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# Intellectual Property Rights for Digital Design and Manufacturing: Issues and Recommendations

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# Abstract

The Adaptive Vehicle Make (AVM) program of the Defense Advanced Research Project Agency (DARPA) has objectives internal to its traditional research aims and related to larger national manufacturing roles in defense preparedness, and, by extension, in American manufacturing competitiveness. Pursuing these manufacturing objectives through innovation and invention are consistent with, but from a defense policy perspective, exist independently of the recently announced national Advanced Manufacturing program and its establishment of 15 pilot and demonstration centers.[1] Inevitably, however, whenever "innovation" and "invention" are engaged, the issue of intellectual property rights comes into play.

This paper examines the intellectual property rights issues associated with the use of a digital process for developing design, performance and manufacturing specifications for complex assemblies like land, sea and air craft. The intellectual property rights issues are addressed from the perspective of commercial organizations; these issues include understanding risks of creating and sharing new manufacturing models; providing tangible incentives (both economic and technological) to collaborating participants in a non-traditional commercial structure for further development of the technology; and implementing rules and procedures that will appeal to participants in both the short- and long-term.

This paper proposes a specific, but adaptable framework for the operation of the Intellectual Property Rights management mechanisms necessary to bring the AVM digital design process to maturity. It also includes descriptions of essential institutional structures, governance processes and agreements required to define the scope of Intellectual Property Rights (IPR) within a collaborative development environment, the essential IPR management role of the entity, the operating elements necessary to incentivize technical investigators, the records management to enable the use of existing proprietary know-how, and the essential structures to hold, share, and protect the know-how developed by the collaboration.[2]


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[1] B. H. Obama. (2013). Presidential statements on national objectives of "retention of leading edge competencies, enhanced innovation, speedy access to component goods and services, proximity to consumers, and knowledge synergies" [Online]. Available: http://manufacturing.gov/nnmi.html

[2] M. F. Molnar. Editor. (2013, November) *Draft Guidance on Intellectual Property Rights for the National Network for Manufacturing Innovation* [Online]. In setting out these core IPR policy elements, the paper echoes the work of the Intellectual Property Task Team of the Advanced Manufacturing Program Office. Available: http://manufacturing.gov/docs/nnmi_draft_ip.pdf

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# Executive Summary

The Adaptive Vehicle Make (AVM) program of the Defense Advanced Research Project Agency (DARPA) has pioneered technology-based design and fabrication innovations to decrease the time to produce complex vehicles by fivefold. Central to this approach is the use of discrete components that accurately represent commercial products, properly embody expertise, and correctly characterize techniques. The possession of this information provides competitive advantage in the current marketplace, but its widespread availability is critical to a future functioning environment for digital design and manufacturing.

As a steppingstone to that future, the recently founded Digital Manufacturing and Design Innovation Institute (DMDII) will continue to develop AVM technologies. This paper reviews the recognized systems of Intellectual Property Rights (IPR) protection available within the collaborative context of the DMDII. We recommend that the Institute adopt trade secret protection as the default mode of operation based on the relative expedience of trade secret protection compared to other processes, the lower cost of trade secret protection, and its general flexibility within a collaborative development environment.

This paper also addresses the necessary governance structure to support such an IPR régime and makes specific recommendations regarding the incorporation of provisions supporting the recommended IPR approach in affiliation documents and agreements. Discussion is also devoted to issues of valuation of innovations to provide guidance to DMDII and the collaborators in support of commercial licensing of innovations developed within DMDII.

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# 1 Purpose of this White Paper

This paper considers the intellectual property rights issues raised by the development of innovative tools for use in digital processes for the design, simulation of behavior, prediction of performance, and specification for manufacturing of complex assemblies like vehicles, aircraft, and ships. Of particular concern is the handling of intellectual property or know-how, embedded in software elements that represent the physical properties of the components like engines, drive trains, and cooling systems that a design combines into the subsystems that comprise a completed vehicle. Furthermore, there is embedded in the design process understanding of the complex operational environments and knowledge of manufacturing techniques that make the industrial production of these complex products possible.

These intellectual property issues became visible during the DARPA Adaptive Vehicle Make (AVM) project. They are central to a functioning environment for digital design and manufacturing, and they present challenges to widespread adoption of AVM technologies. A resolution to these challenges requires an analysis of intellectual property management and recommendations for its use in a cooperative as well as competitive market. Properly tuned intellectual property management will be required for the successful transition of AVM program technology to commercial use in general and to further development in a collaborative organization like the Digital Manufacturing and Design Innovation Institute (DMDII) in particular.

