Are We Ready for Nanotechnology? Redefining the Human in Public Policy

Liz Johnson, M.H.D.L., M.A.
George Washington University
Complex Systems Institute
University of North Carolina Charlotte
3625 Windbluff Drive
Charlotte, NC 28277
United States of America

Paul Youngman
Associate Professor of German
Director UNC-Charlotte Center for Humanities, Technology, and Science
College of Education 458
University of North Carolina Charlotte
9201 University City Blvd.
Charlotte, NC 28223
United States of America

Abstract

This article analyzes the purported future of nanoscience and technology (NST) as it relates to our understanding of what it is to be human and to the corresponding ethical dilemmas we face in light of this emerging science and technology. The authors contend that NST will be the technology modality that finally forces an explicit reformulation of our relationship with technology and therefore creates a new approach to public policy as a response to this transformative technology. We assert that a clear line dividing humans from their technologies or, more broadly, dividing the organic from the inorganic, has never existed, and that NST will be the technology that finally makes this important distinction clear. We argue, therefore, that public policy needs to be prepared for this new understanding by taking a species-centered approach to what promises to be a fundamental change in our concept of what it means to be human. Such an approach will more effectively address the complexity and purportedly unlimited application of this potentially planet-altering technology.

Key words: nanotechnology; complexity; species centric; transhumanism; NBIC; CTEKS.

1. Introduction – Future Potential and Policy Context for Human

"**Science Finds - Industry Applies - Man Conforms**," 1933 Chicago World's Fair Motto

The marvelously deterministic motto of the 1933 Chicago World's Fair, with its implied linear march to the technologized human, sums up one way of understanding the relationship between humans and their technology. Such inevitability was the theme of many world fairs in the past, but we posit another approach. We suggest that technology lies at the heart of what it is to be human. Attemptingto tease out technology from the human and establish it as a deterministic force bent on eradicating some mythically pure form of the biologicalhuman misses the point: we are our technologies, and they are us. While this is not a commonly-held position, we believe that nanoscience and technology (NST) will be the innovation that finally forces an explicit reformulation of the way we understand our relationship with technology. Consequently, this will require a new approach to public policy.

Therefore, we argue that public policy needs to prepare for this new understanding by taking a human-centered approach that reflects what promises to be a fundamental change in our conventional conception of what it means to be human. Such an approach will more effectively address the complexity -- and purportedly unlimited application -- of this potentially planet-altering technology. This paper examines the potential promise and threat of nanotechnology with an eye on what it means to be human in light of this emerging technology. With its purported unlimited capacity for change, NST has presented unforeseen challenges to policymakers who must begin with a new definition of being human.Policy is and always will be about societal goals and how we fulfill them. But in the face of limited resources, policy actions are fraught with difficulties. Environmental policy expert Paul Sabatier (2007) recognizes the unique challenges to policymaking when he notes, "given the staggering complexity of the policy process, the analyst must find some way of simplifying the situation to have any chance of understanding it. One simply cannot look for, and see everything" (p. 4).

This is especially true when it comes to an emerging technology like NST. In response to Sabatier's point, we propose establishing a simple policy context for human sustainability that uses a human-centered approach and takes into account various competing definitions of what it means to be human and focuses on the promises or threats of policy outcomes to the human species. It will serve as a unified and holistic construct that will subsume societal ends into policy considerations within a technology-centered or technology-dominant social environment. Paradoxically, our "simple" approach will tap into current complexity theory whereby the parts are greater than the whole, and uncontrolled emergence evolves (Rescher, 1998).

2. NST Potential Impacting Human Policy

Our focus is on NST – the emerging technology that promises to have the most radical impact on the human condition and the one that effective policy is best positioned to address given the emergent nature of NST. As renowned political theorist Langdon Winner (2003) testified in the 2003 congressional hearings on the societal implications of nanotechnology, "technological change is never foreordained, the future is never foreclosed." Winner declaws, so to speak, the determinist's "inevitability" of technology argument by taking a common sense approach that seeks to identify our human needs as well as the fundamental purposes of technology. While those are important questions, we suggest the conversation should begin with the question of what it is to be human and what our relationship is to technology like NST. We argue, following Donna Haraway's (1991) famous dictum, that we are our technologies and they are we (p. 180). Any border we like to think exists between us and our technologies is imagined at best. The proliferation of artificial joints and limbs, cortical implants, cochlear implants, and the like should put to rest the idea that we can exist separately from technology. We take an even more radical stance and suggest that even traditional technologies like simple tools are a part of our personal ontology and us as well. When, for example, a human picks up a hammer, it feels separate because we can put it down and walk away when we wish. We suggest that while this may be the case, even a simple tool becomes a part of us because as we learn to deploy it, we take in the information patterns associated with using that tool, and thus become an enlarged virtual body with the capability, when it wants, of using the hammer. Thus the idea that we can separate Homo faber from Homo sapiens is as specious as the Cartesian body-mind duality.

