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The Myth and the Meaning of Science as a Vocation

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1. Introduction

The philosophy of science has been too concerned with the question of *how* we generate knowledge in the sciences and not concerned enough with the consequences of the *fact* that we know quite well how to change our material world and our lives by using science. Indeed, science is the ultimate power in the material world because it is the foundation of modem technology, engineering, industries, and the economy of developed nations. Through its creation of knowledge of physical material, the scientific method (Popper 1959) has enabled the implementation of the civilized world, transforming the entirety of human life: housing, clothing, culture, transportation, maneuvers of war, agriculture, and medicine. The directions of scientific research and the consequences of successful or unsuccessful science are of paramount importance for nations and continental communities. Science is not only a method of thinking, or a structured investigation of the world in order to conceptualize it in a unified and consistent manner; science is also a mechanism of increasing the power of a person or group (i.e. that group's ability to act effectively upon objects, human or otherwise), and this is what is fundamental about science today. The knowledge obtained by science is a mechanistic knowledge that is always primarily concerned with information that can be employed by industries or governments to produce specific products, services, or actions. Politicians, industrialists, insurgents, and philosophers, cannot and will not ignore scientists and their activity, since the existence of the former categories thoroughly depend upon the activities of science. Once we are fully aware that science can overcome difficulties and change aspects of our world, the preeminent question becomes: what is it imperative to change first, and how are we to set this project in motion? With the realized power of science and technology, the old mythology of the scientist is dead, and the vocation must redefine its ethos as a path to meaning with the aid of moral philosophy.

Many natural scientists of the past and the present have imagined that they pursued their activity according to its own inherent rules in a realm distinctly separate from the business world, or at least in a realm where business tended to interfere with science from time to time, but was not ultimately an essential component, 'because one thought that in science one possessed and loved something unselfish, harmless, self-sufficient, and truly innocent, in which man's evil impulses had no part whatever', as Nietzsche once commented (Nietzsche 1974, p.106). With the extreme technological changes that have occurred in the last fifty years and the orchestrated management changes in the culture of science, it is now obvious that science is intimately tied to private businesses, industry, and society. Within this structure, the scientist has generally unknowingly defined him or herself in accordance with obsolete myths that have tended to handicap the scientist's freedom of action, by obscuring the modern political and economic realities of science, and neglecting the inherent responsibilities of the scientist as a critical actor in the theater of human civilization. The increasing incorporation of academic science and private industry, and the governmentally supervised nature of modem academic science, has corrupted the traditional freedom and character of the scientist. In order to navigate oneself and find meaning within the new structure of science, scientists now desperately need a fresh ethos that at once considers modern realities of the politics and management of science, societal urgencies, and global politics, as well as establishing a moral perspective where modern scientists can be actors with their own intentionality and responsibility.

In the culture of science, myths and ideologies are of critical importance for the formation of the scientist, because these ideas determine how scientists conceive of themselves as professionals and free individuals. More importantly, these ideas determine how scientists approach scientific activity, which exists in a social context, and which ultimately has the potential to dramatically change the characteristics of civilization as it is played out on the political and technological battlefield. It is a commonly held notion in the community of the natural sciences that science now is essentially what it was when it was described by the Nobel laureates of the past; those sweet, cushioning, pleasant words consecrating the 'temple of science'; the picture of a humble, rational, and noble Einstein is imprinted into our memories. By dismantling these obsolete myths of the scientist and surveying contemporary trends in science, this article will explore a more realistic perspective toward the field of science. The goal of this investigation is to determine the modern reality and ultimate meaning of 'science as a vocation' (Shorett 2003). Finally, moral philosophy will be demonstrated to be a critical element in the self-assertion of the scientist and the elucidation of the meaning of science as a vocation in a global technological society.

2. 20th Century Idealism and the Temple of Science

Albert Einstein imagined the 'temple of science ' as a path for the scientist to escape the banality of the world; it allowed the practitioner to construct a beautiful mathematical world picture which existed at the center of their emotional life, like the inspiring geometry of the petals of a rose. In his essay, *Principles of Research,* he sees science as a spiritual exercise of the highest type:

> The longing to behold this pre-established harmony [of the natural world] is the source of the inexhaustible patience and endurance with which… [scientists devote]… to the most general problems of our science… The state of mind which enables a man to do work of this kind is akin to that of the religious worshiper or the lover; the daily effort comes from no deliberate intention or program, but straight from the heart (Einstein 1954, p.227).

Einstein's poetics of the essence of the scientist constitutes one of the myths that has surrounded the scientific life and that is still prevalent in the minds of scientists, students, and the public today (e.g. see the Fall 2003 issue of the journal *Daedalus,* 'On Science', published by the American Academy of Arts and Science). There may exist a religious experience in science, but this is in no way different compared to any other creative profession, religion, or daily life itself, and ultimately these childish poetics of the scientist are not fit as an ethos for the modern scientist who must confront a dramatically more complex world than the one that Einstein had to find his place within when he wrote these words prior to World War II.

