. One, I had been, for years, vice president for development and I learned the value of vital skills such as: effective communication, multi-disciplinary teamwork, self-learning, and English. And I felt strongly while managing people that engineers that don’t have these skills do not succeed in the hi-tech industry.

Dave: I see, so coming back stems from mismatches you experienced in the real world?

Ami: Yes, so I definitely came with an agenda to implement what I've learned in industry. Deep in my heart I feel that I am an educator. I want to teach this generation, and I want to give my view, vision, and experience. So, this is one point.

Ami: The second point is, as a CEO of company, I was not so successful in developing strong ties with academia. Normal connections between academic and industry are in the form of teaching courses or hiring academics as consultants. But IP transfer agreements were always very complex. In addition, academics are pure theoreticians and don’t do much applied science, and what they do should be transformed to efficient products. So, I strongly believed that the academy and industry can and should work much better together, coordinated under the banner of lifelong learning, while performing both basic and applied research.

## The Importance of Soft (Shift or Vital) Skills for Engineers Today

In ThreeJoy Associates practice we eschew the term “soft skills” because it seems to imply these critical skills of being an effective human being are less important than technical skills in engineering practice. Instead we talk about shift skills because we believe the following skills are a basis set for personal and organizational change effectiveness, quite similar to a basis set in an n-dimensional vector space. That is, these are exactly the skills that must be mastered personally and organizationally in a world of fast-paced change. In particular, we believe there are 5+1 core shift skills in the basis set:

1. The shift from technical rationality to reflection- or conversation-in-action.
2. The shift from rational thinking to body and emotional feeling.
3. The shift from language as merely descriptive to language as generative and action-filled.
4. The shift from planning to entrepreneurial effectuation and little bets.
5. The shift from problem solving to polarity management.

And the 5+1th shift can be thought of as a corollary of the second:

- The shift from obedient following of orders to courageous initiative.

Ami’s list of important skills differs from the lists above, and many employers and practitioners, when asked to name key soft skills, will speak generally about “communications,” “teamwork”, “lifelong learning” and so forth. These skills are important, and the ThreeJoy approach simplifies the journey by emphasizing the “basics” or core shift skills above, and considers the usual employers’ list as “derivative” of the core.

Nonetheless, both roads lead to Rome, so let’s get Ami’s take on the importance of what he calls “vital skills.”

> Dave: One of the points you talked about was the importance of vital or soft skills. In your experience in an Israeli hi-tech setting, what do companies do to develop vital skills in their people?
>
> Ami: I can take myself as an example. I graduated from a classical research university, Ben Gurion University in Be'er Sheva. There was no emphasis on vital skills, but during the PhD I read a lot of papers, so I got a good knowledge of English. I wrote papers and I learned a lot by myself. So, the master’s degree and the PhD gave me self-learning, English, and some kind of presentation skills, but this is something that I did not receive in my BSc, which was my first degree, and which is required in order to succeed in the industry.
>
> Ami: But other aspects like teamwork, multi-disciplinary work, and working with other disciplines — I definitely did not receive it. I learned it by myself in the industry. I don't remember anybody in the industry investing in me. I worked in this very small startup 12 hours a day, and we didn't have time for any courses, etc. So small and medium startups would like to get the engineers well prepared.
>
> Ami: I think that the larger companies in Israel, which have thousands of workers, are investing in training the engineers once they arrive. But I don't see investments specifically in soft skills.

It's more an investment in learning how to work in the particular culture and environment. So, it's a little bit teamwork, internal management, and some kind of project management. I didn't see a clear view, course, or seminar on developing soft skills.

Ami: It's worth mentioning in this point that a recent survey that has been done by the Innovation Authority in Israel has stated two main issues. There's a demand for 15,000 engineers and software people, but at the same time, almost 40% of the companies are not hiring juniors without experience, because the industry doesn't have time to invest; they prefer to pay a higher salary and take somebody more experienced.

Ami: And this comes back to my thesis, that vital skills should be developed while learning in school. By the way, I believe that if you develop the vital skills during your learning, your learning process is better. If you know how to learn by yourself (self-learning), at your second year your learning (and grades) would be much better.

Dave: In my country, when companies like Microsoft are asked about this, students with strong soft skills like those graduating from Olin College are 18 months ahead of their colleagues without them. They are “project ready” AND can be productive much more quickly.

## Initiating Change: Conversation about Story, Personae & Process

Many leaders in higher education go through formal strategic planning processes and Afeka is no exception, but the importance of these processes is oftentimes less in the “planning” and more in the “conversation” that takes place around the formation of the plan. *A Whole New Engineer* emphasized the importance of conversation, story, and culture, and, as we go through the interview, please note the complexity Ami calls out and the potential for resistance and failure without insufficient conversation.

One of the strengths of *A Whole New Engineer* was its emphasis on broadening the goal posts for the new engineer, and, as we go through Afeka’s process, note the emphasis on defining the “student profile”. In ThreeJoy practice we use the design thinking notion of personae to help define the values and content of educational transformation, and the conversation with Ami has a similar emphasis.

Dave: You said that you're in the middle of a change process to better align Afeka grads with the needs of Israeli startups. What are the key steps?

Ami: It will not happen in one year, and you can’t do it by yourself. You need to have faculty members, administrative staff, students, and alumni with you. So, in other words, you need thousands of people to be with you in the change, or you may find yourself alone. So, the steps that we have accomplished until now are as follows.

Ami: It took us a year and a half to build a strategic plan for the organization. All senior and mid-level managers, a group of 50 people, answered together the question written on the blackboard at the first meeting: How do we see our workplace in about 5 and 10 years? One major issue in the strategic plan was to educate engineers in the profile that is required today.

Ami: First, we started to talk about engineering education and not training, because we are not giving only knowledge, we are giving also skills, capabilities, ethics, and broad knowledge. So, we shifted from training to education.

Ami: And then it took us another year to define the profile of the engineer: the future graduate of Afeka. What is our dream graduate? And there were a lot of arguments, but we finally reached common ground on scientific knowledge, engineering knowledge, vital skills, engineering capabilities, ethics, languages--Hebrew, English and software — and broad knowledge. This is the profile of the ultimate Afeka graduate.

Ami: And since then, almost two years since, we have started to implement the change. I'm not talking only on a change in program or curriculum; I'm talking about change of the whole process during which the student is with us from the beginning of his or her journey with us.

Dave: You mentioned outputs. What about inputs?

Ami: First of all, after defining the output, we went to define the input. What is a typical student profile? In Israel they come to us at the age of 22, after three years of compulsory army service, and another year of customary international traveling (these days in Asia or South America). When they arrive, they have forgotten what they learned in high school. Those who took officer training have very nice soft skills from both their training and service experiences: they know how to lead, to suggest, to think, to work with people, and to multi-task. But most are lacking soft skills and deep knowledge of math.

## First Steps: Go Outside the Formal Curriculum

Impatient change agents want to make a big impact immediately inside the curriculum, but this is a prescription for an uprising and, sometimes, unemployment. Signaling that change is coming through new messaging, tangible changes outside the curriculum, and even changes to physical infrastructure can be helpful to soften the culture to the coming change.

Witness each of these elements in the following excerpt. Also notice the move to industry-related projects in existing or easily-modified course containers. Sometimes it is possible to make vision-appropriate changes early without much resistance, and this, too, is evident in what follows.

Dave: What were the key steps in the process?

Ami: First of all, we have established a very active teaching promotion center. We are investing in the required time and infrastructure, based on open calls to our faculty stating: suggest whatever you think is innovative and we will support you. We have dozens of courses and several dozens of lecturers that are dealing with innovative pedagogy, including project-based learning, flipped classes, combinations of both of them, blended courses using short video clips, innovative evaluation process including student peer review etc.

Ami: The second path is extracurricular activity. I strongly believe that learning is not only in the classroom. It is also definitely outside of the classroom. And, at the beginning, our faculty said, "No, students will not come because they are not receiving credit for it". After two years of activity with dozens of clubs, hundreds of students, active, happy, curious – it's going much faster than changing pedagogy.

Ami: The third path is changing the physical layer at Afeka: innovative learning spaces either for faculty or for students. By the way, our faculty have shifted about two years ago, all of them, to open space. In addition to open-space environment which encourages discussions, all faculty received laptops and we are working hi-tech style: work anywhere that you want. And similarly, with students.

Ami: Another path concerns developing strong ties with the industry, which includes: joint R&D projects and students' final-year projects in the industry. In parallel, we are working on the curriculum itself with the goal that each course will have its learning outcomes expressed in the level of knowledge and skills. So, for each of these five paths, we have nominated managers and funded activities, and this is the realization of the change. The first year was very, very hard – a lot of resistance from faculty and students. But I believe that now we have passed the peak and it's going much better. I see progress.

## Next: Planning, Little Bets, Failure & Having Fun

Educational planning comes from the tradition of planning in large organizations and businesses, but some of the best thinking about entrepreneurial thought and action suggests that planning is often not possible in entrepreneurial endeavors precisely because no causal model is available to relate cause and effect in a reliable chain. This is the process of what Sarasvathy (2008) calls effectuation, or what Sims (2011) calls little bets. The current popularity of advocating "failure" as part of the process of achieving success comes from this lineage of thought and can be seen in the next excerpt.

