**Action Research for Innovation and Technology Transfer:**

**A Response to the Request For Information from National Institute for Standards And Technology**

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## Introduction

This submission is in response to the Request for Information (RFI) from the National Institute for Standards and Technology (NIST) and the White House Office of Science and Technology Policy (OSTP), published in the Federal Register, Vol. 83, No. 84, Notices 19053-19054, May 1, 2018, to obtain information relative to optimizing technology transfer and increasing the return on investment (ROI) from federally funded research.

The purpose of this submission is to identify and articulate the essential factors for successful innovation and technology transfer, including the determination of leadership behaviors, methods and practices for creating a culture of innovation. Furthermore, the outcomes of this study can offer a basis for examining and instituting recommended policy changes for improving research productivity, innovation, and sustainability from federally funded laboratories and universities.

Invention and Innovation

Invention is developing new ideas. Innovation is getting those ideas adopted in the marketplace and receiving a sustainable return on investment. Most federal laboratories and universities are good at invention but not at innovation. A study by the Brookings Institution indicates that 84% of the Technology Transfer units within universities do not even cover their operating costs (Valdivia, 2013).

The innovation process involves conceiving and producing an output (for instance, new ideas, products, technologies, and services) within an environment and normative context (economy, market, and culture) and getting it adopted and embedded in the organization and its ecosystem’s culture. Innovation is a product, process, and context. As a process of social action, it involves the practical engagement of diverse groups of stakeholders in interaction performing essential functions and tasks that transforms work into products and services that are valuable and useful for people and society (Hellstrom, 2004, p. 645).

As a product, innovation is an outcome, which could include products, services, and new technologies but also fundamental change or transformation of an organization or ecosystem. For innovation to be sustainable, a sufficient return on investment (ROI) is required to compensate stakeholders, payback investors, and replenish the resources consumed. Accordingly, the productivity of the R&D and innovation process is a measure of the amount of resources utilized and the return achieved in the form of a societal benefit as well as return on resources consumed to replenish the capital base and provide incentives and profit through the process of conceiving, developing, diffusing, and adopting new ideas, products, and services. The goal of innovation productivity is to develop and get new ideas and products adopted (effectiveness) with the least consumption of resources (input) and the attainment of maximum utility and return (output). In this regard, productivity improvement at each stage of the innovation process is an important objective of the federal government as well as federally funded labs and universities.

Innovation productivity can be improved as long as the ratio of input to output increases over time. This is because effectiveness of output and efficiency of input represent the crucial dependent variables involved in innovation productivity. In the world of democratic capitalism, the resources consumed to produce successful innovation are returned to the investors and owners of the innovation creating a sustainable cycle of input to output.

The concept of new growth theory (NGT) suggests that there is significant potential for increasing innovation with existing resources, i.e., increasing the number of new products, services, and other outputs while holding the resources constant (Romer, 2007; Cortright, 2001). This definition and method of measuring innovation productivity lends itself to applications in all types of organizations, and at all levels. It satisfies the criteria of scope and precision, and if standardized, could facilitate a central focus and commonly accepted perspective among stakeholders.

Barriers to Innovation in Federally Funded Labs and Universities

There are four barriers to innovation in federally funded labs and universities: the enduring emphasis in research on the traditional scientific method, the disciplinary structure of universities and federal labs, the strong emphasis on individual achievement as opposed to collective achievement, and the fragmented culture and competition between the subculture of research and subculture management.

The first barrier to sustainable innovation is an over-emphasis on the application of the traditional scientific method, which attempts to reduce realities to a single set of factors or methods. Several researchers have repeatedly demonstrated the way in which the narrow perspective and method of the scientific method stalls progress in other areas that might otherwise contribute significantly to the development of knowledge, the use of resources, and the implementation of the innovation process in the new growth economy (Fuller, 2007; Gergen, 2001; 2015; Gergen & Thatchenkery, 1998; Provance, 2010). Some attributes of innovation cannot be quantified, as participants’ behavior in the activities of the innovation cycle differs according to individual and organizational history and culture. Moreover, people engage with each other in a variety of contexts, which results in different conceptions of innovation, are not generally going to commit and act upon a contrary view of the process. This dynamic interaction and interplay between these different subcultures impedes innovation in universities as well as business enterprises.

The second barrier is the disciplinary structure of universities, which segregates knowledge into numerous subject areas and departments. Most universities’ departments are extremely decentralized, based on academic disciplines and utilize different theories and methods of invention and innovation. These units enjoy a high degree of autonomy and academic freedom and function according to their unique traditions and specializations. The hierarchy within each unit and the lack of engagement with a broad range of stakeholders need for successful innovation, in conjunction with a strong culture of individualism, and the incentive systems, which emphasize individual performance over collective action, combined with the narrow focus and emphasis on analysis (deconstructing or breaking reality down into discrete variables and micro-units) further undermines successful innovation.

In addition, the high degree of role specialization based on different functions in organizations, including the functional areas of accounting, information technology, human resources, engineering, manufacturing, facilities, marketing, distribution, sales, and so on—serve to fragment effort and undermine collective action. This division of labor and dissociation between the parts of the whole is quite evident and affects the ability of people to work together toward common objectives (Schneckenberg, 2009).

Part of the difficulty in fostering innovation also appears to stem from the internal competition between administration and the faculty. Universities’ administrative culture, with its strong emphasis on business efficiency and performance, competes for resources and attention with the academic culture of research and teaching. The clash between these divergent subcultures is a constant source of constant frustration and confusion for many faculty and staff members, which often devolves into in-fighting with both sides blaming the other for the issues faced by the university (Sanderson, 2006).