Outside of the scientist's subjective experience, an understanding of the life of the scientist also involves a notion of the activity itself. Writing in the same era as Einstein, another German Nobel laureate, Erwin Schrödinger, conceived science as a superfluous activity. 'What is operating here is a surplus force remaining at our disposal beyond the bare struggle for existence: art and science are thus luxuries like sport and play…'(Schrödinger 1935, p.24) More obvious today is the fact that scientific innovations are the foundation of modern technologies and industries, from telecommunications, to pharmaceuticals, to nuclear power. The views of Einstein and Schrödinger are both quite idealistic, but this may be because both of these scientists were theoretical physicists who didn't consider the wider social or economic dimensions of the work of the greater scientific community. Importantly, these types of views should always be bracketed as extremely limited historical perspectives.

Robert K. Menton, commonly referred to as the father of the sociology of science, inaugurated an equally idealistic approach to the study of science as a vocation in England. Merton's views on science have left a lasting impression upon the consciousness of contemporary scholars in the field. In 1942, Merton wrote: 'The ethos of science is that affectively toned complex of values and norms which is held to be binding on the man of science. The norms are expressed in the form of prescriptions, proscriptions, preferences, and permissions' (Merton 1973, p.268-9). Toward the goal of the 'extension of certified knowledge', Merton expounded four central norms at work in the ethos of a scientist: universalism, communism, disinterestedness, and organized skepticism (Merton 1973, p.267-78).

'Universalism' states that the truths of science will be recognized as valid despite their proponent's gender, class, race, or nationality. 'Communism' means that the products of science (knowledge) are common property not only of the public domain, but also of humanity. 'Disinterestedness' deals with the scientist's position with respect to the knowledge that they are creating; they are not interested in the outcome of their activities, whether water is composed of hydrogen and oxygen or gold and silver, it makes no difference to the scientist; and Merton states a general lack of fraud in science as the evidence of the 'disinterestedness' of scientists. 'Organized skepticism' refers to the suspension of judgment and the systematic doubt of the scientist. Even though Merton's norms have received criticism in the past by many scientists, they are still widely recognized today.

While some of Merton's norms are a redundant chanting of the scientific method, others are merely ideals, which have been transcended by the modern culture of science. 'Universalism' and 'organized skepticism' are two proposed norms of science that are the logic of the scientific method transposed onto the social life of the scientist, and are thus redundant and superfluous. 'Universalism' as a social norm is dismissed with the fact that any person can create or test scientific theories because they are logically so: if certain people were excluded from proposing scientific theories this would be an *ad hominem* fallacy of logic. The proposed norm of 'organized skepticism' is closely related to the act of falsification that is inherent in the scientific method. Karl Popper formulated the falsification of theories in *The Logic of Scientific Discovery* originally in 1934:

> …There is the testing of the theory by way of empirical applications of conclusions which can be derived from it…if the singular conclusions turn out to be acceptable, or *verified*, then the theory has, for the time being passed its test...But if the decision is negative, or in other words, if the conclusions have been *falsified*, then the falsification also falsifies the theory from which they were logically deduced' (Popper 1959, p.33).

Skepticism is only a mental characteristic, 'to doubt'; but 'doubting' and 'suspicion' are not science. Falsification is to prove an idea unsound by experience, and the falsifying nature of science, thus, supersedes and incorporates skepticism, because to falsify presupposes an inherent doubt. Merton's proposed norm of 'communism' is refuted by the modern reality of intellectual property; science now tends to patent information. Scientists may still inherently desire to share their results with other scientists, but this is because they have received their knowledge from the community itself, and it is necessary to share results in order to continue to learn from others, and generally to be involved in a larger human endeavor. The proposed norm of communism is perhaps Menton's most reasonable, but as national borders close to foreign scientists, international conferences are eschewed, and intellectual property is used to isolate scientific products, communism in science is a declining prospect. 'Disinterestedness' is incomprehensible; fraud is rampant in the sciences as the pressure increases on scientists to create new products, publish in the best journals and produce more patents. Scientists are not inherently disinterested in their work, despite their being *indifferent* to the facts of material being. Merton's norms are not supported by the modern era of science.

The recent transformations that have occurred in the culture, management, and politics of the natural sciences are the processes that have invalidated the myth of the scientist. It must be remembered that the myth of the scientist is just that, a myth. 'Myth is constituted by the loss of the historical quality of things', commented Roland Barthés (Barthés 1972), and this is precisely the problem with the myth of the scientist: it fails to take into account the dynamic nature of the society of science, and the emerging life of the scientist, which is continually recreated due to shifting political pressures, funding opportunities, societal necessities, and legal obligations. Myth is always the prism through which we see the illusion of the scientist; an illusion that tends to obstruct the ability of scientists to know themselves and the structure that they function within.