The emphasis on having fun comports with the three joys of iFoundry (and the origins of the name ThreeJoy) – the joy of engineering, the joy of learning and the joy of community. Let's listen.

Dave: So, how's it going now?

Ami: It's going much better. We see progress on a monthly basis, but it must rely on a culture of change. In order to implement such a major change, you need to build an atmosphere that is open to changes, that accepts failures, that is definitely OK with doing experiments with them not succeeding. That's OK, that's the hi-tech experience. That's the place that I'm coming from. Nobody knows what the right solution is. I'm not willing to wait until somebody invents the solution and we adopt it. So, we are ready to dig in, and I'm happy that we are already two years into it, so we passed the major obstacle. It's still not easy to do, but the train is accelerating, and that is the spirit that I'm talking about. It's about a willingness to experiment and to accept that some of the experiments will not succeed and we'll go to the next step and enjoy it.

Ami: You must enjoy the process. If you do it by force or because you are obligated, it will not succeed. So in this sense, this is the process we have experienced during the last four years. But

> now the ingredients are on the table, the platform has been established, and it doesn't all depend on me. There are many people now in the organization that are actually making the change using the platforms we produced.

## Resistance to Change is Inevitable, So Embrace Useful Opposites

In ThreeJoy practice, we say that academic change is a NIMBY ("not in my backyard") problem like choosing the site of a nuclear power plant. Everyone wants the power. Nobody wants the plant. Likewise, in curriculum change, "Innovation is great. Just don't change my course". Therefore, resistance to change is systemically inevitable, but resistance is part of change, and different cultures express their resistance differently.

Moreover, change is resisted by all stakeholders: faculty, staff, students, and employers, differently and in different degrees, but resistance comes from all sides; in part, because culture tells everyone, "That's not how we do it here".

Nonetheless, far from resisting resistance, a key to success is to embrace it, and a particularly effective way to do so is through the practice of polarities. Polarities are opposites that need each other. Which is better? Inhaling or exhaling? Individual work or team or community work? Students or faculty? Teaching or research? Tradition or innovation? Our usual approach is to embrace one pole or the other and view the decision as an either-or choice, but Johnson (1992) calls out these polarities and suggests that the key is to manage them to get the best of both poles.

Listen to the resistance and tensions from each of three groups in the following excerpts.

## Resistance from Faculty

The run-of-the-mill resistance in these situations comes from faculty members and much of the effort in change initiatives works to embrace and work beyond that resistance to achieve substantial change. Listen closely to the following excerpt.

> Dave: You talked about the early resistance to your change efforts. How would you characterize the resistance you faced?
>
> Ami: OK. So first of all, I must say that I anticipated that such a deep change would face resistance, but it came from groups I didn't think would resist. The resistance was definitely much stronger and different from what I was expecting. There were three resistance groups: faculty, students and administrative staff.
>
> Dave: Yes, say more.
>
> Ami: Before talking about each one of them, let's talk about change more generally. I think, from my experience, and here I'm bringing my startup experience to bear, organizations of any size change only when they are facing a large threat. And that was one of the challenges here because none of the three groups at Afeka perceived an immediate threat. And, to a certain extent, they were right. We have nice student and employer demand, our reputation is good and improving, and our financial footing is sound.

Ami: So, if I start with the faculty, the typical question I was facing was, “Why do you want to make a change? By any parameter by which we judge Afeka activity—applications and admissions, hiring by industry, and happiness of the students, or by any financial or operational parameter—we are OK”. I needed to explain that in my role, I need to take responsibility for Afeka’s future 10 years from now and that I strongly believe that since the inputs and outputs have both changed, if we do not change, there is a huge risk that we will become irrelevant, or worse, that we will vanish. This is one point.

## Resistance from Students

Sometimes change agents assume that students will be a power for change, and Olin, iFoundry, and UFMG ENG200 are great examples where students can be powerful change agents themselves. However, left to their own devices, students can be as conservative or even more conservative than faculty, as evidenced from the following excerpt.

Ami: Second, and something that was quite surprising, was the students. A year ago, after a lot of discussions, we changed the learning process by moving from mid-term and final exams toward assisting students to learn during the semester; we developed several kinds of projects, quizzes, model projects and teams, and various ways to give the vital skills and to accelerate the learning during the semester. And, in doing this, we were surprised that we almost faced a strike by the students. It almost came to that. They were not able or didn’t want to handle it. And then you need to explain a lot and to communicate. In one of my discussions with the students, one of them said, "We don't have a reference". Do you understand the sentence? "We don't have a reference".

Dave: Yes.

Ami: The students said, “This evaluation methods are not similar to last year”. And then I said, "This is exactly what we want. We want you to have the skills to deal with new problems that you have not seen before. It's much harder, but in this sense, we prepare you better for real life and support better understanding and utilization of your knowledge.

## Resistance from Administrative Staff

Change leaders face such daunting odds that they often expect their longtime staff members to loyally follow them into the change trenches, but my own experience in several difficult change initiatives suggest that comfy staff members are among the most resistant change fighters, and loyal leaders are often hesitant to make necessary personnel changes in the face of frontal or passive-aggressive tactics by these individuals.  Listen to the following discussion.

Ami: The third group is administrative people. I was quite surprised by this resistance, but I guess it is clear from my talk by now that I effected a complete, dramatic change in all the processes in Afeka. Suddenly, a CEO from the hi-tech industry comes to a public organization, with a certain mode of work accompanied by a certain high level of energy. When I became President, I shifted the “organization energy level” to 100%, and not all administrative people were happy with it. They were used to a more relaxed working pace. As a natural process some of them left, but since we have been growing in the last three years we have hired many new people—a fact that helped change the organizational culture. We are experiencing a nice demand to study at Afeka. The student body have grown during the last four years by almost 35%, with an increase in the average admission grades. We used to be 2,300 students, and now we are 3,100.

Ami: Thus, several dozen people have left during the last four years because the new atmosphere and spirit didn't suit them.

Dave: Yes.

Ami: We set a new “working point” and gave the opportunity, tools, and support to everybody to adapt. While the majority moved forward with additional new hiring, some decided to leave due to various reasons.

Ami: I think that the current group is quite happy because you need to be very unique and to like the atmosphere in hi-tech, and now Afeka is in constant change and working through uncertainty. From my experience, there is a group of people to whom this mode of work doesn't fit. They want to be secure, they cannot handle changes, so these are the three resistance groups, and these are the three answers or the solutions provided.

This account of resistance is classic, and at ThreeJoy, we see it in all its richness in every change engagement. I asked Ami for any other insights, and he added one that was recognized early in iFoundry and continues to be important in all successful change initiatives, community.

Dave: This is a lovely account of resistance. What else would you like to add?

Ami: One last remark. With faculty, with all three groups, I have discovered something that I did not know at the beginning. If you group them in communities, you can make the change much easier.

Dave: Yes, beautiful insight.

Ami: In other words, the students are now working in clubs because they are together, and this social interaction gives comfort, support, and they see it’s everybody's challenge, so they are moving forward.

Ami: And then I was completely surprised that the same solution worked with the faculty. And now, we have communities, groups of 10 to 15 faculty members that meet every few weeks. One group talks about PBL, another group talks about flipped classes, and another group talks about problems and so forth.

Ami: We didn't plan it. You know by trial and error` we arrived at the situation in which students and faculty are working in groups and implementing the change together. We are providing the infrastructure and they are moving forward by themselves.

## Recapping Key Shifts Illustrated in the Conversation

I recall smiling after the interview as I reflected on its richness, and on all the things that President Moyal said. There are many different ways to make educational change, and many of them require adaptation for different cultures and circumstances, but it is interesting that there are key practices that guide effective leaders when they are successful. In ThreeJoy, we often speak of shifts in practice and here we recap some of the salient shifts in practice that came out in the conversation:

6. Shift from administration to leadership.
7. Shift from the status quo to an exciting and necessary adventure.
8. Shift from tech skill above all else to the centrality of shift (or soft) skill.
9. Shift from bullet points of a linear plan to a complex and engaging story of growth and change.
10. Shift from strategic plan as object to strategic plan as extended and ongoing conversation.
11. Shift from students as objects to students as persons (personae or profiles).
12. Shift from starting with courses and curriculum to starting outside the curriculum.
13. Shift from industry as outside of academia to bringing industry into the classroom as practical and necessary.
14. Shift from ignoring resistance to embracing resistance.
15. Shift from individuals as change agents to communities as change organizations.
16. Shift from Either-Or decision making to managing this pole AND that pole together (polarity management).

With regard to number 11, note that all 11 of the listed shifts are themselves polarities.

The process Ami described in the interview took place over four years, and Afeka is now on the threshold of moving into the danger zone of changing course content and curriculum. We conclude with some final thoughts on the keys to success for moving inside.