The old discussion of technological determinism versus social constructivism is also a "chicken or egg" question. We argue that technology reshapes humans daily and that we reshape it daily in return. The complex processes of interactions between animate and inanimate make for co-evolution. The human as a coherent and rational being with a right to autonomy and freedom, coupled with a strong sense of agency and a solid grasp of a single, stable, knowable reality, was a figment of the Western Enlightenment imagination. We are -- and always have been -- part of a larger complex system; not the ruler of that system, but an important part of it, given our capability to create. This has rearranged what it is to be human with a promise to continue the rearranging on a grand scale. Think of how drastically we have altered our living conditions in light of powerful network technologies like the railway-telegraph system, the roadway-telephone system, and the computer-Internet system**.**

Approaching any technology as if it were primarily a negative development against which we humans must do battle is a non-starter (Cameron & Mitchell, 2007). Such thinking carries with it the underlying assumption that technology controls humans. Marshall McLuhan says it is "absurd and ignoble to be shaped by such means" (McLuhan, 1962, p. 247). The fact is that we can control the proliferation of technology about as well as we can control our fellow human beings -- that is, not very well. But just as humans can solve difficult problems, so can technology. Additionally, just as humans are shaped by fellow human beings in a process that does not have to be "absurd and ignoble," we will also be forever shaped by our technologies. The process is socially negotiated, not socially constructed or mythically deterministic.

We have precisely the technologies we want and need; the difficulty lies in the deployment of our technologies, which typically follows a pseudo-organic life cycle. Technology is conceived in the minds of engineers and scientists, birthed in laboratories, and workshops, and then mature in commerce and industry. In this life cycle, according to Winner (2003), it is the emphasis placed on the value of resources and time invested that tends to subvert the appropriate role and importance of technology within society. In other words, money is first invested without fully considering the impact on the human. Winner (2003) recommends that the debate and evaluation of the impact should be the first and most important step, instead of the "opportunistic means-to-ends logic" that has dominated policy debates in the U.S. We live in a hierarchically complex world with mature advancing technologies. Added to that, we are entering what many hail as the next industrial revolution, the NST revolution (Alloff, Lin, Moor & Weckert, 2007; Jones 2007;Berube, 2006; Bond, 2004; Ratner & Ratner 2003).

According to futurists like Eric Drexler, author of the seminal NST work *Engines of Creation* (1986), the potential benefits of the Nanorevolution are limited only by our collective imagination. Others believe that the unexpected and unpredictable consequences could be as dramatic as the benefits (Alloff, Lin, Moor & Weckert, 2007; Kurzweil, 2005). As the Drexlerian narrative goes, once nanotechnology is fully mastered, scientists will be able to create tiny machines able to assemble anything, atom by atom, from any kind of raw material. Tiny machines will be able to repair bodies from the inside, cell by cell, potentially "eliminating disease, aging, and death" (Alloff, Lin, Moor & Weckert, 2007, p. 353). Some predict the development of nanofactories that will manufacture whatever humans want, even immortality. Others predict that the use of nanoimaging to digitize and electronically express consciousness will enable humans to exist forever as recopied data files (Wachowski & Wachowski, 1999). "The next frontier is ourselves," states UCLA medical researcher Gregory Stock (Garreau, 2004, p. 6). NST will conceivably enable a fusion of technology with human tissue and brains so we will have the capacity to engineer our own human evolution (Garreau, 2004). Even if only a small percentage of these predicted advancements are realized, NST is the technology that will finally solidify the understanding that we are never separate from our technologies. Because the "next frontier is ourselves," as Stock puts it, we will be dealing with a good deal of implanted NST in our bodies, whether for rehabilitative or enhancement purposes.

The difficulty will lie in the fact that due to its quite literal inconceivability (nanoparticles exist beneath light waves and can therefore not be seen without the assistance of powerful scanning-tunneling microscopy and sophisticated software to produce images), this will seem a mystery, apparently beyond our control or understanding. The "inevitability" contrivance has the power to delude individuals into believing they are powerless with no stake or voice in the transformative technological changes that influence their lives now and in the future (Winner, 2003). But just as with all other technologies, we will shape it, and it will shape us. That dialectic has proven definitive in constructing, sustaining, and maintaining all human societies since the Paleolithic and Neolithic eras (McClellan & Dorn, 1999).