As for the position of the Nobel laureates of today with respect to the life of science, in comparison to the concordant laureates of the past, views have changed. The 1993 Nobel laureate in medicine, Philip Sharp stated that '[Universities] are no longer viewed as ivory towers of intellectual pursuits and truthful thoughts, but rather as enterprises driven by arrogant individuals out to capture as much money and influence as possible' (Krimsky 2003, p.179). In 2002 upon receiving the Nobel Prize in chemistry for his work in mass spectrometry, John Fenn had proclaimed, 'Academics are just like pimps…They are prepared to go through all sorts of hoops to get funding. It is a scandal' (Haller 2003, p.iii). Science as religious experience? Superfluous play? Disinterestedness? Since the middle of the 20th century, the structure of science has changed markedly, irretrievably altering this vocation.

3. The Structure of Academic Science

Science, if it does not take place in an industrial or government laboratory, is always academic science, or that science which has developed and occurs in a university setting with its own unique culture and responsibilities. 'Academic freedom' has long been considered essential for the university and the research activities of the scientist. The autonomy of the scientist is associated with academic freedom, and it is a central aspect of the myth of the scientist associated with the views above. The question of academic freedom in science is now intimately involved with the structure of science itself, its political relations, funding, and legal obligations.

3.1 Science, Government, and Private Industry

The rise of a scientifically driven society in the United States of America (USA) was summoned from the nation's experiences in World War II. At the closing of the war in 1944, President Roosevelt inquired whether scientific research could be a foundation for nation building in his letter to the director of the Office of Scientific Research and Development, which had overseen the application of scientific research to the war effort. Roosevelt wrote: 'New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more fruitful employment and more fruitful life' (NSF 1944). In response, the acting director, Vannevar Bush, composed a report entitled *Science: The Endless Frontier* where he outlined the implementation of a National Science Foundation (NSF) for the coordination and endowment of scientific research, primarily in colleges and universities, for the advancement of medicine, national security, and the economy (NSF 1945). Prior to the War and the creation of this program, scientific research funded by the American government was largely limited to the Department of Agriculture. *Science: The Endless Frontier* took the next logical step in nation building by focusing on the eradication of disease, the raising of the standard of living of citizens, and the direct development of new products and industries through the investment in scientific capital. It was directly from this policy initiative that much of further American scientific development and economic growth depended upon.

Recent dramatic changes in science funding and policy began in the USA in the 1980s, when transgenic organisms were deemed patentable, and policy makers decided to further integrate academic science with private industry to spur economic growth (Krimsky 2003, p.30). Between 1980 and 2000, American university and college spending for research and development (R&D) increased from 6.5 to 30.2 billion dollars (Krimsky 2003, p.79), up from ~20 million in 1920 (NSF 1945). In the same time period, industry support accounted for a larger share of academic research, increasing from 0.26 to 2.3 billion dollars, and from 4.1 % to 7.7% of total university funding (Krimsky 2003, p.80). Now, up to 30% of funding for top US universities comes from private businesses (Krimsky 2003, p.80).

The European Union (EU) and other major industrialized nations of the world are also experiencing an elevated interest in science for the creation of wealth and power through the development of intellectual property — patentable products and processes. Frank Gannon, executive director of the European Molecular Biology Organization, stated the rationale for an increased expenditure for science:

> …So-called advanced economies have to find new ways to maintain their privileged status. The common solution is to focus on new discoveries that bring with them ownership of commercially valuable intellectual property and re-

> quire a phase of development and manufacturing in a highly skilled environment. Thus, the seeds that need to be sown are now investments, from both industry and government, into science and technology, with the aim of creating well-paid jobs in the high-tech sector and new products for an increasingly demanding global market (Gannon 2003, p.117).

Beginning with an initiative started in January 2000, the EU aims 'to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion' (van Dyck 2003, p.1110). In 2002, to raise the financing of European science, the EU developed a plan to increase R&D investment from 1.9% to 3% of Gross Domestic Product (GDP) by 2010 (van Dyck 2003, p.1112).

The more or less random funding of science pursued after the initiative of Vannevar Bush has now been deemed inadequate to meet national priorities in the United States. The government and industrial groups who support university research through massive amounts of funding do not do so with the hopes of totally unforeseen discoveries anymore. Most scientific activities are directed and evaluated according to how well experts believe such courses of research will fulfill the proposed goals. Where governments have inherently trusted scientists to produce meaningful results prior to this era of increased funding, governments are now demanding more accountability. In 1993, the US Congress passed a law, which demands that before academic science is funded that it is to be strategically planned out, that performance indicators be implemented during the course of the project, and that a thorough evaluation of progress must be made before the continuation of funding (Mulvey 2002, p.58-9).

However, all economic systems are operating with limited resources, and in this sense, governmentally planned science ('economic instrumentalism') does tend to give specified economic results and more direct 'value-for-money' research, but an important, potentially dire, consequence is that it also tends to limit the scope of national science and ultimately, neglect many studies for public advancement. Stanford economist Paul David has expressed his concern about the narrowing of the scope of national science by the '…efforts to make public research institutions behave more like the profit oriented corporations with whom they are meant to collaborate, and the restructuring of government research funding processes to make them less like the traditional system for awarding grants to support scientific inquiry, and more resembling a market in which R&D teams bid for fully specified contracts' (David 2002, p.53). The 'grantract', as he defines these contracts, creates a narrowing of national research span, potentially weakening scientific and technological expertise and flexibility.