## Keys to Successful Curriculum Reform

There are many precursors to actual curriculum change and reform as evidenced from the Afeka example. Once the decision is made to move inside the curriculum, a number of shifts can aid effective, even transformative curriculum reform. We list six here:

1. Shift from changing everyone and everything to changing only those most ready to change.
2. Shift from one-shot planning to experience development using little bets in an incubator.
3. Shift from egotistical curriculum thinking (“just like mine”) to the 4 spirits of curriculum change.
4. Shift from what only faculty think is necessary to what all stakeholders like and wish about the current curriculum.
5. Shift from curriculum committee arm-wrestling to modern action frameworks.
6. Shift from shuffling courses and boxes to creating experiences and modifying architecture.

Each of these is briefly discussed in what follows.

Change those most ready to change. Change is usually done uniformly over a college or a school, but the first shift advocates only attempting transformative change with those who have an appetite for it or are otherwise under the gun for it.

Provide an incubator or locus for little bets on educational change. For others who are not quite ready to change inside the curriculum, Number 2 suggests forming an incubator (see Chapter 2 of WNE and the iFoundry story) for performing experiments of educational transformation. Doing it this way reduces the consequences of failure and also increases the chances that the success will be witnessed, which will then change some hearts and then minds.

From ego-based curriculum design to 4 spirits as a basis for evaluating change. A primary problem in curriculum change is that faculty members see their undergraduate education as the "ideal" curriculum and curriculum fights end up being little more than egotistical arm-wrestling contests or worse. Number 3 advocates starting the curriculum change process with what we call the 4 spirits of change: motivation, personae, polarities, and culture. By shifting to things that actually matter, curriculum fighting can become substantive rather than ego driven.

Getting a sense of what students, faculty, alums, and employers like and wish. It is also important to engage with faculty, staff, students, employers, and alums and find out what they value about the education of your unit and also to find out what they wish were different. At ThreeJoy, we use a number of prompts (oftentimes a simple, "I like" and "I wish" exercise) to tease out these things. This "data" can often be helpful during moments when faculty return to egotistical arm wrestling as the preferred mode of debate.

Use modern action frameworks and rigorous shift skills. Curriculum committees don't work because of the aforementioned NIMBY problem. At ThreeJoy we combine modern action frameworks such as agile methods + design thinking + 3J custom 5+1 shift skills training into a process with tight deadlines, definite assignments and surprisingly effective deliverables (we call this the 4 sprints process). This requires cooperation by the bulk of the faculty to be successful, but given that faculty often teach these methods, they are sometimes loathe to not walk the talk on hypocrisy grounds.

Move beyond boxes to experiences and architecture. Curriculum design often ends up being about filling the boxes with things quite similar to what is already being done. To make effective change first shift to thinking about courses as motivating or even transformative experiences. Next, realize that architectural shifts are among the most powerful to opening up possibilities and unclogging what appears to be an over-constrained system.

This description is an intentionally brief summary of some of the key ideas behind an effective process to move inside the curriculum and make transformative change. Make no mistake. This is a difficult challenge, but an effective process backed up by effective shift skills and appropriate architectural moves can lead to good outcomes.

## For More Information

ThreeJoy welcomes conversation-in-action (CIA) around these topics. Write to Dave Goldberg at deg@threejoy.com for CIA or to learn about 3J product and service offerings for educational change.

ThreeJoy ShiftPapers™ highlight practices at transformative schools around the globe worthy of study and emulation. The author, David E. Goldberg, is perhaps best known as an AI pioneer (genetic algorithms) and for his book, Genetic Algorithms in Search, Optimization, and Machine

Learning (Addison-Wesley, 1989) and his latest book *A Whole New Engineer*: The Coming Revolution in Engineering Education (ThreeJoy, 2014). In 2010, Dave resigned his tenure and distinguished professorship at the University of Illinois to work full time for the transformation of higher education. A trained leadership coach (Georgetown) and president of ThreeJoy Associates, a change leadership, training, and consulting firm in Douglas, MI., Dave works with an amazing cohort of change agents both in- and outside of his ThreeJoy Coaching Club. Contact Dave at deg@threejoy.com or sign up for an introductory strategy session at www.MeetWithDaveGoldberg.com.

## References

Afeka College (2019). Afeka College website. https://www.afeka.ac.il

ENG200 (2019). ENG200 website. http://eng200.eng.ufmg.br

Goldberg, D. E. (1996). "Change in Engineering Education: One Myth, Two Scenarios, and Three Foci". *Journal of Engineering Education*, 85(2), 107-116.

Goldberg, D. E. & Somerville, M. (2014). *A Whole New Engineer: The Coming Revolution in Engineering Education*. Douglas, MI: ThreeJoy.

Johnson, B. (1992). *Polarity Management: Identifying and Managing Unsolvable Problems*. Amherst, MA: HRD Press.

Sarasvathy, S. (2008). *What Makes Entrepreneurs Entrepreneurial* (Darden Case No UVA-ENT-0065). Charlottesville, VA: Darden Business School. https://www.effectuation.org/sites/default/files/research_papers/what-makes-entrepreneurs-entrepreneurial-sarasvathy_0.pdf

Senor, D. & Singer, S. (2009). *Start-up Nation: The Story of Israel's Economic Miracle*. New York: Twelve.

Sims, P. (2011). Little Bets: *How Breakthrough Ideas Emerge from Small Discoveries*. New York, Free Press.

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# Systems Engineering: Learning from the Boeing 737 MAX Crisis

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**The disasters that struck two Boeing 737 Max airplanes recently have had severe human and economic consequences. Examining the chain of events that led to them indicates a very questionable management by the Boeing company of the project of the new 737 model. A lot can be learned from this case regarding important emphases in systems engineering, in the areas of product reuse, documentation, modification management and development process planning. The disasters could have been prevented had the process been run under the PSI conceptual framework, which is now being studied and developed.**

## 1. Background – Boeing 737 Max Disasters

On October 29th 2018, a Boeing 737 MAX airplane belonging to Lion Air Company crashed about 12 minutes after takeoff, a disaster in which 189 passengers and crew perished. On March 10th 2019, an Ethiopian Airlines 737 Max crashed about 6 minutes after takeoff, killing 157 passengers and crew. These events prompted, within a few days, the grounding of all the 737 Max planes delivered so far to airlines and the cessation of deliveries of new aircrafts out of the production line.

The extent of the loss of human lives in the two disasters is stupendous, and I do not discuss it here. My aim is to examine these disasters from the perspective of systems engineering with its broad aspects – the technological one, of course, but also the human and the managerial ones. The thesis I propose is that developing a complex system requires a continuous balance of three factors: the nature of the problem or need to be solved (denoted by P for Problem), the stakeholders involved in the process and their capabilities (denoted by S for Social), and the way in which the subject is dealt with, including work processes, company structure, organizational culture and more (denoted by I for Institutional).[1] Imbalance between these factors leads to failure. A simple problem will not be solved if one tries to solve it with an army of people personnel and bureaucratic practices. In contrast, it is impossible to develop a plane with the methods of a startup company. Such claims seem obvious, but the fact that Boeing has failed in precisely such a balance, and the fact that many failures have been analyzed and can be explained and even improved in this way shows that the thesis is indeed valid.

1 Further information on the PSI framework, with which complex processes of systems development can be analyzed, can be read in the following sources: Subrahmanian E., Reich Y. and Krishnan, S. (2020). *We are Not Users: Dialogues, Diversity, and Design.* MIT Press, in press; Reich, Y. and Subrahmanian, E. (2017). "The PSI Matrix - A Framework and a Theory of Design". *ICED'17*, Vancouver, Canada; Reich, Y. & Subrahmanian, E. (2019). "The PSI Network Model for Studying Diverse Complex Design Scenarios". In *eProceedings of ICED'19*, Delft, Netherlands.

First, to understand the significance of the Boeing 737 MAX disasters, we will try to understand their economic implications for Boeing and its environment. We will then try to reconstruct the process of development that led to the failure of the aircraft and try to understand how a company like Boeing got into such a situation. Finally, I will analyze the case from the perspective of systems engineering.[2]

## 2. The Economic Impact of the Disasters

Both disasters have heavy economic implications for Boeing. These include at least the following: lawsuits by the victims' families, lawsuits by pilots for income losses, lawsuits by airlines with which contracts have been breached and to which flight-approved planes have not been provided, cancellation of future purchase contracts and cancellation of contracts with suppliers. Not all of these implications can be quantified today. Just to illustrate – Boeing lost 2.9 billion dollars in the second quarter of 2019, and another $4.9 billion are secured for compensation to airlines. Its inventories volume rose to $6 billion and the stock lost 25%. In the longer term, various airlines have announced that they may cancel purchasing contracts of 737 MAX and purchase Airbus aircraft instead. In addition, these events are likely to occupy Boeing in a way that harms the company's ability to engage in other major projects. For example, Boeing recently stopped working on the Pentagon's order for replacing nuclear missiles and postponed the development of new passenger aircraft. These are corollaries whose significance for the company is not yet known.

## 3. The Chain of Events that Led to the Disasters

The 737 Max project began after Airbus announced the improvement of its A320 model, a single-aisle plane used in many flight routes, by installing a new engine that would save about 15% of fuel consumption. The change should have been minimal so that no new pilot training would not be required except for a brief refresh. In fact, it had to "feel" like the old model. This issue is of the utmost importance for saving money and time. To compete with the new Airbus model, Boeing had to quickly embark on a similar project and succeed in bringing a new aircraft to market in the shortest time. This constraint has instilled in the company a sense of urgency that took priority over any other consideration, such as engineering quality, and even over product reliability.