## 1.1 Approach

This study consists of an analysis of the technical environment in which the collaboration will seek to conduct its research, posits considerations confronting collaborators in that research environment and makes recommendations appropriate to the unique elements of the collaborative structure. The paper broadly adopts the analytical perspective of the participating commercial vendor organizations that could contribute technology elements of component models or otherwise advance the digital design and manufacture of complex commercial products. From that commercial entity perspective the issues include:

- What are the risks of creating component, context, and manufacturing process models and then releasing them for widespread use?[3]
- How can these risks be mitigated?
- What are the potential rewards of creating and distributing these models?
- How can these rewards be protected?
- How will a consortium-based framework of incentives, rules, and procedures like the DMDII create an approach attractive both in the short and long term?

[3] In this context, "risk" includes opportunity costs of participants' commercial exploitation and individual corporate gain left unrealized for the sake of a more limited share of a "greater" benefit—in the form of both know-how and remuneration—distributed more widely across the manufacturing community.

# 2 The AVM Design and Manufacturing Model

The goal of the AVM project was to compress the time required to produce a new vehicle fivefold. To achieve this goal, the project adopted the paradigm prevalent in the semiconductor industry of designing end products through assembling together individual components whose behavior was well known and whose function within a larger design could be validated through software simulation. In adapting this approach to vehicle design, the AVM project created a number of new software tools that link together to work on a common digital representation. Using the AVM tool chain, a designer can experiment with a huge number of combinations of components, extract practical from possible designs through performance simulations against requirements, verify manufacturing lead times and material availability, and then automatically generate component orders, numeric machine code for custom part creation, assembly instructions, and a logistics plan.

## 2.1 Process Overview

The AVM Design Process follows the pattern of Model Driven Architecture in which the designer begins work with highly abstracted representations of key components in a conceptual design that evolves into a fully detailed design ready for manufacturing. The META tool, named CyPhy, provides the primary user interface into the META Tool Chain and implements the design process flow. Through CyPhy, a designer pulls the various parts and subassemblies of a vehicle from a component library and connects them together functionally to form a design.

With a large set of components, and the option to substitute many different individual components to fulfill the same function, the number of possible designs expands according to a combinatorial function. Design constraints, or requirements, are expressed in test benches that can be as simple as insuring that a design is no larger than a certain space, as straight forward as determining top speed over rough terrain, or as challenging as understanding the degree of protection a hull affords occupants under deforming forces. During software simulation of performance the designer can evaluate the cost and benefits of each potential component against the vehicle requirements to select out suitable designs.

An important part of the AVM approach is to bring manufacturing concerns and verification of performance back into the midst of the design process in order to avoid cycles of rework on inadequate products. In addition to characterizing vehicle performance, test benches provide information on product lead times, assembly constraints, and manufacturing costs that allow a designer to form a complete picture of the feasibility of a design.

## 2.2 The Role of Software Models

AVM uses a model-based methodology for design, evaluation, and manufacturing assessment. Each individual component in a design is a model that may have a software module that imitates the behavior of its real life counterpart, a representation of its physical dimensions and features, and manufacturing or procurement information. For example, a real diesel engine puts out varying amounts of torque with variances in fuel feed. The software module in a diesel engine component model produces varying values for torque output with corresponding variances in values for fuel input; the CAD representation shows the physical features of the engine; the manufacturing information identifies its vendor, how much it costs, and how long it will take to deliver. The more complex the component model, the more inputs it takes into account, like atmospheric temperature and pressure, and the more outputs it produces, like waste heat and vibration, and most importantly, the closer the correspondence between the model output and what an observer would see under the same circumstance in real life.

The context models embedded in test benches are similar. A context model contains all of the simulation information of the test environment or analytical formulas for an assessment. A context model for determination of maximum vehicle speed would have the fuel feed and shift logic that drives the engine model used as an example in the previous paragraph. A context model for manufacturing assessment might compute manufacturing cost from the number of bends in a type of material that produces the finished product.

Neither computer modeling nor software simulation is unique to the AVM program. Aerodynamic and automotive engineers, to name just two examples, routinely use both. Where the AVM approach differs is that prevailing practice requires the creation of a single purpose simulation that includes both the design and its test environment. AVM seeks to provide a flexible yet consistent multi-purpose capability inherent in the models so that a designer can match them to a variety of contexts. AVM separates the simulation context, the degree of surface grade or roughness of sea, and packages them as individual test benches. Through the employment of different test benches with varying configuration values against an independent digital design with various component options, a designer can subject many different designs to many different analyses.