Besides these types of considerations for the economic productivity of nations, there has been discussion on how these political and operational changes are affecting the vocation of science. Hilary and Steven Rose expressed concern as far back as 1969:

> Many … share an anxiety over the increasing dependence of the university for external sources of money for research and the scale of the teamwork involved in the new 'Big Science.' The danger is that the new organizational structures of science threaten to engulf its traditional values of autonomy, public knowledge, disciplinary communism and personal commitment, making it impossible for the myth of science to be recreated. Science in this archetypal sense would stop (Rose 1999, p.262).

Since the rise of current political realities, a set of problems have been identified in the vocation of science, including but not limited to, conflict-of-interest, lack of openness in science, lack of freedom for the scientist, and the marginalization of the scientific endeavor. These issues will be briefly discussed in the next section; the discussion that follows is largely based upon Sheldon Krimsky's book *Science in the Private Interest* (2003) that explores conflicts-of-interest in the scientific community.

3.2 Critique of the Structure of Academic Science

3.2.1 Conflicts-of-Interest

One of the major problems that has developed along with increased integration of academic science and private industry is a greater prevalence of conflicts-of-interest in science. The Association of American Medical Colleges in the United States defines conflicts-of-interest as 'situations in which financial or other personal considerations may compromise, or have the appearance of compromising an investigator's professional judgment in considering or reporting research' (Krimsky 2003, p.129). Krimsky's book provides a plentitude of examples where academic scientists find themselves in situations that have conflicts-of-interest, such as their participation in governmental advisory committees. Between 1998 and 2000, in 92% of US federal advisory committee meetings for the safety and effectiveness of medicines (such as antidepressants and anti-inflammatory drugs, etc.), at least one board member had financial interests in the topic under review; furthermore, in 88 out of 159 of those meetings, one half of all government consultants present had financial interests in the products being evaluated (Krimsky 2003, p.96). These interests include stock ownership in the companies producing the drugs, consultation fees associated with those companies, and/or research grants directly related to the products. Isn't it conceivable that these committee members could rule in favor of allowing potentially unsafe drugs to enter the market especially if they are to profit from this decision in the amount of hundreds of thousands, if not millions, of dollars? Generally, there is an oversight process that exists to minimize conflicts-of-interest in order to insure the best judgment in the evaluation of these products, but a waver process has often allowed scientists with financial interests to be involved regardless of their conflicts-of-interest (Krimsky 2003).

Besides advisory roles, many scientists have dual affiliations both with a university and a private company, and these dual affiliations often have consequences for the academic research of the scientist. A 1992 study of approximately 800 biotechnology faculty members found that 47% consulted with industry, 25% received industry grants, and 8% had stock ownership in the company associated with their research (Krimsky 2003, p.111). A 1992 study of 267 published articles (from 14 journals) produced by Massachusetts-based scientists had indicated that at least one leading author had a financial interest in the outcome of the study in 34% of the cases (Krimsky 2003, p.113). In some cases these financial interests have been shown to produce bias in the judgment of scientists, while in others there has been demonstrated to be outright deceit, where scientists have lied or been involved in illegal activities to protect their products, and profits, to the detriment of others. The problems with conflicts-of-interest include the greater inherent bias in reporting results, deception in the presentation of data, and the manipulation of others who rely upon the scientists' expert and independent judgment. These behaviors tend to arise from external financial interests that can create massive wealth for the scientist, and these behaviors can exist where proper oversight is nonexistent. Krimsky produces a damning indictment of the academic scientist who has more and more overstepped certain 'moral boundaries'. 'The science professorate, once a calling for scholar-teachers, has become a staging ground for self-interested entrepreneurs who want the dignity and prestige of the position and the freedom to advance their pursuit of personal wealth', writes Krimsky (Krimsky 2003, p.224).

3.2.2 Freedom of Communication in Science

With the greater proportion of private funding in academic science, many more scientists are now withholding from their colleagues information from scientific studies. In a 1986 study, 44% of scientists with industry support, and 68% of scientists without industry support in the US, said industrial contracts hindered the free exchange of scientific knowledge and cooperation in research (Krimsky 2003, p.82). In a 1994 study, 88% of life-science executives indicated that confidentiality agreements between their companies and universities required that students were bound to these contracts as well (Krimsky 2003, p.82); thus these changes are effecting the greater university community and not only a subset of professors. In a 2002 study of geneticists, 47% of respondents indicated that information, data, or materials associated with published results had been denied to them in the last three years, and 27% of those who withheld data cited commercial reasons for these actions (Krimsky 2003, p.83-4). These examples demonstrate that the integration of private industry and academia is reshaping the lives and motives of scientists in important ways.