At the beginning of the process, Boeing encountered a problem. The 737 is lower than the Airbus, so the new engine installed in the Airbus and destined for the Boeing, which is larger than the old engine, does not have enough clearance from the ground to be installed in the same location on the wing. The solution Boeing decided to adopt was to change the installation position with respect to the aircraft wing, a step that altered the aerodynamics of the aircraft including its balance and made it tend to raise its nose in extreme situations, including, sometimes, during takeoff. To make up for this, Boeing tested all kinds of unsuccessful solutions and finally added software program (called MCAS) that would enable the elevator to compensate that tendency and lower the aircraft's nose.

Seemingly, this is a series of changes (although we do not have information on all the other alternatives considered) with a logical plan of action which, if implemented correctly, might have led to a proper solution of the problem. What is the meaning of "correct implementation"? This means that the change that they want to make in the aircraft (the problem to be solved – P) will involve all the factors that it will

2 The current paper is not academic in the full sense and is not backed by many sources. In its writing, I relied on many sources on the Internet related to this subject, some of which are specified in the bibliographical list. Some of the numbers do not match between the sources, but the they are close enough. Anyone interested in more information can find it by running a simple web search of key words like 737max, MCAS etc.

influence (including the pilots, the Federal Aviation Authority – the FAA, and the airline representatives – S), and it will be carried out in an orderly and uncompromising process of system engineering (I); the purpose is to have an accurate balance between all these factors.

However, the plan's implementation was poor. The changes were partially implemented, incorrectly, by outsourcing parts of the software without adequate quality and operational checks. It is unclear whether this issue caused the disaster, but it reiterates the mistakes that Boeing made in outsourcing the Dreamliner project, which still carries losses of $25 billion.[3] In 737 Max, too, it was a choice between a cheap workforce and the use of skilled Boeing engineers who would do the job faster and better but at a higher cost. The system that was installed was not sufficiently tested as required by the modification. Furthermore, the planning submitted to the FAA for licensing was modified later during development to one that was worse for the pilots, but the documents submitted for licensing were not updated. If an experiment had been performed as required, as it was after the crash, it would have been clear that the system could not have been approved.

Boeing also did not notify the pilots of the change in the aircraft, and the FAA did not require re-licensing and/or fresh training for pilots. There was an expectation that in an emergency, the pilot would be on top of the situation, but the system was built in such a way that it could not be overcome. It was supposed to operate in 15-second rounds, where for 10 seconds it lowers the nose of the aircraft and in the remaining 5 seconds it is cut off, and that was when the pilot could intervene. However, after 5 seconds the system would regain control and not allow the pilot to act or even to understand what was happening. In fact, the aircraft was designed for failure in the event the problem occurs.

With the solution it created – an aircraft with a new engine and a system that supposedly automatically solves the problem without the need for pilot training – Boeing could match its offer to the airlines to that of Airbus. One can see how tempting the offer was and how much it disrupted the development process it necessitated by the fact that it quickly made the 737 Max Boeing's biggest success – sales of $200 billion even before the prototype production.

## 4. How Does a Company like Boeing Get into Such a Mire?

How can this event be explained? Considering Boeing's success in developing complex systems for many years, it must have had the skilled workforce with the knowledge to handle this challenge. The first explanation is human error. These do happen, but a mistake is not the cause in this case. The other explanation is unethical decision-making,[4] which results from a desire to cut short schedules even if the solution is not tested and is not reliable as standards require and does not involve or even disregards other stakeholders who bear some responsibility in this matter (the FAA and pilots). The Boeing Dreamliner project was also a financial failure because of the mismanagement of the development process, but it cannot be attributed to an ethical problem, at least not according to the information we have today. That failure revealed the difficulty of dealing with such significant economic challenges with adequate systems engineering. At the end of the Dreamliner project, Boeing seemed to change its development and production

3 On this issue and its analysis by means of the PSI framework, see: Reich, Y. & Subrahmanian, E. (2019). "The PSI Network Model for Studying Diverse Complex Design Scenarios". In *eProceedings of ICED'19*, Delft, Netherlands.

4 I use this concept rather that other concepts deliberately, since when a product is developed, where safety is the primary consideration, it is unthinkable to produce it with less than the utmost precision.

process to balance all PSI factors, but the 737 Max disasters prove that the change was not deep enough and not internalized properly in the organization.

## 5. Will Boeing Recover?

The dry statistics show that over the years, many large companies disappear, and others appear in their place. Kodak is a classic example of this, AT&T is another example and there are many others.[5] Will Boeing be part of that statistic? Boeing is likely to overcome these hurdles, if only since it is too significant an economic linchpin for the US economy, and it directly and indirectly employs approximately 1.5 million workers throughout the United States, being a military strategic asset as a major weapons manufacturer. But this stability of Boeing may not be the case for all its 13,600 suppliers in the US – some will probably go bankrupt.

## 6. What Can We Learn from Boeing's Functioning?

Much can be learned from Boeing's conduct. Some of the insights are clear. Realizing some of them would not have solved the problem by itself and perhaps it may not even be directly related to the disaster, but the spotlight directed at Boeing allows us to relearn some basic insights of systems engineering.

### 6.1 Reuse of New Development

When using an existing product for future development, one must keep in mind that the new product can be very different in its behavior from the old one. In order to realize such use, the product documentation must be accurate in order to avoid as much as possible the effects of a chain of changes that is never-ending and whose meaning is unclear. It is also possible that a small change will become a significant development project and not just a fix. Our case indicates that. This issue is related to a possible imbalance between the problem (P) and the development process (I).

### 6.2 Documentation

A derivative of the previous insight is the subject of documentation. In systems engineering, many topics must be documented: requirements, system architecture, analyses, testing, final product description and so on. A topic that lacks proper documentation is decision-making considerations and more importantly, the implementation of a problem-matching decision-making process. This can be seen in many examples of product development. In the current case, it is unclear even today exactly what considerations led to the existing solution in detail. With no significant documentation and a procedure for its testing, no one bothered, when a change was made to the MCAS software, to consider that the solution's meaning should be re-examined. This issue reflects a possible imbalance between the problem (P) and the development process (I).

### 6.3 Change Management

This insight is derived from the previous two. Any change in requirements, even the seemingly simplest one, is potentially an innovative project. In the history of engineering there are many instances where

5 The two examples I noted before exist today under the same name, but their activity is very limited compared to what they used to have, and their market value is negligible.

changing requirements has resulted in a situation exceeding the boundaries of knowledge and ending in failure. An example of this is the failure during the construction of the Quebec Bridge in Canada in 1907 that killed 75 workers who were on it. The bridge was built as a single beam with a span that was greater than what had been previously attempted and did not even hold its own weight. The change was a bigger span and the principle of the solution was no longer valid. Each change should be carefully managed while accurately analyzing the impact of it on the rest of the system. In many cases, the analysis must be not only logical but also computational, by running a simulation and even by examining a prototype. The reason is simple: complex systems feature the phenomenon of emergence of behaviors that are unpredictable without these measures. Another example can be seen in Section 2 above, which analyzes economic effects that expand in unknown ways.

Finally, it is important to note that in the concept of a system I include not only the technical system but the entire organization that develops the system, its suppliers and product operators and even its customers – we, the passengers. It is imperative to make them part of the simulation, thus ensuring that balance of the three factors of PSI.

### 6.4 Determining the Development Method Is Part of the System Engineering Process

Every project can and should use a development process that is appropriate to it. Because of the difficulty for the organization of being flexible enough and changing the development process dynamically, most organizations adapt some processes to several needs, such as a tender-response process, a new product-development process and a process of developing an existing product. The development process of the 737 Max version with its outsourcing seems to have been chosen because of incorrect budget constraints and it was not complemented by corresponding test operations. In fact, the whole process was lacking a proper inspection and licensing procedure, and therefore it failed to meet the safety requirements as it became known later. Had the development process been seriously considered as a system with requirements and properly developed, these problems would not have occurred. This issue also expresses an imbalance between all components of the PSI.[6]

## 7. How Can All This Be Combined Together?

Some of the above insights may seem simplistic to veteran systems engineers or project managers. But they must have seemed that way to the 787 Max project leaders or those of the Dreamliner project. However, the fact that they and a company like Boeing with its great human capital have failed more than once in the last twenty years shows that failure is possible and that it has tremendous implications. If we look at the reality of developing complex systems around us, we will realize that there are more failures than successes. If we used the right tools and problem-matching development processes and organizational capabilities, while balancing the PSI components, we would likely avoid failures as well as overcome many problems in existing projects, improving them even if we defined them as successful.

6 Anyone who wishes to study this issue in depth will find out that the imbalance occurs at a different conceptualization level of PSI – probably in matrix of network models of PSI.