Like all other technologies, we will employ NST to manipulate and control our physical environment and adapt ourselves to it. Consequently, the study of policy alternatives will continue to be of major importance as we evaluate the sustainability of NST, its compatibility with humans as a species, and the corresponding value of such progress. Researchers Stephanie Un and Nick Price (2007) tout the boundless possibilities of technologies like NST. In their estimation, NST is just another example of how we humans use our investigative nature to explore the smallest parts of matter – parts that can be manipulated at the nanoscale with a length between one and one hundred nanometers.They remind us that it is imperative to understand that with NST, the special characteristics of reactivity, potential instability, and composition may increase risks, but they also aid in the understanding and control of the simple building blocks of matter. The difference between NST and other technologies is that it may be possible that humans will no longer be the passive victims of the natural laws of science. Rather, we would be active manipulators, affecting not only our environments, but also our own evolution. In short, we wouldbecome more God-like.

Rather than dwelling on what amounts to trans-humanist understanding of technology, Un and Price (2007) focus on bridging the gap between people and technology in order to provide meaningful solutions and not just dwell on possibilities. From their perspective, people need to imbue the future with human needs at the center of innovation, instead of technology creating the future (Un & Price, 2007). Winner (2003) also promotes a public policy position that establishes societal ends as the defining criteria with the possibility that some advanced technologies may not be necessary. We propose a public policy position that establishes the human as the defining criteria. Very simply, the issue is: "Do we want the human species to survive, and what do we want it to look like?" At what point does a cyborg become less than human? These are imposing questions with a long-term horizon given the emergent nature of NST. However, our policy choices in the near future may very well lead us to a point of irreversibility. If we are serious about the survival of the human, it is critical that advances in technology remain under the direction and control of shared values and not immune to human intercession (Garreau, 2005).

3. Human-Centered Approach to Policy: Human Permanence

A human-centered approach is only possible through international policymaking focused on sustainability. This would by no means be a perfect framework, but it has the potential to direct the necessary attention and resources to a central core tenant of being human; that is, we maintain that our species is valuable and should survive.

Further debate over the fate of our species should address how long into the future we want humans to survive and whether we should choose to make humans permanent. Billions of years into the future, our sun will die out, making life on earth uninhabitable. Is it too soon to plan for that actuality? A human-centered policy framework can provide perspective for species permanence. Policymakers have done a good job in the past of implementing effective policies that have reduced the deaths of humans on an individual basis. Entire endangered species have been targeted for survival, with the Endangered Species Act protecting more than 1,300 species in the United States alone[1]. We have yet, however, to give our own human species the same focus and funding. There is no current government agency or bureaucracy that deals solely with planning for and preventing human extinction. Human extinction researcher Jason Matheney (2007) asserts that risk reduction investments in the extinction of humanity are market failures, where an individual human enjoys no perceptible benefit from his or her investment in risk reduction. Human survival could then be considered an economic good, requiring deliberate polices to protect humans. The difficulty is that few leaders direct policymakers to plan far beyond their current political administration, much less develop risk assessment policy on the value of future generations of humans (Matheney, 2007).

Futurist Nick Bostrom (2002) also views human extinction reduction not only as a good, but as a global public good for shared stakeholders for future generations of humans. International participation would be necessary to deal with expected side effects of NST, along with other anti-extinction actions. Policymakers need to take into account how to interact internationally for the global public good. This course of action is an integral step in developing a human-centered policy. Still, there are numerous agents who pursue varied and often opposing goals in policies regarding humans. There is no unified authority that has the power to direct or halt technology, making it impossible to stop the development of adverse technologies, according to Bostrom (Bostrom, 2002). What Bostrom overlooks is that all technologies come with risk and reward and that an international authority controlling all technological development would not necessarily yield positive results.

4. The Problem: Context, Perspectives & Approaches Defining Human

The manner in which we define the human and agree to protect its integrity will be an arduous but necessary task that must be completed no matter what the environment. There have been difficulties over the centuries in defining what is human due to conflicting social institutions like religion, government, science, and linguistics. "Language is a code," a system of norms that legitimize and authorize arbitrary boundaries and accepted definitions like that of the human (Bourdieu, 1982, p. 45). The struggle over the classification of humans is a struggle "over the monopoly of the power to make people see and believe . . . to impose legitimate definition of the social world and, thereby, to *make and unmake groups*" (p. 221). The power of imposing a view of the human through mechanisms of division creates the reality of the unity and identity of the group. The human-made divisions of nationalism, gender, race, ethnicity, and religion are a "discontinuity in natural continuity" while this approach would transcend it (p. 221). The divisions could be unmade with a human-centered conceptualization. It would more accurately reflect an objective idea of human in a framework without the institutional biases that would be otherwise needed to protect its power. The conceptualization and definition of the human throughout human history has had "great political consequences" and will continue to do so (Fukuyama, 2002, p. 12).