3.2.3 Lack of Freedom Due to Goal Directed Science

Before the managed strategic direction of scientific investigations, science was once congruent with the will of the scientist. Now the scientist finds himself in an economic structure that determines his or her objectives according to the needs of the government or the market. The autonomy, independence, and will of the scientist are broken. Krimsky states that the scientist now doesn't have the freedom to pursue research where this research is not in accordance with institutional priorities:

> To a large degree, universities have been taken over by money managers and academic entrepreneurs who are looking for financially lucrative research. This scenario usually translates to research that will result in intellectual property. Conversely, research that reveals degradation of our natural resources, that exposes charlatan claims of companies, or that investigates the environmental causes of disease usually offer no financial benefits to the university (Krimsky 2003, p.179).

Often these alternative research projects for the benefit of society are not completed by the proper regulatory agencies, and often the scientist has a place in filling the gaps in governmental oversight.

Once science had become a goal directed activity, it also has tended to become more of a 'large-scale' project, which involves more funding and more collaborators within and between universities. As science becomes 'large-scale' where is the freedom? Only the persons who choose to start the project have any freedom (this will be discussed more below). Furthermore, the great expense of science constricts the freedom of the scientist. In the recent article 'The changing norms of the life sciences' by Peter Shorett, Paul Billings, and Paul Rabinow, the authors challenge life scientists to re-think the meaning of 'science as a vocation' in the light of the facts concerning the norms of modern research. They state:

> …indeed, contemporary experimentation in the life sciences, whether conducted in university, industry, or medical settings, is thoroughly dependent on

> a diverse array of sophisticated and expensive tools sold by private industry. The critical distinction is no longer between the production of knowledge and the development of commodities, but between different modes of organizing research that in all cases require massive capital outlays to function (Shorett 2003).

It is evident that in this research environment, scientists need large financial support from external groups to conduct meaningful research. However, as funding opportunities for research are diversified, and more non-profit groups contribute to science, the opportunities for diverse research have increased.

3.2.4 Marginalization of Scientific Activity

Much of science is driven by market economics where private companies strive for profits, and often it is the free market *itself* that drives the production of novel products, and not the needs of consumers. The market economy creates needs to sell ever more esoteric or expensive products in order to outsell and gain more profit than competitors. In a study of genetically modified organisms, the authors of *Engineering Genesis* conclude: 'For most current genetic engineering developments the context and purposes are set to a large degree by the market, and, as has been seen, this can pose problems in marginalizing other values' (Bruce 1998, p.263; this idea is also proposed by Krimsky, 2003, p.179). In some cases, we see the academic scientist's efforts pigeon-holed into industries that are quite exterior to the great needs of humanity. The commodification of science has definitely robbed it of its mythology and pulled scientists from their ivory tower. However, their freedom and innocence is the price that is paid for the realization of the power of scientist's discoveries.

From the statements above, it should be clear that the majority of institutions fund modern science to build up a knowledge structure that ultimately leads to economic, military, and political power. Furthermore, the knowledge structures that surround the sciences are only developed as far as they support these institutions.

4. Weber, Heidegger, Foucault, and the Ideology of Science

In 1918, Max Weber concluded that science could not posit values, and those values which science operates in accordance with were imposed on it, thus presenting the fact that the scientist is forever subject to external influences and ideologies. Weber stated in his famous lecture *Science as a Vocation:*

> Who — aside from certain big children who are indeed found in the natural sciences — still believes that the findings of astronomy, biology, physics, or chemistry could teach us anything about the meaning of the world? … What is the meaning of science as a vocation, now after all these former illusions, the 'way to true being,' the 'way to true art,' the 'way to true nature,' the 'way to true God,' the 'way to true happiness,' have been dispelled? Tolstoi has given the simplest answer, with the words: 'Science is meaningless because it gives no answer to our question, the only question important to us: "What shall we do and how shall we live?"' That science does not give an answer to this is indisputable. The only question that remains is the sense in which science gives 'no' answer, and whether or not science might yet be of some use to the one who puts the question correctly' (Weber 1958, p.143).

From the discussion of the politics, economics, and social norms of science provided above, it is evident that science itself is not providing direction for scientists, because scientists are functioning in a political and economic framework that is increasingly controlled by government policies and private corporate decisions. Weber also understood this in his time, and he ended his lecture with the recognition of those invisible political forces and ideals that control the movements of the scientist: 'We shall set to work and meet the "demands of the day", in human relations as well as in our vocation. This, however, is plain and simple, if each finds and obeys the demon who holds the fibers of his very life' (Weber 1958, p.156). Weber's demon is the ideal itself which directs the practitioner's activity, whether this is ultimately found in the demon of military conquest, the demon of vanity, or the demon which is in fact not a negative entity, but a principle of justice.