## 2.3 Sources of Proprietary Information

Proprietary information and identifiable intellectual property reside in a number of places within the AVM tool chain. The chain includes several models (component, context and manufacturing), along with remote execution services, and a design process flow.

### 2.3.1 Component Models

The primary location for intellectual property is in the vendor and manufacturer supplied component models. A component model will contain a CAD representation, normally protected under copyright, which provides the physical dimensions and appearance of the component. It may also contain a software module, also normally protected under copyright, which reproduces the behavior of the component for simulation. Since the quality of simulation depends largely on the quality of the information in the models, there are strong incentives for the use of proprietary information that may be subject to reverse engineering or revelation through direct examination.

### 2.3.2 Context Models

Context models aid the evaluation of the requirements that a successful design must meet. Those that provide a simulation environment embody knowledge of that environment to model things like rough terrain, wave action, or corrosive effects over time. Context models may contain a great deal of empirical data derived from extensive observation in the field. In cases where the observations are difficult to make, require expensive facilities, or must be acquired over long periods of time, the empirical data will have significant value. And, of course, critical to a context model is sensitivity to what factors are, and what are not, important to model.

### 2.3.3 Manufacturing Models

Manufacturing models hold know-how about manufacturing techniques or assembly ordering. Time and cost to manufacture estimates include information about how particular manufacturing tools work, how fast they can produce a desired product, how quickly bits require replacement from wear, and at what speeds they should run against materials of a certain sort fed to the machine at a certain rate. Generally, this information requires a great deal of experience collected over time. Such information and resulting techniques might normally be protected by patent or hidden from competitors as internal processes.

### 2.3.4 Remote Execution Services

Some test benches are computation intensive and execute on remote servers. These servers have a service interface not unlike many offerings in the currently exploding cloud services business. Creating and managing these services requires know how that may confer competitive advantage.

### 2.3.5 The META Design Process Flow

The META tool chain implements a design process flow that is potentially patentable. The various techniques for expanding and winnowing the design space may also contain candidates for patent protection. Any improvements to the process flow may confer advantages in time to market for their discoverer.

## 2.4 Infringement Risk

Because AVM uses a model-based methodology, the quality of the models is a prime contributor to its success. However, an accurate model may include enough information to derive values that the manufacturer may not wish to disclose, like aircraft engine maximum ceiling. Moreover, the values and the algorithms inside the models may expose information beyond what vendors normally reveal in the public domain in the standard course of business about their expertise or internal processes.

A vendor must therefore address the questions "*Can a model be so good that it gives away my competitive advantage?*" and conversely, *"Will it expose deficiencies in my products that competitors may readily exploit?"* Further, the quality of information in a component, context, or manufacturing model may reveal proprietary information that is neither patent nor copyright protected but hidden inside company facilities.

We propose the following thought experiment. If a third party independently creates a model, does he infringe upon the rights of the manufacturer of the product? Does that manufacturer then give away that same information when he creates his own model? How then does the manufacturer protect it or at least derive sufficient value from releasing it?

For the AVM project, individual contractors created component, context, and manufacturing process models. They relied upon performance data, some public, some under disclosure restrictions, from the manufacturers that make the products, developed their own representations of the manufacturing machines and processes, and drew from experience with the environmental contexts. In order to avoid infringement challenges for commercially available products, they approximated some values and applied engineering judgment in assigning others, generally in a way that leaves the intellectual property issues unresolved.

# 3 Intellectual Property Issues in the Context of DMDII

Announced by the President on February 25, 2014, the DMDII is headquartered in Chicago and led by UI Labs. This competitively selected consortium consists of more than seventy companies, universities, nonprofits, and research labs. This partnership will work to enable interoperability across the supply chain, develop enhanced digital capabilities to design and test new products, and reduce costs in manufacturing processes across many industries.[4]

A principal national policy purpose for establishing the DMDII along with other National Network for Manufacturing Innovation (NNMI) Institutes is to support America's retention of a "leading position in advanced manufacturing."[5] Its objective presents several challenges that warrant careful consideration in formulating the operational IPR framework.

> First, the research objectives have *high priority* from a defense community perspective, as well as having a national profile.
>
> Second, the DMDII research is proposed to proceed on a *collaborative basis* with multiple investigators from diverse backgrounds.
>
> Third, it is likely that there will be tools developed that will be *competitively significant* among the community of manufacturing collaborators, placing a premium on the economic value of these innovations and thus a premium on the process for protecting and managing the allocation of associated licensing, royalties, and other rights.
>
> Fourth, for the duration of the Institute, this program will come under the scrutiny of several agencies of government, including the White House, as well as the media, academic interests and a global community of competitors.