## Bibliography (all sources accessed on September 3rd 2019):

"The Real Reason Boeing's New Plane Crashed Twice". Vox, April 15th 2019. https://www.youtube.com/watch?v=H2tuKiiznsY

"Terrifying Final Minutes of Doomed Boeing 737 Max". 60 Minutes Australia, May 6th 2019. https://www.youtube.com/watch?v=OxPsxmU_ocI

Dominic Gates (2019). "The Inside Story of MCAS: How Boeing's 737 MAX System Gained Power and Lost Safeguards". *Seattle Times*, June 22nd 2019, https://www.seattletimes.com/seattle-news/times-watchdog/the-inside-story-of-mcas-how-boeings-737-max-system-gained-power-and-lost-safeguards/

Peter Robison (2019). "Boeing's 737 Max Software Outsourced to $9-an-Hour Engineers". Bloomberg, June 28th 2019. https://www.bloomberg.com/news/articles/2019-06-28/boeing-s-737-max-software-outsourced-to-9-an-hour-engineers

Darryl Campbell (2019). "The Many Human Errors That Brought Down the Boeing 737". *The Verge*, May 2nd 2019. https://www.theverge.com/2019/5/2/18518176/boeing-737-max-crash-problems-human-error-mcas-faa

Ashley Holub (2019). "Boeing's 737 Max Crisis: Why the Medical Device Industry Should Care". *Medical Design and Outsourcing*, August 15th 2019. https://www.medicaldesignandoutsourcing.com/boeings-737-max-crisis-why-the-medical-device-industry-should-care/

# Wealth of Nations, or How to Re-Invent

Aviram Sariel

**Patents can help but they can also cause harm, and patents that remain unused can, apparently, only cause harm. This paper describes the latter harm, arising from patents that are not used at all, and several of its characteristics. Since these patents are numerous, and some of which can be quite useful, a scheme is proposed for their utilization, even and especially if their exclusivity has expired. This utilization, I argue, may have state-scale economic potential.**

1.

A few years ago, together with Daniel Mishori and Joseph Agassi, I published an article on a problem that we found in a theory of patents1 in an esteemed but nearly un-cited journal. Strangely enough, it was this about which we actually wrote. Our thesis was simple: Many patents succeed, reach the market, become products, and make the inventors and the intellectual property owners wealthy and the users happy, i.e., humanity gains. Yet a similar number of patents – about half – never reach the market and are heard of no more. They are abandoned by their inventors or the controlling interests, or fade away after the patent expires. In the latter case, they are nearly impossible to revive, as they have no protection against copies, rendering it very difficult to justify investment in their commercialization. Precisely because they are in the public domain, they belong to no one. We gave examples of such cases, the simplest being the electric car – which was invented before the internal combustion engine – and cannabis. In both these cases, the lack of exclusive rights reduced interest in commercialization of these products, so that until very recently, they were not available to us. The case of cannabis is even more complicated, as it was also illegal, so that states basically granted monopolies thereon to organized crime. Whatever the case, in the absence of exclusive commercialization rights, new enterprises struggle to succeed in the marketplace, as patents are the most important tool that we have to achieve exclusivity.

2.

Our thesis is also related to theory: It turns out that the idea of patents emerged as part of a historical process within which the European countries at the end of the Middle Ages and beginning of the

1. Sariel, Aviram, Daniel Mishori, and Joseph Agassi (2015). "The Re-Inventor's Dilemma: A Tragedy of the Public Domain". In *Journal of Intellectual Property Law & Practice*, 10.10: 759-766.

Renaissance actively sought and acquired the guilds' professional secrets. To do so, they conferred time-limited exclusivity to those willing to reveal the secrets, and thus succeeded in quickly conveying the secrets from the guilds to the entrepreneurs of the day. This process was based not on inventors' human rights, but rather on its value for the state: We have evidence from England of patents that were accepted on forks, which were in fact invented in Venice. Basically, the states robbed each other and the guilds, and accumulated wealth at the latter's expense. And when the secrets dried up, only one type of secret remained that could not be nationalized: new ideas. At a certain point, the guild members, or what was left in their wake – i.e., engineering – began approaching the entities that replaced the guilds, asking for the same protections for new, untested ideas.

3.

The inventors justified the need for protection, as without it, said the first documented inventor – Brunelleschi of Florence, who invented a sort of ferry – others would copy his idea. The city of Florence, which sought an efficient ferry, granted a three-year patent to Brunelleschi, and thus was the patent born: Power negotiations, wherein the inventors did not want to give away their ideas without healthy compensation in their bank accounts if their idea should succeed. The states tended to go along with this, as inventions cost them nothing and enriched their economies, which were far more important than Brunelleschi's ferry. Thus was born the patent process, via which the risk was taken by financial backers who hoped to see a quick enough return on their investments.

4.

With time, the process became far more sophisticated. By a certain point, a tendency had developed to view inventions as the rightful property of the inventors, but therein lay a flaw: Firstly, in terms of property, there is no need for patent laws as at hand is property whose copying is simply theft, no less. Such theft, however, while easily described, is hard to stop. Secondly, many claimed that the invention is first and foremost a social outcome, i.e., Brunelleschi did not invent the ferry, rather those who taught him riverboat design did so, and his contribution is no greater than theirs. In fact – and even though a search for "the inventive step" is part of the accepted discourse in patent law – it is difficult to find criteria that explain this step. Even today, we rest on patent examiners' "hunches".

Instead, an ingenious argument was raised, perhaps the inventors should not have rights to the patent in principle, but they might be the best managers of their own applications. According to this idea, social welfare dictates that the inventors must hold the rights to commercialization of their inventions, not because Steve Jobs invented the round-cornered smartphone, but because he brought high revenues into state coffers thereby (this was actually the case: Apple succeeded in convincing the public that it owned the rights to the round-cornered mobile phone). The ability to commercialize an invention, it is argued, is inextricably entwined with the ability to imagine and invent it: Whoever does not believe in people's rights to round-cornered phones hasn't paid attention to the fact that other phones had sharp corners; and does not know the market for round-cornered phones. Instead, we should grant the inventor the right to commercialize the patent on her invention. The meaning thereof is that society looks for good commercialization managers and finds them mainly among inventors and their immediate environment. "Their immediate environment", as the argument was quickly generalized to a comprehensive structure, which depends upon the management acuity of the organization that employs the inventors and finances them. Thus, the social welfare argument in fact justifies the legal and commercial structure of what we call “commercial rights” today; and for other reasons entirely, justifies those who viewed the invention as a type of property owing to the inventive step. Thus, if the inventor works at a faculty of engineering, the rights belong to the university; if at a company, the rights belong to the company. These entities are considered the inventors in a general sense, as this view regards them as especially successful managers – of inventions.

5.

Thus, society’s right is actually an obligation to profit from a classic, capitalist structure. Social welfare theory states that the good of all is what demands giving inventors, their employers, their investors, and their partners the exclusive right to use their inventions, which patent examiners believe to be new and to be acting as described in the documentation of the invention, and so on and so forth. The examiners have several criteria therefor.

6.

Here is where our story begins: We found a critical point that arises from patent theory: Ownership of an invention is not a basic human right that states must uphold, but rather a utilitarian transaction, which perhaps shares its name with human rights, but it is different from them. This interaction is good, and it yields the most impressive and enriching thing in the world: progress. Therefore, we proposed that the state execute it more than once for every idea, i.e., that the state also act to commercialize patents that the inventors, investors, and partners may have failed to commercialize.

7.

Toward this end, we asked what happens when these excellent managers don’t succeed. According to the naïve reply, expired patents are available to anyone interested, and therefore are of course exploited perfectly by a perfect market. The less naïve reply is that the entire patent structure necessarily exists in a free market. In fact, in a market that is not free, patents don’t even make sense: If one political party or monarch or other entity controls a state’s economy, that entity controls not only every idea that reaches the market and its management, but it also has low motivation to market new products to replace old, revenue-yielding ones.[2]

8.

While the patent system is a kind of clever intervention in free market processes, it is an intervention that assumes that without investors, engineers, and managers, there will be no products, and therefore we must ensure their existence. And among all of these players, the investors are capitalists, i.e., they are characterized by the desire to see a return on their risky investment in a product not currently in the marketplace (note: Our discussion addresses nascent ideas for products that have not yet reached the market, or those that have exited the marketplace, and so forth: If the idea materializes into an available product, it lies outside the scope of our analysis).

Without a patent, prospective investors will be less likely to invest in a new idea that could fail. Also,

2. Arrow, Kenneth Joseph (1972). “Economic Welfare and the Allocation of Resources for Invention”. In *Readings in Industrial Economics*. London: Palgrave, pp. 219-236.

we argued, investors will be even less likely to invest in an old idea that hasn't been tested, i.e., an expired patent. Therefore, even if 20 years have passed since a patent's registration and the idea behind it has suddenly become relevant, there is no chance that funding will be raised therefor. If you know of a plant the smoking of which creates similar effects to those of alcohol, yet the former cannot be patented, you won't find investors who will wage your cannabis wars for you. And if you think of an electric car (full disclosure: I own two), you won't be able to convince car dealers in Israel to go forward with it, despite the fact that they know quite well the size of the market and how Israel is perfect for electric cars, and how little infrastructure is needed to drive from Tel Aviv to Eilat. But they also know that the moment electric cars start to sell, there'll be heavy competition.