Finally, the academic (and research) culture of most universities is generally more oriented toward individual achievement rather than collective and relational action. While the pervasive culture of individualism in American universities supports the process of discovery and invention, it is quite often a barrier to the practical implementation of innovation. While the culture does promote individuals’ novel ideas, publications, and citations, it lacks effectiveness in engaging and coordinating the knowledge and commitment of stakeholders for the implementation of those ideas. The innovation process demands a more relational and collaborative set of practices. In other words, the strong culture of individualism, reinforced by universities’ promotion and tenure processes and incentive systems, is not very effective in promoting teamwork and collective action in building and leveraging relationships across existing disciplinary, functional, product, regional, and international boundaries to capitalize on new growth economics.

Research has demonstrated that while individualistic cultures outperform most collectivistic cultures in the generation of new ideas, publications, and citations, cultures that place a strong emphasis on collectivism are more effective in the implementation of new ideas (Taylor & Wilson, 2012). This means that a culture that focuses on individualism would be more successful in developing and fostering new ideas and inventions, while those based on collectivism would be more effective in engaging key stakeholders, building relationships and social capital, and creating meaning and collective action in implementing those ideas. The integration of both individual and collective perspectives is necessary for the complete realization of the innovation process. Translating new ideas from the research arena to the market requires proof of concept, legal protection, business planning, developing and testing prototypes, organizational design, hiring the right people, creating supplier and distribution contracts and channels, and marketing the innovation to customers; in brief, collaboration across disciplines and functions is required.

The lack in the capability to engage, connect, collaborate, and conduct interdisciplinary work and a culture that expects and supports collective and coordinated behavior impedes successful innovation. From this perspective, it seems apparent that most American universities are ill-equipped to become the engines of economic growth that they claim to be. This is not due to a lack of resources, as argued by many university leaders, but rather to a lack of leadership, suitable culture, and relational structures, methods, practices, and skills that are required to effectively implement the innovation process, create jobs and industries, and stimulate economic development and growth (National Science Board, 2010).

## Need for a Shift in Perspective

Research universities have reified Vannevar Bush’s *Science: The Endless Frontier* (1945) from a proposed national policy to a complex, monolithic research system, with an expensive and ever-growing infrastructure that demands constant funding. The leaders of research universities (and funding agencies such as the NSF and NIH and European Commission) assert that without increased funding, an innovation crisis will emerge, making the entire nation suffer.

But, if public funding is only one of many causal or mediating variables, including environment, culture, market, leadership, teamwork, competencies, skills and methods, how important is it to the outcome? How much of the relationship does it account for? Is the concept of new growth theory (NGT) simply a myth? Moreover, if innovation is observed in cases in which additional resources were not supplied, such as in the case of NGT, does the argument for additional public funding still hold? Finally, one must determine the limits or range of funding required for innovation.

Considering all the questions associated with the relationship between public funding and innovation, one is left wondering whether the argument for increased public research funding is a response to a national economic crisis or a plea by research universities to sustain an ever-growing infrastructure.

Presently, the question whether public funding leads to greater innovation even over long term remains debatable, largely due to a lack of standardized data, metrics, and reporting, and uneven performance. Leaders in government and higher education need to be more transparent in acknowledging that a high percentage of public funding feeds the infrastructure of big science. If researchers are spending up to 40% of their time performing administrative tasks (National Science Board, 2012) and writing articles based on studies, which are not relevant and contribute little to knowledge about improving performance (Shapiro & Kirkman, 2018; Pearce & Huang; 2012), or whose findings cannot be reproduced (Flaherty, 2015; Khaneman, 2012; Nosek, 2015; Nosek, Spies, & Motyl, 2012) then, truly, public funds are being wasted. Recent studies have reported that out of the 1.9 million articles published each year in 28,000 journals, a mere 10% are read by any individual apart from the author, editor, and reviewers (Eveleth, 2014). Moreover, fewer than 33% are even cited (Elsevier, 2013). Such findings weaken and make questionable the claim that greater funding will lead to increased innovation.

In addition to the difficulty of measuring the output of research funding, there are several other issues and concerns associated with university research, including the high cost of compliance (estimated to be 24% of the annual research expenditure at Vanderbilt University; and according to a 2015 compliance study of eleven universities for 2013-14, estimated to be $27B per year for the 11 universities), unethical and fraudulent research practices, ineffective peer review (Bartlett, 2017; Colquhoun, 2016; Van Noorden, 2011), as well as recent claims of fake news by political parties regarding issues of national importance, such as climate change. These concerns raise questions about the integrity of scientists and the reliability of their methods (*Economist*, 2013; Ioannidis, 2005; Edwards and Roy, 2017). To overlook these issues while increasing public funding with the hope of improving innovation will only continue to erode the public’s trust in science and the traditional scientific method. What is needed is a sustainable method of funding R&D for invention in labs and universities while connecting with the private sector for innovation to improve technology transfer and increase return on investment as indicated in the President’s Management Agenda CAP Goal 14 (2018).

## Requirements for Successful Innovation

Innovation starts with engaging the right stakeholders and collecting data and developing explanations that reframe perceptions in new ways and offer new insights and opportunities for change from existing thoughts, beliefs, and patterns of behavior. The basic premise of this submission is that successful innovation essentially involves Action Research (AR). AR is based on mixed and converging models and methods of research performed by a diverse group of stakeholders who come together, interact with and learn from each other, and construct or design something new, and then, test it, and collectively plan, enact, and embed it in the larger ecosystem.