A collaborative development environment which results in prompt sharing and rapid commercialization of the various innovations must address the risk of ceding advantage to any single participant, or otherwise being subject to challenges of unfairness or conflicts of interest unrelated to the technological efforts themselves. The successful establishment of a consensual IPR mechanism within the DMDII framework will thus be an important measure of and contributor to the viability of the AVM approach and its sustainability among non-collaborating competitors.

## 3.1 The Role of the DMDII

The DMDII figures prominently in transition plans for AVM technology because the goals of that organization align so well with those of AVM. The purpose of the Institute, to provide resources and policy impetus for an essential evolution in the application of critical technologies to design and manufacturing processes, is entirely consistent with the more focused vision of AVM. Moreover, its stance as a facilitator between private companies, government, and

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[4] See http://www.manufacturing.gov/dmdi.html and http://www.manufacturing.gov/docs/dmdi_overview.pdf for additional information.

[5] President's Council of Advisors on Science and Technology, Transmittal Letter of Advanced Manufacturing Steering Committee " *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing,"* July, 2012. Available: EOP@WH.gov.

academia makes the Institute an ideal path through which to release AVM technologies for further development and ultimate marketplace acceptance.

Each collaborating entity within DMDII is in a similar economic position. Participating in the DMDII holds the prospect for collaborators of gaining access to innovations they and others have developed at a cost lower than if pursued and protected unilaterally, or perhaps even, of gaining access to innovations where it might otherwise not have been possible in a competitive market.

Similarly, this community of collaborators is alike as potential donors of preexisting know-how to the common effort, in that each may be forgoing the economic gain available from a monopoly exploitation of uniquely held know-how in favor of contributing their expertise to the common good, in return for a far reduced remuneration, but a leveraged collaborative research effort. The intent of this "commons" structure of the Institute is that all participants share and share alike an enlarged pool of intellectual property.

We expect one of the largest impediments to the creation of common intellectual property and mechanisms for sharing it to be the traditional, commercially motivated tendency of innovators towards such individual protection and commercial exploitation of their own innovations. Without a significant, meaningful appreciation of the IPR context, both risks and rewards that arise from the common efforts of competitors, we do not believe that DMDII will be able to properly manage the essential function of creation of *shared* intellectual property.

Similarly, for the AVM approach to work on a wide-scale, there must be a successful resolution to the IPR issues of sharing information that confers competitive advantage. What role then can the DMDII play as a collaborative body that DARPA, other government entities, private companies, nor academia can play individually? Simply stated, the DMDII may serve in microcosm as a test case for the wider marketplace. If the DMDII cannot create mechanisms for the proper sharing of intellectual property within the constraints of a collaborative community, it is difficult to see how they can occur outside of it in a competitive marketplace.

## 3.2 Core Intellectual Property Rights Issues

There are several core intellectual property rights issues confronting Institute management and participants.

- The legal posture of the Institute itself and the significance that plays in relationship to the commercial entities and other collaborating parties, especially with regard to licensing of innovations;

- the treatment of innovations resulting from collaborations, including the means of protecting innovations against theft or infringement, and publishing or otherwise distributing and sharing them among participants, licensees, and other third parties;

- the treatment of intellectual property brought into the Institute by participating members of the Institute;

- the treatment of any revenue, remuneration or other compensation accruing as a result of successful exploitation of innovations to the collaborating participants, other participants in the Institute, the Institute itself, the United States, or other parties, including issues of valuation;

- the expression of the terms and conditions in agreements between the Institute and its participants.

The issues and corresponding recommendations in this document reflect considerations identified by the interagency Advanced Manufacturing National Program Office (AMNPO) hosted by National Institute of Standards and Technology,[6] and in particular the intellectual property framework issues identified by the AMNPO intellectual property task team in its November 2013 "*Draft Guidance on Intellectual Property Rights for the NNMI.*"

### 3.2.1 Institute Mission and Its Intellectual Property Implications

The national objectives set out in the President's Council of Advisors on Science and Technology Reports in 2011 and 2012, in several of the President's announcements, and in his 2013 State of the Union message all target manufacturing innovation for investments by the Federal government, the states, and industry. Restoring to the U.S. the colocation of research and development into advanced manufacturing techniques with the manufacturing activities themselves will allow the retention of leading edge competencies, enhanced innovation, speedy access to component goods and services, proximity to consumers, and knowledge synergies.[7] These and other benefits are expected to attract large and small manufacturers, universities, and individual subject matter experts to participate in the Institute; the obligation of the Institute operator is to provide a framework for these collaborations that is sustainable and demonstrates desired industry impact. The collaborative structure of the NNMI institutes, including the DMDII, embodies a highly evolved model based, at least in part, on the need for competitors to collaborate in innovations for advanced manufacturing.