Martin Heidegger reiterated Weber's conclusion with yet more intense clarity and simplicity: 'Science does not think' (Heidegger 1968). With this statement, he is criticizing the 'one-sided view' and 'one-track thinking' that is the methodology of science, and its trend toward the expansive entanglement of the scientist and the whole field of scientific inquiry. The natural scientist generally does not question, and does not answer, why they find themselves performing certain tasks, because they are obscured in the process of using the scientific method itself and discovering knowledge; a redundant application of one form of thought tends to inhibit other forms of inquiry. Heidegger reached this conclusion late in his life, although, in his rectoral address given at the University of Freiburg in 1933, he stated something perhaps even more meaningful for the elucidation of the meaning of science, which still does not contradict his later conclusion, but points in another direction: 'All science is philosophy, whether it knows and wills it — or not' (Heidegger 1990, p.7). Here, he is inferring that through the act of science, a specific philosophy is being employed, a philosophy which doesn't necessarily emanate from the method itself, but an ideology which can be placed upon it, not merely as a monolithic directive to be found in all science, but a philosophy that can be *known* and *willed*; a diverse set of imperatives that is employed uniquely in each individual case. Heidegger invites us to ask: when doing science, what is the philosophy behind these actions (a philosophy which is always there, whether it is *known* and *willed,* or not)? The answer is not found along the path of the inert methodology of Karl Popper, which is continuously mistakenly referred to as the lone pillar of the philosophy of science. The answer to the question lies in the external ideology that is bound to science itself, always and everywhere: this is Weber's 'demon'.

Because of its mere investigative methodology, science itself (the posing of hypotheses and the falsification of theories) operates in a dimension without values and thus ultimately without ethos in itself; science is not religion. Science, by itself, is unable to take the necessary step of faith in accordance with an idea or principle. The step to be taken, a step involving a faith, is what is needed to divert the scientist *from* nihilism and *toward* meaning. Without this clarity of commitment, science itself provides nothing for the scientist in the sense that it doesn't tell him or her what to do, and it remains an opportunity for anyone interested in imposing an ideology to deceive or confuse scientists for political or other operational reasons — thus ideology is a weapon and generally unknown threat to scientists; but it is also along this path that the meaning of science is found.

Academic scientists now commonly describe themselves as 'entrepreneurs' or 'little companies' in themselves, and admonish young scientists to think of themselves in this way. It might be added that biological scientists may be more appropriately described as 'biotechnology human capital', the ultimate metallic cog without identity in the larger machine. *Does a reduction to this category not prove the point that these are games of metaphysics?*

While some scientists may come closer to one category or another, these terms *more* or *less* describe the potential magnitude of being a scientist, since ultimately scientists are individuals that can either strive to create their own companies as entrepreneurs or they can use their science as an impetus towards art, or philosophy, as long as each individual creates their own unique place in science, which they, out of necessity, do. The myth of the 'temple of science' is an ideological weapon either used against scientists (a deception that they allow themselves to be drawn into), or it is used by scientists against themselves, to make their lives easier, simpler, more musical, crystal clear, less complicated, pristine, more enjoyable, and ultimately more rewarding. The reality is that the current conditions of science have killed the myth of the scientist, because modem realities have taken away the traditional freedom of the scientist.

Each scientist, as an individual, must find his or her way beyond those demons that Weber illuminated and the vacuous myths of the scientist. The scientist, however, has the *power of science* itself to reflect upon for the accomplishment of his or her own self-assertion. As Michel Foucault pointed out, the scientist is 'he who, along with a handful of others, has at his disposal, whether in the service of the state or against it, powers which can either benefit or irrevocably destroy life. He is no longer the rhapsodist of the eternal, but the strategist of life and death' (Foucault 1984, p.23). These strategists are Louis Pasteur, Robert Koch, Frederick Banting, Otto Hahn, Robert Oppenheimer, and Edward Teller, among many others. As the 'strategist of life and death' that scientists should recognize themselves to be, that is, as a *power,* scientists need to use this power effectively in the correct directions and according to the most appropriate principles. The alternative is allowing external groups to decide the future of scientists, which in all cases is not the best alternative.

Modern science is driven by economic choices, and these choices are everywhere determined by *ideology,* not facts alone. Operating with limited resources, one research path is always being performed at the expense of another (David 2002, p. 39); even where similar countries have the same amount of funding for science the character of the science can be markedly different. The scientists' opportunity is to use their power according to meaningful moral principles, and not to be confused, or led away from *meaning* and toward the instrumentalism that can marginalize one's efforts or compromise one's values.

5. The Meaning of Science as a Vocation

Ultimately, meaning is always in reference to a person or group. The meaning of science as a vocation may be income alone, or it may be meaningful for the scientist and humanity in a positive or negative way. For 95% of those in the society of science, those technicians, students, and even most staff scientists, the meaning of science as a vocation is nothing more than income, because they lack the power to make it anything more than this. For the other 5%, those scientists who are professors, group leaders, directors, policy makers, the meaning of science as a vocation can be a higher calling in specific ways. Those scientists who have some ability to control their research paths, whether this is through choosing to work in a laboratory with a specific character, or with a colleague who has a specific perspective, or whether this is accomplished through the free selection of topics of research in an existing position, these scientists can choose research paths that have moral significance; paths that have more moral significance than others.