Action research (AR) derives from a philosophy of pragmatism. It embraces and utilizes a variety of mixed models, including appreciative inquiry, semiotics, science, and actor-network theory (ANT) to construct meaning while building a network of supporters to coordinate action and solve a problem or capitalize on an opportunity. It uses mixed methods of research and logical inference to collect and analyze data and develop grounded theory of action based on the knowledge, experience of stakeholders, which, when enacted, can instigate the desired change. It forms an inclusive, open, democratic, non-hierarchical, descriptive, meaningful, explanatory, predictive, and performative approach to innovation and change.

Action research (AR) as conceived here is a face-to-face group process in which a group of diverse stakeholders, with different backgrounds, roles, and experiences, from different disciplines, organizations, and cultures gather in a workshop setting to co-create a grounded theory of action resulting in new knowledge, improved relationships, increased commitment, and successful innovation.

AR is based on mixed models and methods, including *Appreciative Inquiry* to identify and build on past strengths and assets; *Semiotics* to develop meaningful hypotheses, propositions, strategies, explanations, and theories; *Science* to evaluate and test those hypotheses, theories, and explanations; and *Actor-Network Theory* to deduce, enact, diffuse, and transform the grounded theories of action and knowledge into physical reality.

AR is not a process in which a group of expert researchers or consultants are used to collect and analyze data and present it back to a group of stakeholders for evaluation, decision, and action as traditionally conceived. Rather, it is a process in which the stakeholders themselves engage in an interactive and relational process to collect data from themselves and other target groups through mixed methods of research, and then collectively interpret the data and develop a grounded theory of action. Throughout this process four critical methods of logical inference come into play: (a) induction to gather and interpret data; (b) abduction to identify hypotheses; (c) retroduction to interpret the hypotheses and construct theories, and (d) deduction to derive action plans based on those theories. The process recycles in multiple iterations of induction, abduction, retroduction, and deduction to develop, evaluate, and test those theories and actions (Danermark, Ekstrom, Jakobsen, and Karlsson, (2002).

The tandem of AR and grounded theory are inclusive, with diverse identities, values, and perspectives, open to multiple interpretations and deductions, sensitive to the power dynamics of stakeholders in situations, integrative as they bring together and incorporate diverse and even paradoxical ideas and approaches, and generative as they developing new ideas and action. Procedures involved in AR and grounded theory enable leaders, stakeholders, and researchers to assess phenomena from the standpoint of different identities, positions, and power, and theorize the way in which they are going to act in different situations to develop, enact, embed, and realize the future.

The application of AR and grounded theory begins with leaders engaging stakeholder groups in appreciative inquiry to identify key categories and concepts derived from their knowledge and experience. The stakeholders’ concepts and categories (*signifiers*) focus initially on their strengths and assets using appreciative inquiry, which are then analyzed and interpreted using semiotics to construct key hypotheses, propositions, and theories explaining the situation and reflecting the meaning, values, and possible strategies and actions required to effect change. The hypotheses, propositions, theories, and actions are subsequently tested and enacted through literature reviews, experiments, and pilot tests utilizing the scientific method. Finally, the grounded theories of action are enacted and institutionalized through the method of ANT to achieve innovation and effect change. The logic and flow of the AR, with converging models and mixed methods constitutes an abductive-hypothetico-inductive-retroductive-deductive-process, as illustrated in Figure 1 below.

*Figure 1*. Relational construction AR process (Warzynski, 2018).

The research strategy and design for implementing the AR converging methods process in Table 1 below demonstrates how AR can be used as inclusive approach to social inquiry, innovation, and transformational change.

Table 1

*Research Strategy (Warzynski, 2018)*

|  |  |
| --- | --- |
| Research Strategy and Design | Description |
| 1. **Philosophical context (ontology and epistemology)** | Pragmatism and social epistemology: Meaning, value, knowledge, and experience can be acquired through collective interaction of stakeholders in a normative context (Fuller, 2007; Latour, 1993; Rorty, 1982) |
| 2. **Methodological perspectives** | Individual perceptions and constructions can be elicited, aggregated, analyzed, interpreted, and reformulated through group interactions using AR and mixed models and methods (Gergen, 2012; 2015; Greenwood & Levin, 2007; 2012). |
| 3. **Type of study** | Case study of universities striving to develop a strategic vision and plan, and reshape its culture (Palshaugen, 2009) |
| 4. **Target groups** | The target groups included steering committee, strategic planning subcommittees, culture change working group, deans group, academic and administrative groups and committees, foundation, student leader’s group, student classes, institute advisory board, alumni association, and department advisory groups. |
| 5. **Research methods** | Target groups engaged in AR and methods for collecting, analyzing, and interpreting data on focused topics and develop grounded theories of action (concept and white papers). |
| 6. **Validation** | Concept papers distributed and posted to the organization for review and feedback; strategic vision, plan, and culture revised and redistributed to the organization for final feedback, revision, approval, and implementation. |
| 7. **Enactment** | Request for proposals (RFP) to identify priorities and projects for funding; approved projects and results communicated widely to campus and key stakeholders |

The AR process using converging models and mixed methods can be used to develop interdisciplinary knowledge, facilitate innovation, and evolve a culture of innovation. It has been successfully used to develop strategic visions and plans, create new organizational structures to support and enact those visions and plans, and develop programs and projects to initiate change. It has been also been widely used to develop organizational networks, cultures, and teams, innovation centers, research proposals, technology installations, and other initiatives that require the development and coordination of meaning and action.