While a broad range of objectives including trade expansion and workforce improvement appear repeatedly among the declared objectives for the NNMI program, sustainability and industry impact are cited as the measurable evidence of Institute success. Given the role of the for-profit manufacturing firms in each Institute, including the DMDII, the success of each Institute's operation will lead inexorably to considerations of the best approaches to the protection of the fruits of those collaborations—the innovations themselves. This intellectual property, whether in the form of artifacts, tools, software, processes or other know-how, must also have systems for their management, storage, security, distribution, and use.

Since the passage of the Cooperative Research Act in 1984, the United States has encouraged the collaboration of industrial competitors in strategically important areas of technology innovation. The Cooperative Research Act permits research collaborations that might otherwise violate the antitrust laws and enables the protection and shared exploitation of innovations under various intellectual property schemes.[8] Indeed, in at least one instance, the SEMATECH collaboration

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[6] "National Network for Manufacturing Innovation: A Preliminary Design", Jan. 2013, Available: http://www.manufacturing.gov/docs/nnmi_prelim_design.pdf

[7] Id. at p. 9 fn. 14, 15.

[8] Public Law**.** National Cooperative Research and Production Act (NCRPA, P.L. 103-42). Available: http://www.gpo.gov/fdsys/pkg/STATUTE-107/pdf/STATUTE-107-Pg117.pdf

founded in Austin, Texas, the U.S. developed an entirely new form of Federal statutory intellectual property protection to support the work of industry collaborators. The Semiconductor Mask Work is a *sui generis* IP protection specifically applicable to the output of chip foundries with attributes of both copyright protection and patent protection.[9]

Collaboration embodies elements that are at once expedient, in taking advantage of common interests from diverse sources, as well as counter-intuitive, in challenging participants to place the benefits to those common interests ahead of individual commercial motivations, at least during the life of the collaborative effort. Nowhere is this subordination of individual benefit to common good more apparent than in the area of intellectual property rights. Organizational science has recently examined the now-familiar cooperative research model and developed theories regarding its implications from an economic perspective. Collaborations such as the DMDII most nearly approximate what has recently come to be coined the *private collective model* of innovative activity. The private collective model is a hybrid of the *private investment* model, where participants gain financial returns from innovations through intellectual property rights such as patents, copyright, and contractual licenses, and the *collective action* model, where the public funding of research creates innovation that benefits all members of society, including the innovators.

### 3.2.2 Private Collective Innovation

Introduced by Eric von Hippel and Georg von Krogh in their 2003 paper published in *Organization Science*[10], the *private-collective model of innovation* explains the creation of public goods through private funding. The model is based on the assumption that the innovators who privately create public goods benefit more than those who only consume them. While the resulting innovation is equally available to all, the innovators benefit through the *process* of creating the public good.

Private-collective innovation depends upon the process-related rewards exceeding the process-related costs. Studies demonstrate that a project will not take off until sufficient incentives are present for innovators to contribute their knowledge to open innovation from the beginning. The DMDII model, as a collaborative exercise in an otherwise highly competitive industrial environment, is an example of private collective innovation whose benefits to the collaborators as well as the marketplace will be the test of its ultimate success.

### 3.2.3 Management of Collaborative Innovation

DMDII must function as a neutral that assures proper protection, fair access, and proportional remuneration for innovations developed and contributed by the DMDII participants. The framework of the DMDII must make that posture explicit, the affiliation and work documentation of the collaborators must be clear to them on the scope of their obligations, and the Institute operator and any subject matter experts supporting its IPR activities must hold those principles uppermost in their policies and practices.

[9] The Semiconductor Chip Protection Act (SCPA) of 1984, 17 U.S.C. § 913 (a) et seq.

[10] E. Hippel and G. Krogh, "Open Source Software and the 'Private-Collective' Innovation Model: Issues for Organization Science," *Organization Science*, vol. 14, Issue 2, pp 209-223, March 2003. Available at ttp://dl.acm.org/citation.cfm?id=970585.

A potential challenge to IPR management posed by the grand vision for the NNMI is the declared intention by the AMNPO to use *common approaches* to a number of institutional policies, "intellectual property, contract research, operations, accountability and marketing and branding."[11] Maintaining a common approach across the diverse entities expected to participate in each Institute, as well as the diversity of institutes in the Network, may be problematic. However, a review of the primary areas of research for DMDII suggests that the initial assessment of IPR framework considerations advanced by the AMNPO IP working group is entirely consistent with a work program devoted to developing digital manufacturing and design innovation technologies.