The propagation of evil (through nuclear weapons and bioweapons) is a meaning of 'science as a vocation' for some scientists; evil would also be the meaning of science in the eyes of the public in reaction to the use of these weapons. Without ethics, religion, or a traditional ideology to follow, scientists are left to be manipulated by others, or left in a permanent state of confusion as to their place in society, which ultimately could lead them to fulfill those less noble desires of the human spirit. The activities of Edward Teller, an eminent scientist, the creator of the thermonuclear bomb, and the proponent of 'star wars' (or now 'missile defense'), are the epitome of what *not* to do in a life of science (e.g. create weapons that can destroy humanity completely). Of course he lived in the Cold War community of hatred, but his legacy still lives with us today. The question needs to be asked: why must humanity continue to walk down this path? Creating the weapons of warfare necessary entails a high probability for the use of these weapons in the future of war; and when a nation spends a significant portion of its national budget on military, this nation will continue to wage war into the unknown. By no means does the creation and diversification of weapons of war ever limit warfare, because the emboldening of weapons of war always magnifies and multiplies warfare. However, it is clear that science can also have a positive meaning, and this is where ethics is used as an aid to finding this meaning.

Ethics is the philosophy of just action, and one of its simplest tenets is that in the cognizant action of humans, the actor should give an equal consideration to the interests of others in comparison with the consideration that is given to the actor, himself. Through the principles and methodology of ethics, scientists can choose their course of just action in society. For example, this could entail the investigation of more efficient alternative energy sources or contributing to the search for the cure to pandemic diseases (both activities which consider the well-being of others besides oneself), instead of the alternate route which could either propagate the weapons of war, or merely minimize one's impact on society for the benefit of a few wealthy individuals.

The production of knowledge toward the curing of disease and the advancing of human life through technology is the only task that can be uniquely realized through science. No other allocation of resources can take the leaps and bounds that science has taken to advance human welfare. These leaps and bounds are thus those acts that dignify science as a vocation. The meaning of science as a vocation is to create an enduring scientific legacy for the benefit of humanity. Arthur Kroker has recently offered the possibility that the meaning of life, for potentially a greater portion of society, was ultimately tied to the use of technology: 'Whatever the case, it can never and probably will never be said of us…that the horizon of technology is not the gamble upon which we stake the meaning of life itself' (Kroker 2004, p.5). It is evident that the meaning of science is not a meaning that can be experienced outside of the process of technological development; the products of science can be reflected upon and the possibility of future advances can be imagined and desired, but meaning is only realized through the technology associated with science, what it has done and what it will do in the future. More specifically, the choice is between the technologies associated with war on one side, and those technologies associated with medicine, the efficiency of society, and environmental integrity on the other side, until the weapons of war are permanently dismantled. The *crisis* of science and the *meaning* of science cannot be extricated from the crises of nationalism, terrorism, pandemic diseases, overproduction, poverty, pollution, thermonuclear war, and the spiritual crisis of modern humanity.

The higher life of science, beyond the euphoric mathematical meditations of an Einstein and the experimentalism of a Hahn, is an act of self-knowledge, self-control, self-clarification, self-elaboration, self-creation, and self-assertion, which at the same time involves a knowledge of oneself and the greater social system which one functions within. As chaotic markets and calculating military generals give priorities in the creation of scientific knowledge, it is now up to the scientist, the agent of technological change itself, to become an active part of that choice and the shaping of society. The scientist is in the correct position for such contemplation and directing of science, because the scientist, unlike so many other industrialists and politicians, knows the techniques, the facts, the potential, and the depths of their work. And specifically, where scientists feel as though they cannot make a meaningful contribution because of their isolation, it is up to the scientist to unite with others in their field to decide a course of just action, and it is through their combined inertia that their goals will be reached. Where scientists come together under the banner of ethical action, they must together strive toward specified goals that have been decided amongst themselves and in accordance with moral philosophy (Liska 2004). In this process, ethicists are central participants needed for a dialogue with scientists in the choice of immediate moral goals. It is critical that moral philosophy and natural science continue to integrate and act in conjunction with one another. This elucidation of a set of morally significant goals is the first step that scientists, in each individual field, need to take in the realization of the modern scientific project, and to lead a meaningful contemporary life of a scientist. Furthermore as science becomes increasingly more expensive to perform, the need for action toward the proper goals is greatly intensified; it is critical to remember that one research path is *always* performed at the expense of another (David 2002, p. 39).

Where human action is controlled, and based upon abstract principles or ideas, whether of a religious origin or otherwise, as a scientist, it is appropriate to elaborate principles to govern one's activities, with a greater knowledge of the social consequences of their work, while having a greater overall consideration for the life of human society. Increasingly, the scientist must not only be mathematician and experimentalist *par excellence,* but the scientist must also be an intellectual and a scholar, as well as a politician, economist, and philosopher. It is the scientists' place to know *their* power in civilization, and to act responsibly in accord with it, and not be an agent of irresponsibility and neglect.