Implicit within the AR innovation process are characteristics of general systems theory (interdependence), pragmatism (practical workability), and social constructivism (inquiry, interaction, and co-development), and new growth theory (leveraging existing resources for innovation). According to Greenwood and Levin (2001, p. 438–439), the core characteristics of this form of research are as follows:

* It is context bound and addresses real-life problems holistically.
* It entails inquiry through which participants and researchers co-generate knowledge using collaborative communication processes in which all participants’ contributions are considered seriously.
* It treats the diversity of experiences and capacities within the local group as an opportunity for the enrichment of the research-action process.
* The meanings constructed in the inquiry process lead to social action, or these reflections on action lead to the construction of new meanings (grounded theory and innovation).
* The credibility-validity of AR knowledge is measured based on whether actions emerging from it solve problems (workability) and increase participants’ control over their own situations.

These tenets of AR can be traced back to pragmatism, social constructionism, and critical realism, and new growth theory, including the founders of pragmatism—Charles Sanders Peirce (1950; 1965), John Dewey (1976; 1991), and George Herbert Mead (1934; 1938), whose concepts and theories emphasize stakeholder involvement and interaction. These ideas were further developed and operationalized in the form of action research by Kurt Lewin (1946; 1947), and refined by Davydd Greenwood & Mortem Levin (2000; 2001; 2005; 2007a; 2008; 2012); and Bjorn Gustavsen (2005; 2008). The ideas were refined, applied, and diffused by Joe Kincheloe & Katherine Berry (2004), Ken Gergen (2012; 2014; 2015), and David Cooperrider & Suresh Srivastva (1987), and Tojo Thatchenkerry (2004; 2006; 2011), and finally validated by Roy Bahskar (1997), Berth Danermark and colleagues (2002), as well as many other proponents within the pragmatist, social constructionist, and critical realist traditions.

**Action Research and Innovation**

Peirce (1965), considered the father of American Pragmatism, asserted that abduction formed the basis of new ideas, hypotheses, and theories related to innovation. He wrote, “Deduction proves that something must be; Induction shows that something actually is operative; and Abduction merely suggests that something may be” (p. 106). Abduction constitutes a pattern of inference in the form of an explanation and hypothesis, the best explanation drawn from observation of data and experiences. Accordingly, “Every single item of scientific theory which stands established today has been due to Abduction” (p. 106). Furthermore, abduction refers to “insight” or “the faculty of divining the ways of Nature”. It is an intuitive or instinctive leap or “guess” based on subjective experience that exceeds inductive inference, inferring a possibility beyond observation and data in the form of an explanatory hypothesis or theory. It consists of the following characteristics: a) It is an inference that is used to reduce the number of possible explanations; b) it is the process of guessing or choosing the most plausible hypothesis; c) it comes into play when an anomaly is observed or an explanation is required to fill a gap in the scientist’s experience (Walton, 2004, p. 9).

Building on Peirce’s concept of Abduction, Norwood Russell Hanson (1958) expounded on the process by which abduction takes place. He stated that “Abduction . . . amounts . . . to observing a fact and then professing to say what . . . it was that gave rise to the fact”. Furthermore, he continued, “Abduction consists in studying facts and devising a theory to explain them” (p. 85), and further, “theories provide patterns within which data appear intelligible. They constitute a conceptual “Gestalt.” A theory is not pieced together from observed phenomena as being of a certain sort, and as related to other phenomena. Theories put phenomena into systems. They are built up in reverse–retroductively. A theory is a cluster of conclusions in search of a premise. From observed properties of phenomena, the physicist reasons his way towards a keystone idea from which the properties are explicable as a matter of course. The physicist seeks not the possible objects, but a set of possible explanations (p. 88-89).

Hanson’s concept of retroduction “linked abduction to explanation and linked explanation to understanding”. According to Walton (2004), this forms the basis of innovation. The traditional scientific method simply supplies the evidence and justification for the explanation (p. 18).

In other words, an explanatory hypothesis that is abducted through retroduction comprises a supposition in the form of new information and proposed knowledge that fills a gap in our understanding by answering the question “why?” It connects to and/or integrates with other hypotheses or theories in our minds as well as with other minds accessed through social inquiry and interaction, empirical investigation, reflection, and/or literature reviews, which result in a larger picture or context that helps us make sense of the world. Paradoxically, a meaningful proposition reduces the complexity of a situation while at the same time connecting it to other information and theories, thus broadening our understanding by predicting and guiding future action (see Walton, 2004, p. 58 for other definitions). It links the precision of a hypothesis to the scope of a broader theory, context, or system.

Brian Haig (1995) took abduction a step further, claiming that it entails more than mere explanation; it forms the outcome of the scientific method in which realist and social construction ontologies and methodologies are integrated in the form of a grounded theory based on experience. He asserted that “grounded theory is reconstructed as a problem-oriented endeavor or opportunistic situation in which theories are abductively generated from robust data patterns, elaborated through the construction of plausible models, and justified in terms of their explanatory coherence” (p. 2). While acknowledging his indebtedness to social construction, he referred to this general reformulation of the traditional scientific method as “abductive explanatory inferentialism (AEI).” He stated, “The AEI method provides a framework for inquiry that takes advantage of realist philosophical work on research problems, generative (social construction) methodology, and coherence justification” (p. 11). According to him, a grounded theory of action entails more than a supplement and support to the traditional scientific method: It essentially forms the scientific method. A grounded theory of action developed by a network of stakeholders using mixed methods is instrumental in addressing social problems as well as constructing theories and visions.