Given the necessity of producing innovation that will have genuine, sustainable impact on both participants and the entire manufacturing environment, the DMDII, like the other institutes, must utilize an *evolved approach to managing the intellectual property protection of collaboratively produced innovation*, regardless of whether that innovation is know-how, software, tools, or processes. Even if innovations are inarguably eligible for patent or copyright protection, the question posed to participants under an Institute's unique collaborative structure and mission is whether either of these is the correct method to protect and support the exploitation of these innovations.

## 3.3 Options for Protection of Intellectual Property

Historically, a Federal role in the granting of patents and copyrights reflected a national commitment to encourage the investment by entrepreneurs in risky, costly or simply unorthodox research. The Framers, Franklin and Jefferson in particular, made explicit provisions in the U.S. Constitution to encourage and reward the useful arts in the newly formed nation. They intended to foster a risk-reward model that would attract intellectual adventurism to the United States and allow the new country to become a haven for risk takers. The recent reports chartering the advanced manufacturing initiatives continue this long-standing encouragement for innovation and entrepreneurship.

However, it should *not* be assumed that the current prevalent mechanisms of patent or copyright protection provide the exclusive or the most effective means for a collaborative enterprise (1) to protect innovations developed by the Institute(s), (2) to structure the licensing of innovations, or (3) to allocate any compensation to the Institute or its participants.

### 3.3.1 Patent Preliminaries

The protection of eligible Institute innovations through patent filings is on first blush a reasonable approach to management of its IPR. Patent protection provides a statutorily recognized method of rewarding the inventor with a limited monopoly over the exploitation of his invention along with providing notice of creation from which some presumptive discouragement of infringement normally will ensue. It provides a recognized basis for establishing both commercial licenses based on a schedule of fees and the royalty-free license to the government presumed under the Institute structure.

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[11] AMNPO Intellectual Property Working Group "*Draft Guidance on Intellectual Property Rights for the NNMI*" Federal Register, vol. 78, Number 219, pp. 68030-68032. Available: Government Printing Office [www.gpo.gov][FR Doc No: 2013-27157

For those inventions for which it is available, that is, those that meet the basic patentability tests of novelty, utility, and non-obviousness, the patent process does require, however, extensive documentation to support these assertions and significant time. When engaged in by multiple parties, patent filing may, moreover, require extensive collateral contractual documentation among the filing parties or agreements and amendments to existing agreements. Patenting requires the assistance of expert counsel, frequently representing each individual investigator or participant, with associated costs.

Not only are all of these activities time consuming, but the process within the U.S. Patent and Trademark Office itself will take time, with patentability reviews, amendments to the application, written and oral dialogue regarding prior art submissions, and other frequent correspondence. It is not unusual for a utility patent to require in excess of three years from filing to initial patentability examination; five to seven years to grant is not atypical. Even these lengthy periods do not begin to encompass the time and complexity associated with international patent application filing or dispute resolution, which historically extend to years-long proceedings.

Accordingly, while there may be certain artifacts of the Institute which for specific reasons like geographic market considerations or threats of imminent competing filings do warrant a patent filing, or at least, the initiation of a filing process, other means of IPR protection may be preferable.

### 3.3.2 Copyright Preliminaries

The breadth of subject matter protectable under U.S. Copyright law, "a work of original authorship fixed in a tangible medium of expression," is arguably extensive. The U.S. statute also confers on the copyright holder, for the period of the grant, the important rights to:

- Reproduce the work
- Distribute the work
- Display the work
- Make derivative works or translations

A "work" may be written words, graphics, fabric, audio-visual recordings, architectural works, jewelry designs, and software represented in any medium. The protection of copyright arises from the moment a work is created, without the affixing of a "notice," although the use of the © symbol or the word "copyright," the name of the author and the first publication date is still highly recommended. While registration is not required to gain protection under the U.S. Copyright Act (17 U.S.C. § 106), registration provides certain immediate benefits, including the right to bring suit for copyright infringement, and to recover damages in any suit for infringement.

Of particular interest to the Institute may be the copyright concept of "works for hire." Under the U.S. statute, the "author" of a copyrighted work is the "creator" of the work. It may be an individual person, or it may be a corporation or other entity *if the individual author created the work as an employee within the normal scope of his employment*. There is also a specific method to qualify a work as a "commissioned work for hire" under express agreements to do so, but it is not likely to apply to the Institute situation.