Entrepreneurship is harder in the absence of exclusivity, and it's no coincidence that countries are compelled to push automakers forcefully to start producing electric cars: In the absence of a patent, the first company to dare to do so will become a test case for all the rest, who will then compete with it. Therefore, electric cars had to wait until an eccentric, wealthy, and especially sharp investor appears – Elon Musk – and for legislation that compelled automakers to introduce changes, largely against the wishes of their managements. Only when the climate catastrophe joined forces with a hostile media in the best sense of the word and to soaring fuel costs, did electric cars resurface. It's not the way we would've chosen for it to happen, i.e., 200 years after the first electric car was driven (yes, you read that correctly: 200).

9.

Therefore, we contended, there are entire domains of technology whose early commercialization failure simply prevented them from reaching the public. We hear of them mainly when they offer long-term advantages – such as electric cars or cannabis – that attract the interest of engineers, and that accordingly frustrate entrepreneurs. Another example thereof is the external-combustion or Stirling engine, which was invented over 200 years ago, and whose patents now lie in the public domain. Almost no one uses these to produce electricity or locomotion from simple fires, even though they are capable of doing so efficiently. The reason therefor, as far as can be seen online from frustrated reports of well-intentioned engineers, is that investors won't invest in them, as there is not and cannot be a patent therefor. The Sharav Sluices invented by the Technion's Dan Zaslavsky – kilometer-high towers that produce energy from the sun – are in the same state of affairs: Their patent has expired. While the towers were invented 20 and not 200 years ago, there is not and cannot be any commercial interest in them, despite the fact that if alternative energy devices fail, it is not due to Zaslavsky's lack of talent in gaining investors' interest, but rather due to world fuel prices, which have fallen, if only temporarily.

10.

Our overall claim is totally general, and as far as can be seen, nearly unaddressed. We say nearly, as there were and still are precedents that appear to have offered a partial solution to the paradox of re-invention: When patenting arose, it was a concession that a state could confer, even if the invention was already acknowledged elsewhere. In certain places, e.g., Germany in the 19th and early 20th centuries, a new concession could be obtained – i.e., re-invention – for a product registered under a patent but that had not reached the market. There were countries, including industrialized countries such as Switzerland, that ratified the patent treaties very late in the game, and meanwhile built an industrial sector that contemned the patent treaties, and thus excelled at the revival of old ideas, usually by means of production via new methods.

In recent decades, East Asia – particularly China, but not only – adopted a flexible approach to patents: Usually, countries that did so were also adept at enforcing unpatented concessions granted to cronies, and they were also usually adept at putting older ideas to use (hence, it seems, China excels at electric car manufacturing). But generally, these countries have tended to ultimately join international treaties, and the further globalization advances, the fewer locales deal with patents in this way: a kind of state-level delinquency… and this is for the better. But on the other hand, these locales also cease to be enclaves in which expired patents can be reactivated.

11.

And there's more: Patents are tested not only against other registered patents, but also against combinations of registered patents. Thus, if you invented a quad ATV with a Stirling engine, don't even bother: The examiners will claim – justifiably – that your invention is no more than a combination of two ideas, a quad ATV and a Stirling engine. They'll reject your application outright, and you can forget starting to raise funding.

The same applies to someone who wants to invent a tank top fitted with sensors that track the wearer's spinal cord condition and her movement in space: great for yoga, combat, and physiotherapy. Yet its patent application will be rejected, as the tank top was invented long ago, as were sensors. The same goes for eyeglasses each of whose lenses is designed for a different activity, i.e., one for close reading and the other for distant reading, as the brain is accordingly able to coordinate both eyes efficiently. The technical specifications therefor were invented long ago and called "monovision"; ask your optometrist how much cheaper they are than progressive lenses, and how much wider the wearer's field of vision is with monovision.

In all of the aforementioned examples, which constitute entire families of technologies with "offspring" from two or more "parents", a heavy constraint has been imposed upon technological initiative: While not becoming impossible, it absolutely becomes harder. For example, the basic technology for force-extracting fuel from oil shale, or fracking, has existed for a long time and could have been used beneficially if it had been exploited earlier. But only when fuel prices went through the ceiling did it become worth it to the Americans to develop the idea, which has led the US toward energy independence.

12.

Wait: There's more: There are also patents drafted explicitly to block competition, and which are not at all aimed at reaching the market: Companies produce them, register them, and trade in them. But at no stage are such patents – called "blocking patents" – representing at least a tenth of all patents worldwide, intended to be realized, for the benefit of the society that enacted the patent laws and enforces them. Note that blocking patents are ideas that a commercial company believes may result in strong competition to the products that it makes – products that are already on the market, likely because they are protected by an older patent, and have already taken in big investments in their production, marketing, and complex branding. And in order to prevent such competition, companies invest in superb R&D personnel who invest their time in creating ideas that will never see the light of day. Throughout the patent period, these ideas never become products, as they are protected by patents held by that company, and after their patents expire – see above – they have zero chance of justifying financial backing by investors.

13.

The damage that this situation causes is great, particularly in what we call “older technologies”, or those that can do something that’s already done, better, at lower cost, and most importantly, at less harm to our planet. In other words, patents reflect technologies that compete in the free market, a few of which have short-term advantages that suit their era. These are the technologies that win out, owing to the resources invested in them by stakeholders who are protected by patents. Inter alia, stakeholders make sure to hide the technology’s drawbacks or its dangers. Other technologies have short-term drawbacks, and some, most interestingly, have long-term advantages. By these I don’t mean staying power yet a slow pace, like the fabled tortoise, but rather a big advantage that is only seen in retrospect. In the present moment, electric cars are the hare, while automobiles that run on internal combustion appear to be sliding; under present circumstances, cannabis is being resurrected as a legal commercial industry, hotter than the lit end of a joint; at this very moment, there’s a sugar substitute called Mannitol that appears to have properties that can prevent Parkinson’s. Like the Stirling engine, Mannitol was invented over 200 years ago, and like the Stirling there is no way on God’s green earth to obtain a patent for it. Only a short time ago, it emerged that Mannitol has the ability to slow the clumping of proteins in the brain, the main cause of that disease. But because there is no patent for it, and none is foreseen, it is difficult to interest pharmaceutical companies in conducting clinical trials on Mannitol. The only thing such trials could achieve is a slight rise in sales of a sweetener that someone else produces. If Teva Pharmaceuticals could be granted the rights to Mannitol, those rights could lead it to backing the clinical trials needed to advance it as a medication.

14.

Mannitol is a complicated case, as there are producers, marketers, and a market for artificial sweeteners that will demand compensation if their product is “snatched” by pharma and its manufacture blocked by exclusive concessions. We decided to address a more ideal case to present a possible solution: We propose forming a standing committee to re-commercialize existing inventions, or those that are not patentable even though they are not in any market. Such a committee would act on two levels: Firstly, it would identify technologies and inventions that are errantly imprisoned under the classification “the public domain”, which presently constitutes nothing more than a black hole for ideas. From among these, the committee would choose ideas that it deems worth commercializing, and act to find appropriate entities to manage the asset alongside granting them time-limited exclusivity, just like regular patents.

Secondly, the committee would be open to entrepreneurs that would themselves, fueled by their own creativity and profit-seeking, identify ideas that despite their having been in the public domain for years, are revivable, such as fracking and electric cars. The committee would re-grant time-limited exclusivity to such entrepreneurs, who would find existing ideas that are not on the market and demonstrate why it is worth reintroducing them.

15.

These are the principles of a solution, but not the full solution: We stated the problem and the theoretical structures that created it, but not the legislation thereof. Two important issues remain, regarding the rough-sketch outline. One is that this outline could be used as social capital granted to weak populations: Do residents of outlying areas need income? Grant them a concession on Mannitol. Let them close the deal with Teva, Kamada, or CTS Group; or market Mannitol themselves. The ultra-Orthodox sector lives under the poverty line; will they really benefit from exposure to high-tech? Let's give it the concession to sell the relevant architecture of digital processers that Intel for some reason chose to bury (and they do exist).

16.

The other issue – and perhaps the most important of all – is that such a committee could be very profitable to the state and to society, particularly for the first country to form one, which will rush to use old inventions as a foundation for a new industry. Activating an idea – even in only one country – could procure it fast, inexpensive access to the best alternative technologies developed in the past, the use of which would save and divert resources (fuel, for example, as aforementioned), and could help to formulate solutions whose cost would be prohibitive otherwise, if they are feasible at all (Sharav Sluices; preventing Parkinson's). In particular, restoring inventions to their former glory could better use the most important source that we have for human richness. In order to do so, what is needed is mainly legislators who are keen to pass laws, and the decision to conduct a cautious, well-managed pilot. In a refreshing change, money doesn't even enter the picture.

# Economic Policy and the Welfare State

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**The modern welfare state is a mix of two opposing perspectives. As a result, economic policy makers in Israel face a constant challenge of balancing opposing ends, hence they are also always subject to criticism. The purpose of this article is to outline the challenge of formulating economic policy in a welfare state. This would imply that government investment in civilian R&D in the State of Israel constitutes a justified investment in this economic sector.**

The modern welfare state is a mixed of two opposing perspectives – Capitalism and Socialism. As a result, economic policy makers in Israel face a constant challenge of balancing opposing ends, hence they are also always subject to criticism from both left and right conflicting political sides in the parliament as well as in the media and the general public. This arise with every action, or avoidance of action, by those who, based on their ideology, interpret economic decisions as contradicting their fundamental values. The purpose of this article is to outline the challenge of formulating economic policy in a welfare state, and to claim that the public discourse in Israel on economic issues requires broad-minded thinking of, among others, politicians, economists, NGO's, economic press and the business community.