Social inquiry, essential to innovation, proceeds through five stages of dialogue, as indicated in the AR converging methods model indicated above. Each step is based on clear ground rules and driven by a set of questions and expected outcomes. The result of the dialogue and collaboration is an explanation and a grounded theory of action that facilitates learning, understanding, and commitment, and fosters relationships, networks, and coordinated action. The typical sequence of the process was follows:

1. Inquire: formulate key questions and collect data (Abduction and Induction)
2. Analyze and interpret data (identify similarities and differences in values, interests, and needs) (Retroduction)
3. Construct a grounded theory of action (Deduction)
4. Enact and pilot the theory to test its efficacy
5. Embed the theory (connect it to culture, structure, and processes)

Table 2 below summarizes the AR converging methods process as it may be used for facilitating innovation and developing a culture of innovation.

Table 2

*AR and Converging Methods Model (Warzynski, 2018)*



Implicit in this approach to innovation is the theory of enaction or enactivism, as conceived by Humberto Maturana and Francisco Varela (1987), which proposes that we adapt and change through interaction with our environment, and in doing so, we also alter the environment. The theory of enaction plays a central role in social, cultural, and systemic change (Baerveldt & Verheggen 1999; Greenwood & Levin, 2000; 2007; Luhmann, 1996; Weick, 1995). It explains the way in which individuals, groups, organizations interact, construe meaning, and coordinate action to effect change.

According to Steve Torrance and Tom Froese’s (2011) theory of inter-enactivism, individuals, groups, and systems are self-regulating (autopoietic) entities capable of adapting to and changing their environment (examples include climate change and cultural change), who, through interaction, configure and reconfigure relationships, construct and diffuse information and knowledge, and enact and embed new meaning and patterns of behavior, also increasing existential awareness about themselves and the world around them.

The implications of this idea of “being in the world” is expanded upon by Greenwood and Levin (2007b):

In our view, the essence of the democratic process is the co-generation of knowledge . . . collective knowledge generation processes built on active and practical experimentation aimed at solving pertinent problems . . . This grounding of sensemaking in context and practical choices creates the possibility of overcoming “the hegemony of the ruling class” . . . AR makes some small but significant inroads by creating processes that give rise to knowledge and action designs that are authentically in accord with a broad array of stakeholders’ interests . . . The co-generating knowledge creation processes of AR are a promising way of supporting democracy (p. 265).

AR, therefore, comprises more than a framework of converging theories (appreciative inquiry, semiotics, scientific method, and actor-network theory) and mixed methods of research (qualitative and quantitative). It also consists of several methods for logical inference (abduction, induction, retroduction, and deduction), which can result in a grounded theory, and new knowledge which when evaluated and tested can lead to successful innovation.

The AR process has significant implications for federally funded labs and universities. If researchers and stakeholders from government, and industry could work together with customers to integrate their knowledge and experience to construct and enact grounded theories of action, it would not only facilitate interdisciplinary knowledge but also open new avenues to invention and innovation. In other words, the fusion of different perspectives, in which, new meaning is construed and action is coordinated would result in greater research productivity, technology transfer, and increased ROI and sustainability for all parties.

This approach to innovation not only serves to integrate different schools of thought, it also suggests new opportunities, avenues, and benefits for funding research and technology transfer. It also offers a clearer understanding of what innovation is, how it is measured, and how it can be increased. This should offer a firmer foundation to enhance the return on research funding.

## Implications for Leaders

From the perspective of social systems theory (Luhmann, 1996), a university is a complex, dynamic, adaptive system embedded within other interrelating, composite, adaptive systems. Research universities must map themselves to a systems paradigm, if they wish to be relevant and develop as cultures of innovation. A one-dimensional epistemology based only on the traditional scientific method is too limited to be adaptive in the emerging world culture. Universities must begin to perceive themselves as adaptive systems that respond to complexity with complexity and change with change. Leaders in higher education and government are uniquely positioned to help stakeholders of all kinds to consider the world and their place in it through many different lenses, based on multiple ontologies, epistemologies, methodologies, and values. Without such a perspective, it is difficult to build support for innovation and technology transfer.

The way in which R&D and commercialization are realized determines the success of innovation. It shapes the culture and context of the organizations and networks themselves: as they act and shape the culture, they are acted upon and shaped by the culture. A university can create a culture of innovation by initiating and supporting the use of action research and converging models and mixed research methods by engaging the maximum possible number of people within the culture. The humanities (meaning-making disciplines), sciences (evidence-based disciplines), and social sciences (relationship-based disciplines) must work together to meet future challenges. The interdependence of these fields within the AR approach is has been depicted in Figure 2.

*Figure 2*. Action research and experiential learning across disciplines (Warzynski, 2003; 2018).

The broader implications of relational AR for higher education and government are numerous. Relational research entails more than a set of research methods to collect data and answer research questions. It is also a powerful leadership strategy that can become a way of being in relationships. AR is a way for leaders to relate to the stakeholders consistently and in a continuous manner. Stakeholders are not elements to be used but respected members of the culture and society in which they reside. Essentially, so-called “applications of relational research” take on new significance. Relational research means finding ways to work across cultures and disciplines, thereby developing theories for innovation grounded in the values and perspectives of the people within the culture that wants to resolve its conflicts. It also means developing productive relationships between political parties, building social institutions to solve social problems stemming from poverty, using AR to improve education, health care, and living conditions in general.