Unfortunately, the quality and locus of protection accorded though copyright is limited; in the case of written works, the limit extends only to protection from infringement by copying of the expression itself. All copyrights, like patents, end at the borders of the issuing nation-state or treaty bound partners. Of greater concern is that copyright cannot assure that a technical *process* reflected in a published work or piece of software code may not be executed by another, non-infringing means. As a precaution, some experts in the field champion the protection of software under *both* copyright and patent, to assure protection of both the written expression of the intellectual property as well as the described process.

Another situation typically providing difficulty under copyright law and potentially present in the Institute's collaborative environment involves "joint works," such as a software tool or website, where the "work" results from contributions of two or more authors. Typically, the authors intend that their individual contributions be combined or merged into a single unified work where each contributor holds an undivided interest in the end product. To avoid accounting complexities, such "joint works" could be recognized in writing upon the initiation of any effort and declared "works for hire" of the Institute.

### 3.3.3 Trade Secret Preliminaries

The long-standing definition of trade secret accepted in U.S. law is found in the First Restatement of Torts, dating to 1937:

> A trade secret may consist of any formula, pattern, device or compilation of information which is used in one's business, and which gives him an opportunity to obtain an advantage over competitors who do not know or use it.[12]

The protections of trade secret law occur under state jurisdiction, and the forty U.S. states which have passed statutes regarding Trade Secrets generally follow a common definition based on the "Uniform Trade Secrets Act."

> "…information, including a formula, pattern, compilation, program, device, method, technique, or process, that:
>
> (i.) derives independent economic value, actual or potential, from not being generally known to and not being readily ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use, and
>
> (ii.) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.[13]

Under the Uniform Act, information accorded trade secret protection generally falls into two primary classifications: business information and technical information. Here, principal interest is in "technical information" including know-how resulting from research activity that includes designs, plans, processes, formulas, manufacturing techniques, software, and databases. If

[12] Restatement of Torts (First) Sec. 757, comment (b) 1937.

[13] Uniform Trade Secrets Act, Section 1. 14 U.L.A. 437-438 (1990).

inventors determine that their technical information has value, they may seek a patent for qualifying inventions, or may choose to protect it as a trade secret.

The essential procedural element establishing the availability of an invention to be protected as a trade secret is the fact of its secrecy. Many inventions have lost their trade secret protection because the inventor failed to account for publication of the invention in an obscure journal, in a foreign language, or in the distant past.

The benefits of trade secret protection also include unlimited duration, in contrast to the limited terms allowed a patented invention or copyrighted work. Moreover, the trade secret secrecy requirement stands in contrast to the patent system's overt publication requirement, and holds in any part of the world. So long as a potential competitor does not independently develop the invention that is the subject of the trade secret or improperly reverse engineer it, trade secret protection remains, and the innovator may seek to enforce their exclusive right against an "infringer."

Trade secret protections are typically embodied in contractual non-disclosure agreements. Where multiple inventors are involved, this will be an agreement among the inventing parties, styled as a Developer's Non-Disclosure Agreement (NDA); a separate agreement between the developers and using parties, styled as a "User" or "Participant" Non-Disclosure Agreement will establish the terms of licensing and use of the invention by third parties. Both of these agreements may contain terms for the allocation of any revenues to be obtained from the licensing or other commercial exploitation of the invention or innovation.

# 4 Intellectual Property Management for a Collaborative Organization

The management of the portfolio of intellectual property resulting from the efforts of collaborating participants will be a primary continuing activity of the Institute. The importance of IPR should be recognized during the enrollment of participants, the entire solicitation and research process, and in the publishing of the achievements of the Institute. One comprehensive approach to the treatment of many of these issues is to incorporate the terms, conditions and controls affecting them into *governance documents*, such as a charter or articles and associated by-laws or operating rules for the Institute that are consistent with the various guidance documents produced by the NNMI.

## 4.1 Trade Secret Protection within the Collaborative Community

It is of undeniable significance that while the handling of intellectual property and the benefits and privileges of exploitation associated with their creation have a central role in the success of the NNMI program and its constituent institutes, the pre-bid guidance for the DMDII contains no mention of patents or copyrights as structural elements, requirements, or specific evaluative criteria. These important guidance materials contain a very generic treatment of Intellectual Property. The November 2013 *Draft Guidance on Intellectual Property Rights for the National Network for Manufacturing Innovation* consistently uses the generic terms "Intellectual Property," "IP" or "IP rights," rather than referring to the specific options of patent or copyright. This choice of terminology is significant in not prejudicing the approach of the DMDII or any other Institute in structuring its IPR régime towards particular IP tools to protect its collaborative innovations and leaves open the potential for broadly discretionary treatment of IPR by the Institute.