The term Capitalism rests on the Latin word Caput, which means "head". Thus, Capitalists apprehend human society as a group of "heads", meaning individuals that leave together in groups for means of security and convenience. Accordingly, John Locke, the 17th century English philosopher, argues, in his "Second Treatise on Government" that "no one can be subjected to the political power of another without his own consent, which is done by agreeing with other men, to join and unite into a community for their comfortable, safe, and peaceable living, one amongst another, in a secure enjoyment of their properties, and a greater security against any that are not of it" (Second Treatise, Ch. 8, Sec. 95).

The person at the core of Locke's thinking is an individual because he is indivisible, meaning it is a unity of existence, a Being which is independent of other individuals (in Latin the word Individual is translated Singula). Therefore, he is also a free creature and has sovereignty over his life. Locke claims that in the State of Nature, namely with no political power controlling them, men are in "a state of perfect freedom to order their actions, and dispose of their possessions and persons as they think fit… without asking leave or depending upon the will of any other man" (Second Treatise, Ch. 2, Sec. 4.). Accordingly, he adds, since liberty is a right conferred on every individual, equality is a central value we all must hold. In his own words, the State of Nature is "A state also of equality, wherein all the power and jurisdiction is reciprocal, no one having more than another, there being nothing more evident than that creatures of the same species and rank, promiscuously born to all the same advantages of Nature, and the use of the same faculties, should also be equal one amongst another, without subordination or subjection" (ibid.). In another place he simply says that men "by nature all free, equal, and independent" (Second Treatise, Ch. 2, Sec. 21).

Based on what has been said, Locke argues, the state is founded when every individual freely decides to join a social contracts in which he hands over the right to enact laws, and the power to enforce them, to a central government: "The liberty of man in society is to be under no other legislative power but that established by consent in the commonwealth, nor under the dominion of any will, or restraint of any law, but what that legislative shall enact according to the trust put in it" (ibid.). However, by consenting to live under a political state, man, that now become citizens, does not allow its representatives to act arbitrarily. First, Locke argues, the laws that the state legislates should reflect the Law of Nature. It means that political law is always limited by morality, namely, in Locke's perspective, it is the elaboration of God's commandments.

Secondly, state authorities are confined to the minimum intervention necessary for keeping individual liberties, since only for the purpose of security man had limit their natural liberties when they joined the social contract. Accordingly, in his "A Letter Concerning Toleration" Locke defines "The commonwealth seems to me to be a society of men constituted only for the procuring, preserving, and advancing their own civil interests" (Toleration, p. 9). In civil interests, Locke includes "life, liberty, health, and indulgency of body; and the possession of outward things, such as money, lands, houses, furniture, and the like" (ibid.). Thus, in the context of this article, it is important to emphasize that the state should not intervene in its citizens' health, education, welfare, religion, etc. If it will do so it will violate their liberties.

Now we can see that from individualism we inevitably drew liberalism and coherently run to capitalism. Meaning, everyone, every individual decides freely what to do with his own life, and what efforts to make in order to earn a living. Consequently, he has propriety rights over the fruits of his labor, which are the product of his own talents and personal choices. According to Locke, since nature was given to all humankind in common, "man (by being master of himself, and proprietor of his own person, and the actions or labor of it) had still in himself the great foundation of property; and that which made up the great part of what he applied to the support or comfort of his being, when invention and arts had improved the conveniences of life, was perfectly his own, and did not belong in common to others" (Second Treatise, Ch. 5, Sec. 44).

Consistent with the idea of property rights, the state cannot put its brutal hand in its citizens' pockets. State tax revenues should be the minimal amount that is necessary in order to provide security for its citizens. Moreover, the state cannot suspend unequal taxes, not even taxes that are in proportion to one's income, simply because it did not contribute to the efforts made by the individual who earn it. The state, according to this line of thinking, should not, absolutely, suspend progressive tax because it will only aggravate injustice. The rightful tax policy under pure and coherent capitalism can only be a kind of skull tax, namely equal amount for every citizen regardless of its wealth. It certainly should not try to balance economic inequality by putting its hands into one's pocket in order to fund services for another citizen who cannot afford it.

To conclude, not surprisingly, Locke is known as the founder of liberalism, and his thinking has had a significant influence on the ethos of the world's largest economic power, the United States of America. Locke's claims that "The natural liberty of man is to be free from any superior power on earth, and not to be under the will or legislative authority of man, but to have only the law of Nature for his rule" (Second Treatise, Ch. 4, Sec. 21). These ideas, i.e., individualism, liberty, principle of equality, property rights, religious tolerance, the right to bear arms and the trust in God printed on the dollar bill, are all fundamental to the American constitution that was formulized about a century after Locke had published his writings.

The liberal conception of the state in Locke's thought has found its economic formulation a century later in another book published in Britain. This time it was a British philosopher of Scottish descent, named Adam Smith. Smith, who is known as the founder of modern economics, argued in his book "An Inquiry into the Nature and Causes of the Wealth of Nations", that in free economics, individuals pursue only their interests: "It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest" (Wealth of Nations, B. 1, Ch. 2, p. 19). However, the actions of individuals who are motivated by self-interest results with the help of an "invisible hand" unintended social benefits. Smith's free market forces bring the economy to equilibrium where buyers' considerations, relative to the quality of the products, their price and quantity, meet with sellers' interests.

The state's regulatory intervention, by this logic, should be minimalist also, and its aim is only to ensure free competition. Therefore, the state must not intervene and change market conditions in a way that benefits neither demand nor supply in any aspect of the economy. This kind of intervention artificially influences the equilibrium, benefits with certain individuals and impairs the capabilities of others. This means that the concern for the individual interest, paradoxically, creates an increase in general good. When, for example, a manufacturer strives to improve the quality of its products and lower its prices to the consumer, it does so to increase its profits, whereas when a consumer insists on buying high-quality and low-cost products, he cares for his own money but also drives the business system to become more efficient and better. In Smith's words:

"By preferring the support of domestic to that of foreign industry, he intends only his own security; and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for the society that it was no part of it. By pursuing his own interest, he frequently promotes that of the society more effectually than when he really intends to promote it" (Wealth of Nations, B. 4, Ch. 2, pp. 488-489).

Upon this, Smith concludes that the state's regulatory intervention should be minimal, which means that the role of the regulator should ensure the conditions for free competition and free market. This means that the state must not intervene and change market conditions in a way that is favorable neither demand nor supply. This kind of intervention will artificially tilt the equilibrium, benefit some individuals while impairing the economic capabilities of other individuals, and, more severely, harm the overall welfare of the economy:

"The statesman who should attempt to direct people in what manner they ought to employ their capitals, would not only load himself with a most unnecessary attention, but assume an authority which could safely be trusted, not only to no single person, but to no council or senate whatever, and which would nowhere be so dangerous as in the hands of a man who had folly and presumption enough to fancy himself fit to exercise it" (ibid.).

We see now how the metaphysical point of departure, claiming the mere existence of individuals, leads to a liberal ethical stance and a capitalist economy. In accordance, the form of government logically drawn from this line of thinking is democracy. Whether representative or direct, in democracy the individuals determine the laws according to which the society will leave. It is important to emphasize that democracy does not mean arbitrary legislation relative to political power in Parliament. Rather, Democracy is a form of government that encourage free discussion that creates pluralistic society and law system aiming in pursuing Justice and Truth.

Two hundred years after Locke's Second Treatise, and about 100 years after Smith's Wealth of Nations, Karl Marx, a German Jew who settled in the British capital, published his book titled "Critique of Political Economy". In the book, known as The Capital after its German title Das Kapital, Marx characterized and criticized capitalism. The basis of Marx's criticism is a frontal attack on the idea of Caput, that is, on the claim that every individual is a self-contained entity, an individual that is independent of other individuals. According to this view, humans do not spend their lives cut off from other humans, but they always live in social settings. This is not for practical reasons but for essential ones. The individual, alternately, is an expression of the society in which it lives, and without which it does not really exist. If the capitalist refers to human society as a group of "heads", the socialist refers to the human individuals as "organs" of society. Marx own words are: "Human nature is not an abstraction inherent in the isolated individual. In its reality it is the network of social relations" (Sixth Thesis on Feuerbach).

This, of course, is the meaning of the term socialism, which implies a substantial, ontological, priority of society over its individuals. For example, let us consider a group of ten people who find themselves on a desert island. In this hypothetical situation, the mental and physical survival of everyone depends on the existence of the entire group. If one of the individuals in the group loses his way, he is likely to lose his sanity as well, and in fact, his humanity will fade away. Clearly, such individual would have difficulty in surviving the physical conditions of a detached and isolated existence. Clearly, the socialist would claim, society allows and promotes the existence of the individual, and so values of liberty and private property become insignificant and artificial, and, in the worst case, false norms that form the basis for exploitation and extortion.