In reality, for the time being, humans are members of a unique species that entitles every member to a higher moral status than the rest of the natural world (Fukuyama, 2002, p. 160). This is a clear example of Peter Singer's concept of speciesism – that humans favor our species over all others (Fukuyama, 2002, p. 143). While we take issue with the higher moral status asserted by Fukuyama, it does seem natural to favor our own species over all others. Humans are unique, given that our brains are the most complicated machines on the planet (Ridley, 1999). Dr. Warner Wells (1960), who studied the bombing effects of Hiroshima, asserts humans have a "…burning desire for knowledge" he describes as an "inbuilt spring" and a perpetual curiosity in that of everything humans desire, touch, feel, and sense. All must be experimented with until the mysteries of the world are unraveled (p. 363). Wells adds "often our inquisitiveness acts like a runaway train with no brake…" (p. 363). Humans are the only species we know of that can formulate, abstract, and debate constructs like justice, free will, moral responsibility, and species survival (Fukuyama, 2002). Fukuyama (2002) is correct, but he leaves out that which

[1]U.S. Fish & Wildlife Service Summary of Listed Species and Recovery Plans as of 7/26/2011 Environmental Conservation Online System.

Wells (1960) makes explicit in his work on the nature of humans – we not only construct, we destroy; we are not only just, we are unjust, and we do not only enjoy free will, we enjoy controlling the will of others.

5. Policy Considerations

Humans also formulate, abstract, and debate constructs in the public arena where policy is created and where policy on the human will be created. Policy is about the allocation of scarce resources to produce beneficial outcomes by taking into consideration both intended and unintended consequences. Technologies like NST quite naturally have unintended consequences (Collingridge, 1992, p. 156). The difficulty with a human-centered NST policy lies in the political nature of technology policy and the power inherent in defining the human. Humans are fallible. Scientists, experts, and businesses can be wrong in their approach to the human. Political scholar Charles Linblom (2009) adds that in all advanced societies, business has a "privileged position" whereby their development of nanotechnology may affect large groups of humans, yet will not be held politically accountable (Collingridge 1992, p. 164). The results of unaccountable consequences could impact the species permanently as most humans are "quite" powerless to alter technology imposed on them by a combination of big business and government (p. 186). This is already seen to some degree in the U.S. The report commissioned by the U.S. National Science Foundation and the U.S. Chamber of Commerce in July 2002 called "Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology, and Cognitive Science," (the latter is shortened to NBIC) is an example of a business/government partnership defining the state of the art (Bainbridge & Roco, 2002).

Given its trans-humanist bent, the 2002 NBIC report is striking in its presumptions of what humans are and are not, Trans-humanism is a movement that has been in existence for more than 20 years. Often viewed by its believers as a logical extension of the Enlightenment and secular humanism, trans-humanism "holds that current human nature is improvable through the use of applied science and other rational methods, which may make it possible to increase human health-span, extend our intellectual and physical capacities, and give us increased control over our own mental states and moods" (Bostrom 2005, p.202). Trans-humanism is not only concerned with present-day science and technology, it also relies heavily on "anticipated future developments such as fully immersive virtual reality, machine-phase nanotechnology, and artificial intelligence" (2005 p. 202). Trans-humanism, to paraphrase the German philosopher of science, Alfred Nordmann (2007), is an approach that involves the engineering *of* the human body and mind as opposed to engineering *for* the human body and mind (p. 43). It therefore presumes that the human is weak in the face of nature and requires certain upgrades, possibly in the form of NST, for its own survival.

In the NBIC report, authors Mihail Roco and William Bainbridge (2003b) place their focus, as ethicist Christoph Baumgartnerpoints out, on physical and mental enhancement and not therapy (Baumgartner, 2006, p. 333). NBIC workshop participant W. A. Wallace neatly summarizes the underlying philosophy:

> If the *Cognitive Scientists* can think it,
> the *Nano* people can build it,
> the *Bio* people can implement it, and
> the *IT* people can monitor and control it (Roco & Bainbridge, 2002, p. 11).

This statement represents supreme confidence in the ability of science and technology to improve on the human. Besides the futuristic bent of the NBIC report, what is most striking about it is the lack of a role for the humanities and social sciences, the two areas of study that help us contextualize scientific and technological developments. One sees this, as Nordmann puts it, in their "visions of mind-machine and mind-mind communication without the cumbersome detour through the human body or language" (Nordmann, 2009, p. 285). This aspect of the report is striking in what it would mean for the idea of "culture." The trans-humanist worldview presupposes researchers who may eventually harness the power of NST to turn humans into mere tools to be manipulated with capabilities of accomplishing tasks in an almost super human manner (Johnson & Culbreth, 2009). A human-centered policy can direct the focus from how the experts think humans can be "fixed" to how humans can survive.

The 2004 European response to the U.S. NBIC report is called "Converging Technologies: Shaping the Future of European Societies," This report does not defer to NBIC, but rather to the less-threatening sounding CTEKS, which stands for Converging Technologies for the European Knowledge Society. It seeks to define a uniquely European approach to converging technologies that is decidedly different from the U.S. NBIC approach.