Important stalwarts in the domain of relational research, Davydd Greenwood and Morten Levin have been trying for nearly 30 years to convey this message to leaders in higher education (Greenwood & Levin, 2000; 2001; 2005; 2007a; 2007b; 2008; 2012). Action research comprises a disciplined way to develop valid knowledge and theory while promoting positive social change. The dialogical model of explanation underlying action research forms the basis for knowledge development and understanding by a community of scholars. It should be at the center of R&D efforts in which the users (governments, social service agencies, corporations large and small, communities, nongovernmental organizations, and so on) have a stake in the problems under study and work as partners to bring about innovation. In this regard, Greewood and Levin conclude,

The overall challenge (is) to democratize research, making the external stakeholders an integral part of the knowledge-generation and evaluation processes. Rather than trying to continue the strategy of claiming that the university is the only social location where competent research is possible, academics would take their skills outside the university to collaborate in broader knowledge-generation and evaluation processes as professional researchers and supporters of collaborative research processes. This is not an entirely new role for universities or academics, but, in our ideal scenario, this role would become the principal one, with autopoetic academic activities reserved for a targeted set of internal university initiatives (2000, p. 103).

In the McKinsey research study, “Leadership in the Context of Emerging Worlds: Illuminating the Blind Spot” (Arthur, 2000), prominent thought leaders from academe and business world stated that the blind spot for most leaders is “in not seeing or understanding the full process of “social reality formation” (p.6) in terms of how experience is cognized, accessed and translated into knowledge and action at the tacit, behavioral, relational, and system levels. They argue for a new methodology – a “distributed leadership phenomenology” that would enable leaders to describe and access relevant experience as it emerges from the tacit and social levels for leadership and innovation. The AR process with converging models and mixed methods used in this case study may be viewed as an important step in that direction (Sidle and Warzynski, 2003).

## Recommendations

In response to the U.S. President’s management agenda, aimed at modernizing the government by shifting federally funded technology to the private sector and reducing the budget for indirect costs, the Commerce Department’s National Institute of Standards and Technology, in conjunction with the White Office of Science and Technology Policy, launched an initiative called *Unleashing American Innovation* with the aim to accelerate technology transfer and increase the ROI of research universities and national laboratories. One of their first actions was to issue a Request for Information (RFI) to generate responses from across the national innovation ecosystem. This initiative presents research universities an opportunity to refocus their perspective from one in which they assert for increased research funding in order to respond to a largely contrived innovation crisis, to one which addresses the development of new approaches to increase innovation. This implies that instead of waiting for increases in funding from the public and forcing their already overburdened worked researchers to bring in more funding through grants, they should leverage their considerable talent and infrastructure to meet the challenges society is facing by designing the future.

AR presents a good way to begin the process to achieve this aim.The underlying assumption of AR is that engagement and collaboration with a broad range of stakeholders increases learning, understanding, and commitment, which, in turn, leads to focused action and desired results. The power of AR for to engage, co-generate, and integrate the ideas and knowledge of diverse stakeholder groups has been demonstrated in this case study and throughout its history (Greenwood, 2012). This method involves integration, bringing together producers and consumers of knowledge for the process of open innovation to discover and produce new knowledge and bridge the gap between different perspectives. By engaging stakeholders in the action research process researchers can develop explanations, rationale, and a culture of decision—making that leads to action rather than a litany of never-ending pleas for more resources. Action research allows groups to formulate theories of action to plan and enact the innovation process.

To redesign and re-energize the innovation system in universities, distributed leadership and collective action is required. Institutional change in a research enterprise cannot be introduced through force or mandates from senior leaders. It needs to be founded in collective empowerment and action of the entire community. The integrating elements that hold a university together are a higher cause to serve society, the opportunity to contribute one’s knowledge, experience, and skill, and the social interaction through which learning is realized, knowledge is acquired and disseminated, relationships evolve, and something new is developed that can make a difference in the world. These also constitute the major components of AR (stakeholder engagement, knowledge development, network building, and innovation). They provide the means required to facilitate the mission, vision, strategies, and culture of the university today. They also provide the “glue” in the form of meaning, appreciation, affirmation, and fulfillment to sustain the knowledge producing enterprise (Thatchenkery, 2011).

Knowledge networking—the combination of knowledge development and network building—implies the synergistic ability of individuals, groups, or organizations to link, combine, and build upon different knowledge domains for the purpose of generating, evaluating, refining, expanding, and applying knowledge to meet a challenge, satisfy customer or stakeholder needs, solve a problem, or achieve a goal within a specific application context. Both knowledge development and networking require individuals and groups to interact with different stakeholders and customers, regarding different subjects, at differing timings than what has been the case in general. They also require the development of alternatives and decisions concerning what needs to be developed, ways to develop it, and the place and time as well as the reason behind the development. In other words, they require individuals and groups to share and build on each other’s knowledge and experience. To accomplish this, individuals and groups must be willing to employ a variety of research methods to obtain information and data, discuss their differences openly, design and experiment with new ideas, and break away from the customary and old ways of perceiving, thinking, and acting.