It is eminently possible that science will forever be an integral part of human society in the future, and that sectarian interest groups will always be interested in gaining control of science for their own benefit, with often a consequential detriment to others. Thus the battle over science is to be fought until the various sectors of society can come to a consensus upon a set of uncompromisably shared values which can accordingly direct science in a unified manner. Real human needs must be satisfied first, while those vane desires for obscene wealth coupled with destructive military power must be tempered for the benefit of humanity.

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PostScript, June 2015*

After many years of informal study of philosophy (primarily Buddhism, Marx, Nietsche, Schopenhauer, Foucault, Heidegger, and Peter Singer, in order, among others), and after my Ph.D. research at the stimulating Max Planck Institute of Molecular Cell Biology and Genetics in Dresden, Germany (Liska and Shevchenko 2003a & 2003b, Sunyaev 2003, Liska 2004a, 2004b, & 2004c), this article took final form when I was a postdoctoral researcher in Canada. Reading it now, as a tenured Associate Professor at the University of Nebraska-Lincoln, I recognize the article still has value, despite its many flaws, hyperboles, and idealism. I addressed some contemporary controversies from various perspectives, and engaged in a "rational search for consensus through argument" (Taylor 1989, p.509). I wrote the article in a verbose style, before learning to "remove needless words" (Strunk and White 1979). It was also written before reading other significant works on the business and politics of academic science (Greenberg 1999, Slaughter and Rhoades 2004, Greenberg 2008). Factual errors include not recognizing: modern science has always been deeply tied to industry (Cahan 2004); business is a fundamental mechanism of innovation and social advancement, and financial evaluation and funding are essential for new innovations (Phelps 2013); military activities are essential to the security of modern trade (Liska and Perrin 2010) and humanitarian purposes; René Descartes and others first separated fact from value in the 17th century (Mariconda 2006); and I also did not appropriately cite the Fall 2003 *Daedalus* article that was noted on the character of scientists (Pesic 2003).

Many issues in the article have become increasingly relevant, such as the need to make constant trade-offs in courses of action and continuously search for more morally significant research paths (Cassman and Liska 2007, Naylor 2007, Liska and Perrin 2009, Liska and Perrin 2010, Liska and Heier 2013, Liska 2014, Dudley 2014). The background ethical philosophy was rooted in Peter Singer's writings (Singer 1993a, Singer 2004, Liska 2004c). Since then, Sir W. D. Ross' *prima facie* duties (first published in 1930) has become a personally appealing ethical perspective, as we do have many conflicting duties and responsibilities, which must be continuously weighed against one another (Ross 2003, Singer 1993b, Shafer-Landau 2010). The American Association of University Professors' 1940 *Statement of Principles of Academic Freedom and Tenure* clearly states the duty of academic science: "Institutions of higher education are conducted for the common good and not to further the interests of either the individual or the institution as a whole. The common good depends upon the free search for truth and its free exposition" (Slaughter and Rhoades, p.172). A related concern in writing the article was the idea that a devoted life of science should be as meaningful as possible, that is, we should strive to learn and create to serve increasingly more people and not be bystanders in society's many grand challenges (Staub 2003, Reid 2005, Stern 2006, Reinhardt and Rogoff 2009, Wuthrow 2010), as the alternative feels unfulfilling, self-centered, and unenlightened (Taylor 1989; Singer 1993a, Singer 1993b, Nussbaum 2001, Singer 2004). Furthermore, probabilistic analysis indicates that a large fraction of scientific work is probably false, does not contribute to real-world solutions, and is thus marginalized (Ioannidis 2005). These conditions result in the need to optimize our scientific activities to be effective at helping increasing numbers of people, assuming the many constraints on our lives, probable failures (Ioannidis 2005), and our many conflicting goals (Ross 2003, Taylor 1989).

Perhaps the greatest goals in writing the article were to increase intellectual control over the path of my scientific research (Foucault 2003), to escape the increasing conformity and constraints on modern life (Aronson 2011, Ritzer 2015), to participate in an open society (Popper 1966), to formulate my personal goals and goal hierarchies (Lazarus 1999, p.70), to dispel any delusions of overconfidence (Johnson and Fowler 2011, Kanter 2006), and to not be corrupted; living among the bombed-out church ruins in Dresden and the thesis that Max Planck unintentionally served the Nazis (Heilbron 1987) left a deep impression on me. Some methods to limit corruption include: a commitment to tell the truth and serve the common good (Kennedy 1997), high integrity is essential to oppose powerful internal and external forces that can bias your judgement and actions (Heineman 2008, Ross and Amter 2010), and an awareness of social psychological factors that drive conformity and the deterioration of ethical standards and values (Zimbardo 2007). Although importantly, in choosing ethical paths, we must also be aware of potential excessive self-harm from the neglect of other critical values (e.g. personal dignity, self-fulfillment) due to any overzealous generosity on our part (Taylor 1989, p.495-521).

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