There are two ways in which the CTEKS report attempted to do this, as Nordmann writes in a recent analysis of the CTEKS report. First, they "place greater emphasis on the social sciences and the humanities and take a more comprehensive approach to the cognitive sciences." Secondly, they attempt to "integrate this convergence within European values to allow for the acceptance of the emerging technologies" (Nordmann 2009,p. 287). In the end, the CTEKS report essentially seeks to define those values by contrasting the shared values of the diverse collection of countries and cultures that make up the European Union with the values explicit in the U.S. NBIC report. The NBIC report envisions the "final frontier" while CTEKS report talks of "procedural norms."NBIC is technologically deterministic while CTEKS is about the "co-construction of technology and society" (Nordmann 2009).NBIC undercuts the humanities and the social sciences while CTEKS upholds these fields as leaders in the societal conversation[2]. Nordmann sums up the primary distinction best. In his view, the NBIC report "marries the ideal of liberated, emancipated individuals with a conception of transcendence, if not manifest destiny. In contrast, again, CTEKS holds to the notion that technology ingeniously adapts nature to human limits and adapts human desires to the limits of nature. This ingenuity consists in achieving ever more with always the same limited means" (Nordmann 2009, 291-92). Taken as a whole, it is safe to conclude that CTEKS contains less trans-humanism and more humanism. It is the CTEKS approach with its understanding that humans do not exist above their physical environment, but within it, that we choose as a policy model.

J. Baxter (2004) wisely points out that the way "we define 'human' determines our view of self, others, relationships, institutions, life, and future. Choose wisely-there will be results" (2004, p. 1). Add to this the fact that we have to define human in light of NST, and one begins to see the difficulty. The question of what is human with the purported enhancing capabilities of NST will occur within the ethical framework of established institutions and cultural norms using the utilitarian greatest good mentality, which sets up quite a challenge for policymakers with changing political winds, priorities, and scarcity of resources. Who benefits from the greatest good is a function dependent on who has power to make decisions and determine values. The term "greatest good" hides under the guise of "we gave it our best effort," so to speak. We suggest that the CTEKS approach involves the greatest good when it comes to NST.

6. Rationale for Defining Human for Future Public Policy

It seems at this point a "*How to Manual*" would be helpful in providing us with a step-by-step guide on how to define human in public policy. Current natural life forms we know of are plants, non-human animals, and humans. Current natural life forms can be enhanced by selection or alteration to overcome the species limitations through natural or technological means. Enhancements, NST and otherwise, can be used for therapeutic purposes to cure disease or disability or to improve traits, characteristics, and capabilities beyond the normal range of species functioning. This is of course a primary goal of the NBIC report according to Roco.

For centuries, technology was created to dominate and control our physical environment.This is the CTEKS approach. On the other hand, the NBIC approach focuses on turning inward and merging technology with "our minds, memories, metabolisms, personality, progeny, and perhaps souls" (Garreau, 2004, p. 6). This is the technological setting where trans-humans can evolve with superior capacities and attributes. There is considerable debate on the ethics, extent, and purpose of manipulating our genes and morphing technology into our biological systems for therapy, enhancement, and life extension. It has been over twenty-five thousand years since there has been more than one kind of human dominating the earth. NST could allow us to instrumentalize and enhance humans beyond recognition as the means to technological ends. Opponents accuse enhancers of playing God and want to erect a "no trespassing" sign on our humanity (Allhoff, Lin, Moor & Weckert, 2007). It will be quite challenging to determine when our essential humanity has changed, been violated, or enhanced beyond acceptable levels of cultural norms. Some, like Pollack (2006), say directing resources towards trans-human perfection or "an ideal human type…makes little sense" in contradicting the basic rules of natural selection.

[2] The U.S. nano policy, 21st Century Research and Development Act: United Sates Public Law 108-153 does consider societal implications with the following verbiage: "Ensuring that ethical, legal, environmental and other appropriate societal concerns, including the potential use of nanotechnology in enhancing human intelligence and in developing artificial intelligence which exceed human capacity are considered during the development of nanotechnology." The initial goal was to allocate 10% of nano funds toward societal implications but has never been fully funded.

"Survival of a species over the long term will depend above all on the existence of maximum variation from individual to individual" (Pollack, 2006, p. 8). Pollack's comment should serve as the centerpiece for effective policy and does, in fact, lie at the heart of the CTEKS approach.

Policymakers work in the realm of policy process with problem identification as a key element in formulating policies and strategies for agenda setting. "A policy problem is a condition or situation that produces needs or dissatisfaction among people…" or is "an appropriate topic for government action" (Anderson, 2006, pp. 82-83). However, as policy scholar Aaron Wildavsky purports, "A problem is a problem only if something can be done about it" (Wildavsky, 1979, p. 42). Something can and should be done about the future of our human species in light of NST. The policy problem, and how human will be defined depends not only on the objective dimensions of the problem, but also on how it is socially constructed (Edelman, 1988). The policy problem and the definition of human may change as societal values and the physical environment adapt and evolve. The magnitude, scope, complexity, and environment of the future are unknown and uncertain. Human can be defined in a myriad of ways and by a myriad of disciplines and institutions.