It is completely acceptable, the socialist argues, that a small group dealing with the challenges of existence will ask each individual to exercise his or her skills for the benefit of everyone. Liberty, in this, context means the ability to act as a group rather than being lost as a detached individual. Hence, the fundamental value of socialism is Work; that is a diligent exercise of the skills of each individual for the benefit of the whole group. Of course, all the resources that the group has created, as a group, belong to everyone in common, meaning that the property is public rather than private. This is the meaning of Marx's well-known phrase, "From each according to his ability, to each according to his needs" (Critique of the Gotha Program); the tasks in a social society are divided according to skills and qualifications, and the resources according to needs.

The political system that fit the capitalism, under this view, is nothing more than "organized power of one class for the suppression of another class" (The Communist Manifesto, Ch. 2). Furthermore, democratic elections are nothing but a situation where "the oppressed are allowed once in a number of years to decide these specific representatives of the oppressed class to represent and oppress them" (ibid.). A socialist might argue that people that were born in a capitalist economy might take it for a fact that in a right social order the few enslave the majority. Marx argued in the preface of his book A Contribution to the Critique of Political Economy that "it is not the consciousness of men that determines their existence but their social existence that determines their consciousness". Throughout history there have always been those who have tried to change the political situation. In preface to the 1883 German edition to The Communist Manifesto Engels argues that Marx's thought that "all history has been a history of class struggles, of struggles between exploited and exploiting, between dominated and dominating classes at various stages of social evolution".

These socialist ideas were realized, politically and economically, in the USSR. The state's role under the communist view was to create a system of central government that will manage the division of labor efficiently, and, on the other hand, manage the use of resources according to the needs. Needless to say, in capitalist terms, the communist state is in fact taxing 100% of every individual work value and provides everyone with basic leaving needs. On the other side, in communist terms, the capitalist state allows some individuals to accumulate wealth at the expense of others, by allegedly keeping the markets free, while not caring to people's welfare.

Both the capitalist view and the socialist view failed the reality test. Today, there is no single country that consistently and fully fulfills the principles of capitalism, and the USSR, the bravest realization of the principles of socialism, collapsed as is well known in the mid-1990s. The cause of failure, in both cases, lies in the attempt to force reality into a definitive conceptual point of departure, and equally important, drawing coherent conclusions from it. Reality has taught us that society is more than a group of individuals, and that every individual is more than an expression of the society in which he lives. Therefore, during the 20th century, the logical dichotomy of "individuals or society", was replaced by the idea that we are both; namely that we are both "individuals and parts of society", and that each aspect is indispensable. Thus, society and man have a mutual essential dependence.

This is the conceptual foundation of the welfare state, the logic of the paradox. Whereby between the individual and the society there is a constant dynamic of benefit and assistance. In his youth, the individual relies on social services and infrastructure to develop and acquire skills, later in life society relies on its mature individuals' productivity and economic contributions. At an older age, the wheel flips and the individual in turn leans on society to sustain itself well. This dynamic is also happening under the possibility that some individuals will contribute to the development of society much more than they benefit from its services, while others will get more assistance from the society than they can contribute to it.

However, it is precisely this dynamic of the changing relationship between the individual and society that becomes a challenge in shaping sustainable economic policies. For example, if we emphasize the socialist aspect of the welfare state, we could lose grip on the spending side of the state budget, and further reduce productivity due to the need to increase the tax burden to finance these expenses. On the other hand, if we emphasize the capitalist aspect, we can create socio-economic inequalities where weak groups in society fail to produce enough market value covering the costs of essential living conditions, neither through their actions in the free market, nor through social security. Therefore, sustainable economic policy is a challenge of balance between the individual and the social, and hence it is always subject to criticism from both sides, the socialist and the capitalist one's.

A balanced criterion for economic policy in the welfare state can be found in the book written by the American philosopher John Rawls. The book was published in 1971 and titled "Theory of Justice". Rawls criticizes the socialist stance because it diminishes individual freedoms in favor of social considerations. According to him, "Therefore in a just society the liberties of equal citizenship are taken as settled; the rights secured by justice are not subject to political bargaining or to the calculus of social interests" (Theory of Justice, pp. 3-4). In addition, and in accordance with the capitalist point of view, Rawls argues, "justice denies that the loss of freedom for some is made right by a greater good shared by others. It does not allow that the sacrifices imposed on a few are outweighed by the larger sum of advantages enjoyed by many" (ibid.). However, a fair society, Rawls claimed, could not agree with a situation in which some people are unable achieve basic living conditions while others are living in extreme wealth. His words are: "All social values—liberty and opportunity, income and wealth, and the social bases of self-respect—are to be distributed equally" (Theory of Justice, p. 54).

It can therefore be said that Rawls's approach, which he called "justice as fairness", seems to seek the balance between capitalism and socialism, and to extract from both the aspects that seem positive. To this end, Rawls lays down two fundamental principles for a vital and just society. The first principle is called "liberty principal", and it expresses the idea that all people have equal rights, and no one has rights with which he could restrict the freedom of others. However, despite this first principle of equal rights, sometimes, in realty, unequal outcomes might develop. This kind of inequality is justifiable if it benefits everyone and especially with the weakened people in society. This way of balancing inequality is the second principle of Rawls theory and it calls it the "difference principal".

Of course, these two principles can be criticized by both sides of the conceptual barricade. On the one hand, it can be argued that the principle of liberty should not be violated by the principle of difference. For example, some people are naturally gifted then others and it is not legitimate to do something in order to balance the situation by progressive taxation that might be justified by the difference principle. On the other hand, some would argue that the principle of liberty presents a distorted picture in which every individual can use social resources equally. In other words, according to the latter, the principle of freedom never exists in the free market society.

The State of Israel is a country where its citizens live in equal rights. Without ignoring public criticism in this regard, it can be said with confidence that Israel is implementing the liberty principle. However, we cannot deny inequalities in various areas in Israeli society. Despite the significant improvement in recent decades in the Israeli economy, as low unemployment rate and the increase of average income, many still cannot afford proper housing, suffer from overloaded public health system and faces difficulties in a struggling public education system. On the other hand, tax rates in Israel are high and 90% of it is collected from of the top twenty percent of the income scale, that means that the tax burden lies on the shoulders of a small part of the Israeli population.

In this state of affairs, any change in economic policy is subjected to harsh criticism. Economists who believe in the application of economic theories for the growth of the Israeli economy, and its integration into the global village, protest publicly when social decisions contradicts principles of the free market. In contrast, welfare organizations, environmental NGO's, workers' unions, consumer associations and others, who seek to draw our attention to difficult aspects of the Israeli economy, cry out when needed economic decisions are taken on the expense of social services, or when they are taken in order to relief regulation imposed on the business community.

This two-pronged criticism is a price we must pay if we try to formulate economic policies within a welfare state governing social democratic society. Israeli society is a pluralistic society, a melting pot of different opinions and attitudes, in which we are all genuinely concern to its success. Therefore, the challenge of economic policymakers requires keeping an attentive ear to the voices coming from the Israeli people, and it also requires determination and composure to manage dynamic inequality as a necessary feature of the welfare state. As explained above, this inequality will be justified as long as it adheres to the limits of the difference principle of Rawls, meaning that it will be a kind of inequality that contributes to and benefits the entire society and especially to the weakened population.

In particular, it can be argued that the allocation of national resources for the financing of civilian R&D in the Israeli economy is based on the principle of difference. According to the Israeli Central Bureau of Statistics, national expenditure on civilian R&D amounted to 57.8 billion NIS in 2017. In terms of GDP, in Israel the allocation of resources to this field was the highest among OECD member states for 2017. However, this figure was mainly influenced by high concentration of multinational companies' development centers in Israel, and less by a government investment. We can see that government's priorities have not changed in the last ten years, though government ministries investments in the promotion of general knowledge increased by about 50% during that period, and the rate devoted to the development of industrial technologies was consistently about 30%.

## Bibliography

Karl Marx (2002), [1845], *Theses on Feuerbach*, Marxists Internet Archive.

Karl Marx, Friedrich Engels (2004) [1848]. *Manifesto of the Communist Party*. Marxists Internet Archive.

Locke, John, *A Letter Concerning Toleration*, in Locke, John, *The Works of John Locke: A New Edition, Corrected, 10 vols., Alaen, 1963, (repr. of London, 1823), v. 6.*

*Locke, John, Two Treatises of Government*, Lalett, P. (ed), Cambridge: Cambridge University Press, 1960.

Marx, Engels, Lenin, Dutt, Engels, Friedrich, Lenin, Vladimir Il'ich, . . . Institut Marksa-Engel'sa-Lenina. (1938). *Critique of the Gotha programme*. New York: International.

Marx, Karl (1867). *Das Kapital: Kritik der politischen Oekonomie*. Volume 1: Der Produktionsprozess des Kapitals (1 ed.). Hamburg: Verlag von Otto Meissner.

Rawls, J. (1999). *A theory of justice* (Rev. ed.). Cambridge, Mass.: The Belknap Press of the Harvard University Press.

Smith, A., Cannan, E., & Teichgraeber, R. (1985). *An inquiry into the nature and causes of the wealth of nations* (1st ed., Modern Library college editions). New York, N.Y.: Random House.

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