Knowledge development and networking requires multi-disciplinary and transdisciplinary research, with the motivation and ability of individuals, groups, and organizations to learn, develop relationships, solve problems, and form decisions. The processes of knowledge development and networking face the same issue in learning: People learn from each other when there are differences, but differences happen when they have problems linking, integrating, expanding, and distributing knowledge. Groups and individuals usually have different starting points, assumptions (beliefs), values (decision criteria), experiences (histories), languages (jargons), methods, and so forth. So, where and how should one begin to bridge these differences? This does not present a new problem. In fact, this was the same problem Charles Sander Peirce, the father of pragmatism, and Edmund Husserl, the father of phenomenology sought to solve. Peirce attempted to create a theory of signs underlying inquiry and provide directions or starting points for scientific investigation, knowledge development, and problem solving. Husserl, on the other hand, attempted to create a methodology to establish an objective foundation for science, free of preconceptions and value judgments. Both thinkers were in search of methods to cross boundaries and solve the problem of conceptual integration.

A pragmatic and mixed methods approach offers major benefits over other single method approaches: it is openly meaning and value driven, requires no deconstruction, addresses context, and can answer research questions that other approaches fail to answer (Denzin, 2009; Greene, 2006; 2007; Tashakkori & Teddlie, 2003). Moreover, the use of converging models and mixed methods can simultaneously answer both confirmatory and exploratory questions and offers stronger inferences through in-depth and wide solutions to complex social phenomena. Finally, mixed models and methods allow one to yield divergent findings, accommodate expression of differing viewpoints, re useful in multi-level analysis of complex phenomena, and can improve findings’ validity by reaching multiple audiences.

Any solution to the problem of differences must satisfy certain conditions to be effective: first, it must have breadth, that is, wide coverage—it must be able to tap into a broad range of specialized knowledge domains and methods relevant to the application context of the problem; second, it must deal with the problem of different languages and jargons; third, it must be relatively efficient in bridging gaps by identifying starting points and creating a common foundation of mutual understanding to build future work upon; fourth, it must deal with problems of personality, power, and status differences; fifth, it must promote an environment of participation, openness, experimentation, and responsibility in order to facilitate learning; sixth, it must establish clear and acceptable criteria or values that allow individuals and groups to progress toward agreement or consensus; seventh, it must be capable of resolving differences; finally, it must lead to action and facilitate learning and the development relationships and networks.

AR satisfies these conditions through the integration of mixed models and methods from different traditions, including social construction, science, and pragmatism, into a single though multi-faceted process for engaging stakeholders with substantial differences in an innovation process that aims to transform ideas and meaning into a physical reality. The algorithm for AR is: open and democratic leadership + engagement of multiple models and methods in broad based learning = new knowledge (grounded theory), which, when enacted facilitates interaction, relationships, networks, and innovation.

Based on this analysis, three ways in which labs and universities can increase their research productivity and innovation outlined below.

1. Include the requirement that future research proposals include an AR component that would allow researchers of proposals to engage in a series of face-to-face AR workshops with groups of interested stakeholders from the sciences, social sciences, humanities, government, and industry, in order to generate grounded theories of action either (a) prior to and as part of their formal proposal and/or (b) following their proposal as a condition of their award. The AR workshop would be enriched by a mixed methods survey, which would require the participants to answer a set of research questions to elicit quantitative and qualitative data, to be aggregated and distributed to the participants for study prior to the workshop. The research design, including research strategy, questions, and methods that would be used for data collection, analysis, interpretation, and evaluation would be shared with and critiqued by the participants before the workshop. (Note: The AR workshop would not act as a substitute for the literature review but would rather supplement it.)
2. In addition to hosting a few open public forums in different cities, NIST and other public agencies could issue a “Call to Engagement” to universities, requesting them to use AR across their disciplines to identify future research initiatives for funding and develop innovative solutions to the technology transfer and return on investment challenge. The grounded theories that emerge as a result of this process could be then considered for changes to public policy to meet critical challenges facing society.
3. A related initiative might be for research universities to use the AR converging methods approach to develop their strategic plans and research cultures, and to integrate or build a mixed models and methods approach to innovation within their institution. Instead of being limited by the traditional scientific method, and creating a plethora of micro-studies, many of which are neither reproduceable nor cumulative, universities themselves would strive to develop strategic plans for their research and culture of innovation.
4. A more radical proposal is to move more toward open innovation as discussed by Chesbrough (2003; 2006). This can be accomplished by rescinding the Bayh-Dole Act or Patent and Trademark Law Amendments Act ([Pub. L.](https://en.wikipedia.org/wiki/Public_law) 96-517, December 12, 1980), which is leading universities in the wrong direction, and transferring ownership of publically funded research to the federal government or an outsourced private exchange, to establish a research market where licenses and equity positions could be purchased and investments offered in the form of stocks, bonds, options, and futures for designated research areas. This could result in the following improvements and benefits:

(a) reduction of the current bureaucracy and high transaction costs of Technology Transfer Offices which incur significant resources and accomplish little in the way of innovation and absorb are losing money and accomplishing little in the way of innovation; (b) engage industry and the public in purchasing and investing in government research to provide greater benefit to society and a more sustainable revenue stream for funding research.

Innovation entails a process, product, and context that creates new knowledge and transforms it into physical reality for the purpose of enriching and sustaining life on this planet. It is much more than just inventing or coming up with new ideas. Federally funded labs and universities, supported by federal monies, must become domains that encourage interdisciplinary interaction between stakeholders, and that facilitate the production and dissemination of useful knowledge for society.