7. Defining Human from a Centric Perspective

The nominal definition includes the properties of the human species that differentiate it from other species without including our underlying structure or essence. Human is a group of more than six billion social animals living with the most advanced cognitive abilities known and who excel at making tools to dominate their environment. The human is a complex, adaptive biological system composed of a biological combination of genes and 100 trillion cells interacting with myriad other complex systems in our environment. According to Fukuyama (2002), human is the "sum of the behavior and characteristics that are typical of human species, arising from genetic rather than environmental factors" (p. 130). Fukuyama adds that our human nature and our concepts of humanity are meaningful and provide "a stable continuity to our experience as a species" (p. 5). The current economic value of an educated intelligent human is estimated to be one million dollars. Humans still have the economic advantage over machines because they learn, have intuition, and grow in "wisdom" as they gain experience (Allhoff, Lin, Moor & Weckert, 2007, p. 340). According to futurist Joel Garreau (2005), to be human is to have relationships. To him, human is the ability to tell a story about culture and values, of who we are, how we got here, and where are we going. We agree with Garreau when he suggests that technology is just a reflection or window in which to gaze and contemplate the human (Garreau, 2005).Teleologicaldefining human requires taking into account purpose, goals, or ends (Lacey, 1996). Conceptually, human is justified in terms of the ends in which it is directed. Currently, there is no clear direction or agreed upon purpose, goals, or ends for humans. We believe this policy gap should lead us to develop a course of action that, in light of technological proliferation, calls for the survival of the species to be the primary focus of public policy choices regarding science and technology.

8. Future of Human – What Choices?

Humans may never agree on the values that define the human, but they may come to some agreement on "how to" contextualize the debate for the future. How many humans will live in the future? To researchers Woodhouse and Kim (2006), "what matters most in the end is the outcome rather than the process. And outcomes are substantially determined not by words and thoughts but by the structure of authority: who gets to decide, and by what conditions they must abide" (p. 16). We believe humans can come to an agreement on the policy outcome of human survival as a species.

Woodhouse and Kim (2006) also bring up a critical point in their work asserting that societal reluctance to think about preparing for major problems with emerging technologies, such as NST, is the norm. We really do not know what is coming, but "we do know we're in it together" (Brand, 1999, p. 123). The construct of time for humans can be viewed as invisible and empowering. Humans can see the past but cannot change it. Humans can change the future but cannot see it (Brand, 1999). Futuristic policymaking considerations have not "come anywhere close to what humanity and its techno scientific agents ought to be aspiring to achieve (Woodhouse & Kim, 2006, p. 34). What we as humans "ought to be aspiring to achieve" is species flourishing, which also fits into species-centrism. The proper role of governance, according to economist Lester Thurrow, "is to represent the interests of the future to the present" (Brand, 1999, p. 122). In order to represent human species' interests in the future, policy needs to share the same visionary components of successful and responsible technology innovation. Policy also needs to be transformative, inclusive, and account for even greater complexity interdependence.

How should humans view the future in order to be responsible? Physicist Freeman Dyson (1992) claims the destiny of our species is based on survival in all six time scales. Humans are constituents of life on earth, the species, culture, tribes and nations, families, and of individual humanity. As a successful species, we have evolved and adapted from a biologically to a socio-culturally determined human species because of the conflicting mechanisms and demands of each time scale. When refining the human debate, it is important to consider the tug of loyalties between the units of life and the time scale given to prepare for the hyper-accelerated Nano future (p. 341). The relation of time scale to units of human life and life of earth provides a system in which to evaluate priorities and alternatives in relation to survival and flourishing.

9. Species Centrism as a Viable Policy Option

In evaluating and formulating a human-centered policy alternative, policy process scholar Anderson (2006) outlines the key ingredients to enhance chances of policy success. Initially, the proposal must be directed at a problem's causes with an eye on solving or mitigating the problem. Human-centered policy supports the idea that technology should be the means for the human ends of survival and flourishing instead of the ends justifying human existence. Next, according to Anderson, the budgetary costs have to be justifiable and reasonable. Finally, the proposal must be "politically acceptable" and "agreeable to the public" (Anderson, 2006, p. 104). Human-centered policy allows the debate to move beyond traditional divisions like race, gender, nationality, etc., to a discussion of specific outcomes, which we believe would be agreeable and acceptable to politicians and the public. What would be an acceptable rationale to be against the survival of your own species and its flourishing? Policymakers will need to fill the role as the architects of the future to ensure humans are not "inevitably" instrumentalized as tools for the ambitious ends of technological domination and control of humans and our environment.

There will continue to be complex societal implications and ethical consequences for policymakers to consider with this new NST potential lurking on the horizon and fusing technology and the human. The visionaries espouse NST as the second coming to an almost cultish degree of fanaticism. They believe the revolution will lead to a coherence of knowledge in the materialist realm. The hyped claims in support of NST cite the rationale of "advancing broad societal goals" (Roco, 2003a, p. 181). It is interesting that scientists in their foresight have chosen the societal goals they deem most appropriately served by NST. They tout improved understanding of nature, increased productivity, better healthcare, extending human potential, and limits of sustainable development (Roco, 2003, p. 181). On paper they seem like laudable goals to pursue. However, there will always be a downside. Researchers, governments, and their conglomerate financiers are not investing in NST out of the goodness of their hearts. These efforts are not based on altruism as the driving factor, but rather on economics, human curiosity, and the often-blind addiction to creating new technology. "[Nanofabrication] is building at the ultimate level of finesse," notes Nobel laureate and Rice University professor Richard Smalley (Ratner, 2003, p. 37). The finesse challenge and God-like potential in NST application is far too alluring to humans.

10. Conclusions

Humans are and will remain anchored, bound, linked, wedded, and inextricably connected to technology in adapting environments. And while technology has made countless improvements for humans, it has, at the same time, created many risks. Policymakers should consider the merits in both the NBIC and CTEKS approaches to NST, but it is the underlying philosophy of the CTEKS approach that will serve as the most effective basis for a successful human-centered NST policy. Policymakers will certainly be challenged when NST begins to fulfill some its great promise in allowing us to alter ourselves and our environment. If we propose to maintain our essential humanity, we may wish to avoid the more trans-humanist efforts afoot when it comes to NST.

Our human values can -- and do – impact the structureof our futures. As humans, we have choices and are not subsequently at the inevitable mercy of hyper-accelerated technological advance. Technology arrives more rapidly than changes in culture or values (Garreau, 2005, p. 10). The nano-human debate is about defining "the" cultural, social and political issue of our age: the possible transformation of the species. The policy must be human-centered with respect for the inherent wisdom in each unique human being. Once the NST revolution arrives, there will be no turning back to "the good old days." We will quite possibly have technologically conquered and dominated the world yet lost our essential humanity (Johnson & Culbreth, 2009). Effective human-centered policy will preclude such possibilities.

References

Allhoff, F., Lin, P., Moor, J. & Weckert, J. (2007). *Nanoethics: The ethical and social implications of nanotechnology*. Hoboken, NJ: John Wiley & Sons, Inc.

Anderson, J. (2006). *Public Policymaking*. (6th ed.). Chicago, Illinois: University Chicago Press.

Baumgartner, C. (2006). Nanotechnologie in der medizin als gegenstand ethischer reflexion: Problemfelder, herausforderungen, implikationen. In A. Nordmann, J. Schummer, and A. Schwarz (Eds). *Nanotechnologien im kontext. Philosophische, etische und gesellschaftliche perspektiven*. (pp. 325-43). Berlin: Akademische Verlagsgesellschaft.

Baxter, J. F. (2004). *Human: defined: Earth's choicemaker*. Retrieved June 10, 2009,from http://www.choicemaker.net/choicemaker.htm

Berube, D. M. (2006). *Nano-hype the truth behind the nanotechnology buzz* (pp. 33-134). Amherst, NY: Prometheus Books.

Bond, P. J. (2004). Vision for converging technologies and future society. *Annals of the New York Academy of Sciences1013*, May, 17-24.

Bostrom, N. (2002). Existential risks. *Journal of Evolution and Technology*, 9, Retrieved on March 2, 2009, from http://www.nickbostrom.com/existential/risks.html

Bostrom, N. (2005). In defense of posthuman dignity. *Bioethics,19*(3), 202-214.

Bourdieu, P. (1982). *Language & symbolic power*(pp. 45-221). Cambridge, MA: Harvard University Press.

Brand, S. (1999). *The clock of the long now time and responsibility the ideas behind the slowest computer* (pp. 2-89). New York: Basic Books.

Cameron, N. M. de S. (2006). Part V. social and ethical implications: Nanotechnology and the human future, policy ethics, and risk, *Annals of New York Academy of Science1093*, December, 80-300.

Cameron, N. M. de S., & Mitchell, M. (Eds.). (2007). *Nanoscale issues and perspectives for the nano century* (pp. 14-69). Hoboken, NJ: John Wiley & Sons, Inc.

Collingridge, D. (1992). *The management of scale big organizations, big decision, big mistakes* (pp.149-187). New York: Routledge.

Drexler, E. (1986). *Engines of creation: The coming era of nanotechnology*. Garden City, NY: Doubleday.

Edelman, M. (1988). *Constructing the political spectacle*. Chicago, Illinois: University of Chicago Press.