The broader implications of relational action research for the society are significant. It can be employed to integrate ideas, bridge differences, and generate improvement in every social institution and sphere of life. Relational research represents a powerful organizational strategy that allows all stakeholders to engage in dialogue concerning important issues and develop grounded theories of action to enhance the human condition—it forms the essence of an active, growth-oriented, and democratic society.

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**Request for Information**

**Federal Technology Transfer Authorities and Processes**

**Last day to submit the responses: July 30, 2018**

### Introduction

In order to advance the President's Management Agenda to modernize government for the 21st century, including the associated Lab-to-Market CAP Goal in coordination with the White House's OSTP, NIST is initiating a Return on Investment (ROI) Initiative [4] with the intent of conducting a comprehensive assessment of the Federal technology transfer system that will identify opportunities to improve Federal technology transfer efforts, policies, and practices. The goal of this effort is to, where appropriate, streamline and accelerate transfer of technology from Federal R&D investments to attract greater private-sector investment for innovative products, processes, and services, as well as new businesses and industries that will create jobs, grow the economy, and enhance national security.

NIST is seeking broad input and participation from stakeholders in Federal R&D, intellectual property, and technology transfer to assist in identifying and prioritizing issues and proposed solutions. This assessment will address: (a) Core Federal technology transfer principles and practices that should be protected, and those which should be adapted or changed; (b) approaches to improve efficiency and reduce regulatory burdens for technology transfer to attract private sector investment in later-stage R&D, commercialization, and advanced manufacturing; (c) new partnering models and technology transfer mechanisms with the private sector, academia, other Federal agencies, state, and other public-sector entities to support technology development and maturation; (d) new approaches that will reduce or remove barriers, and enable accelerated technology transfer, with a focus on areas of strategic national importance; (e) better metrics and methods to evaluate the ROI outcomes and impacts arising from Federal R&D investment; and (f) new approaches to motivate significantly increased technology transfer outcomes from the Federal sector, universities, and research organizations.

This information will only be used as input to the Return on Investment initiative. All submissions, including attachments and other supporting materials, will become part of the public record and subject to public disclosure. Sensitive personal information, such as account numbers or Social Security numbers, or names of other individuals, should not be included. Submissions will not be edited to remove any identifying or contact information. Do not submit confidential business information, or otherwise sensitive or protected information. Comments that contain profanity, vulgarity, threats, or other inappropriate language or content will not be considered.

### Instructions

This template is designed to facilitate responses to the RFI. Use of this form is optional.

It is not required to fill out all of the sections, for example a participant may elect to only provide input on one question.

Save and email it to [roi@nist.gov](mailto:roi@nist.gov).

# Contact Information

|  |  |
| --- | --- |
| Full Name | **Chester Charles Warzynski** |
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| Organization Name | **Warzynski Consulting** |
| Organization Type | **Educational Consulting** |

Questions

1. What are the core Federal technology transfer principles and practices that should be protected, and those which should be adapted or changed?

|  |
| --- |
| The transaction costs for compiance with federal regulations for grants and awards are a tremendous waste of public funds. The system is a bureaucratic nightmare. It needs to be radically streamlined and revised. |

1. What are the issues that pose systemic challenges to the effective transfer of technology, knowledge, and capabilities resulting from Federal R&D? Please consider those identified in the RFI as well as others that may have inhibited collaborations with Federal laboratories, access to other federally funded R&D, or commercialization of technologies resulting from Federal R&D?

|  |
| --- |
| The Bayh-Dole Act of 1980 is counter-productive to innovation. University are geared toward invention rather than innovation. Universities are departing from their original purpose to education, research ideas, and contribute to society. Extensive resources are being consumed to feed the existing research infrastructure and develop and operate Technology Transfer Officers, Innovation Centers, Venture Labs, etc. to commercialize research and create new revenue streams. This has contributed significantly to the high cost of education, inumerable commercial failures, faculty frustration and disillusionment. The massive digression from the original mission of universities has contributed significantly to the high cost of education, poor use of resources, inumerable commercial failures, faculty frustration and disillusionment.  Other issues and barriers to innovation are: (a) lack of engagement and involvement of stakeholders; (b) absence of a mixed models and methods approach to innovation; (c) over-reliance on the scientific method, analysis, and evaluation, and under-emphasis on action research, isynthesis, integration, and social construction of knowledge; (d) rigid disciplinary structure of the university and lack of interdisciplinary and transdisciplinary work; (e) culture of individualism with reward/incentive systems encouraging individual achievement as opposed to collective achievement; (f) competition for resources between academic units and administration. |

1. What is the proposed solution for each issue that poses a systemic challenge to the effective transfer of technology, knowledge, and capabilities resulting from Federal R&D? Please consider the approaches identified in the RFI.

|  |
| --- |
| 1. Use Action Research with converging models and methods and greater engagement of stakeholders in the research, development, and commercialization process  2, Accept fewer single researcher disciplinary-based proposals.  3. Require Action Research as part of the proposal or as part of the post award process.  4. Move more aggressively toward open innovation like Sweden and other coutnries, and provide free access to all publically funded research  5. Rescind or revise the Bayh-Dole Act and create a research exchange market |

1. What are other ways to significantly improve the transfer of technology, knowledge, and capabilities resulting from Federal R&D to benefit U.S. innovation and the economy? What changes would these proposed improvements require to Federal technology transfer practices, policies, regulations, and legislation?

|  |
| --- |
| Rescind or revise the Bayh-Dole Act and create a research exchange market for engaging industry and the public in investing in research and creating a more sustainable return. |

## Thank you for your time and participation.