Ellul, J. (1964). *The Technological Society* (pp. 148-227). Toronto, Canada: Random House.

Edwards, D. & Webster, S.C. (2009). *Humanity's survival 'by no means a sure thing. The raw story.* Retrieved July 10, 2009, from http://www.rawstory.com/news/2008/Chomsky_Humanitys_survival_by_no_means_0227.html

Fukuyama, F. (2002). *Our posthuman future consequences of the biotechnology revolution* (pp. 3-218). New York: Picador.

Garreau, J. (2005*). Radical evolution the promise and peril of enhancing our minds, our bodies – and what it means to be human* (pp. 3-83). New York: Broadway Books.

Haraway, D. (1991). *Simians, Cyborgs, and Women: The Reinvention of Nature*. New York: Routledge.

Jones, R. L. (2007). *Soft machines nanotechnology and life* (pp. 1-14). Oxford, NY: Oxford University Press.

Johnson, L. and Culbreth, J. R. (2009). Counseling in the nanotechnology frontier of the future. *Counseling Today,51*(8), 42-45.

Kurzweil, R. (2005). *The singularity is near: When humans transcend biology*. New York: Penguin.

Lacey, A. R. (1996). *A dictionary of philosophy*. (3rd ed). New York: Routledge.

Lindblom, C. (2009). *Politics and markets: The world's political economic systems*. New York: Basic Books.

Lindblom, C. & Wildavsky, A. (1981). Rune premfors. *British Journal of Political Science,11*(2). 201-225.

Matheney, J. G. (2007). Reducing the risk of human extinction. *Risk Analysis*, *27*(5),1335-1344.

McClellen, II, J. E. & Dorn, H. (1999). *Science and technology in world history an introduction* (pp. 371-372). Baltimore, Maryland: The Johns Hopkins University Press.

McLuhan, M. (1962). *The Gutenburg galaxy: The making of the typographic man*. London: Routledge.

Nordmann, A. (2007). If and then: A critique of speculative nanoethics.*Nanoethics,1*(1), 31-46.

Nordmann, A. (2009).European experiments. *Osiris,24*(1), 278-302.

Ratner, Mark & Ratner, Daniel. (2003).*Nanotechnology*(pp. 2-16). *A Gentle Introduction to the Next Big Idea*. Upper Saddle River, NJ: Prentice Hall.

Rescher, N. (1998). *Complexity a philosophical overview* (pp. 173-183). London, England: Transactional Publishers.

Ridley, M. (1999). *Genome the autobiography of a species in 23 chapters*(pp. 23-37). New York: Harper Collins.

Roco, M. C. (2003a). Broader societal issues of nanotechnology. *Journal of Nanotechnology Research,* Kluwer Academic Publishers, *5*(3), 181-189.

Roco, M. C. (2003b).*Nanotechnology: Societalimplications-maximizing benefit for humanity.* Report of the National Nanotechnology Initiative Workshop, Arlington, VA: National Science Foundation Subcommittee on Nanoscale Science, Engineering, and Technology.

Roco, M. C.&Bainbridge, W. S. (Eds.). (2002*). Converging technologies for improving human performance: Nanotechnology, biotechnology, information technology, and cognitive science.* Arlington, Virginia,National Science Foundation and U.S. Department of Commerce Report.

Roco, M. C. & Bainbridge, W. S. (2004). (Eds.). *Converging technologies for improving human performance*. (National Science Foundation Sponsored Report). Washington, D. C.: National Science Foundation.

Sabatier, P. A. (Ed.). (2007). *Theories of the policy process* (pp. 3-6). Boulder, CO: Westview Press.

Savulescu, J. & Bostrom, N. (Eds.). (2009). *Human enhancement* (pp.26-216). Oxford, NY: Oxford Press.

Un, S. & Price, N. (2007). Bridging the gap between technological possibilities and people: Involving people in the early phases of technology development. *Technological Forecasting and Social Change,74*(9), 1758-1772.

Wachowski, A. & Wachowski, L. (1999). *The Matrix*. Groucho II Film Partnership, Silver Pictures, Village Roadshow Productions.

Wildavsky, A. (1979). *Speaking truth to power*. Boston, MA: Little Brown.

Wells, (1960). Our technological dilemma an appraisal of man as a species bent on self-destruction. *Bulletin of Atomic Scientists,XVI*(9).

Winner, L. (2003, April 9). Science policy and the push for nanotechnology, *Tech Knowledge Revue,* 3.1, May 20, abridgment of testimony Langdon Winner delivered before the Congressional Committee on Science in Washington, D.C.Retrieved June 2, 2009 from http://www.southerncrossreview.org/27/winner.htm

Woodhouse, E. & Kim, B. (2006). Technology under democratic control?: The case of nanotechnology. Under review at *Science and Public Policy*.