We interpret the absence of specific IPR policy direction as an encouragement of a flexible approach. In light of what we assess to be both the impediments to the use of the statutory patent system and the limitations of copyright protections, the use of trade secret protection appears an attractive, prudent, and expedient means for providing protection for intellectual property developed within the Institute program.

## 4.2 Benefits to Trade Secret Protection

Key elements of the trade secret system and the patent system are almost distinct opposites; in a vacuum the selection of one path of protection over another would initially be dictated by considerations of commercial benefit. Here, however, the selection of a protection mechanism is as much a consideration of the collaborative nature of the endeavor and the complexities of the conduct of joint research as it is of the licensing and utilization of any innovations, and these considerations are not trivial.

Table 1 2 - Comparison of Key Attributes of Intellectual Property Protection Methods

| **Issue** | **Copyright Protection** | **Patent Protection** | **Trade Secret Protection** |
|---|---|---|---|
| Subject Matter | Literary work, software, art, musical composition, photograph | Novel, useful, non-obvious elements of invention; all must be established to the satisfaction of USPTO | Broad; protects *any* business or technical information |
| Permissible disclosure | Publication to the world | Full public disclosure required in patent process | Information regarding invention, know-how, ideas released only to parties agreeing to maintain secrecy; requires reasonable steps to protect through agreement, marking, limited access |
| Licensing | Not Applicable; License occurs when owner sells "copies" | Permitted | Secrecy required; NDA is a contractual device establishing terms of license and use |
| Duration | Life of Author plus 70 years | Statutory; 20 year term from date of earliest filed application (made consistent with global system in 1995) | Limitation permitted |
| Exclusivity | "Originality" bolsters claim against infringer | Exclusive to patent holder | Unlimited; scope of exclusivity within owner's discretion |
| Process to obtain | Publication is sufficient; registration establishes additional legal rights | Registration with recognized authority, fees | May be non-exclusive, but must maintain secrecy |
| Expenses | Minimal | Costly; application and filing fees, legal fees, maintenance fees | Costs limited to secrecy measures; but, subject to loss of value through independent discovery, reverse engineering. |

The primary rationale for preferring trade secret protection over patents or copyrights in the collaborative setting comes from these observations:

- Rapid time-to-perfection (effective upon agreement)
- Not subject to prior art/non-obviousness reviews of patent system or originality of copyrights
- Multi-party arrangements possible subject to acceptable financial agreement

The necessary documentation at both the organizational (articles, by-laws) and participant (affiliation agreements, NDAs) levels can stipulate the sharing and licensing of innovations among participants, the government, and third parties. These documents can also provide a basis for appropriate accounting and distribution of licensing revenues and royalties. A separate non-revenue license to the United States for each developed invention or innovation required by the terms of the Institute Solicitation should be incorporated into this documentation.

In some instances, technical information may be capable of protection as a trade secret where it would not qualify for a patent, because it fails one of the three core tests of patentability, novelty, utility, and non-obviousness. The court cases addressing trade secrets have held that while a trade secret "implies at least minimal novelty" the requirement is applied only so far as it not be generally known to others who can obtain value from its disclosure or use.[14]

In the context of the Institute's collaborative environment, a more important aspect of the difference between patents and trade secrets becomes focal. Trade secret protection depends on maintaining the secrecy of the details of the innovation, while patent protection depends upon public disclosure in exchange for the grant of the monopoly. In contrast to the competitive marketplace that U.S. companies and investigators are leaving to advance the state of this art, such secrecy may provide a beneficial cocoon to support the achievements of the stakeholders' objectives until an innovation is fully ready for exposure. There is no disclosure that might allow theft or creative workaround.

Of course, individual collaborators may be drawn to a calculus of whether their participation in the collaborative endeavor is worthwhile when measured against the potential for additional cost from individual activity and the potential of monopoly revenue from a patented invention as opposed to a share in an Institute-licensed trade secret. Certainly, a leading-edge participant that believes it is contributing a disproportionately large share of engineering resource may imagine that the opportunity cost of the collaborative model is working against him. The thirty year history of successful collaborations under the Cooperative Research Act and similar mechanisms that bring thousands of competitors together suggest, however, a value in the collaborative model that exceeds the anecdotal benefits of revenue associated with any single innovation.[15]

## 4.3 Intellectual Property Portfolio

An essential element of the intellectual property rights program will be the establishment of a registry of Institute innovations and participant contributions, patented and copyrighted artifacts brought in to the collaboration. Collaborating participants will bring their protected IP into the community on a voluntary basis, subjecting these contributions to appropriate restrictions on shared use necessary to retain their proprietary interests. Previously patented or copyrighted artifacts will require licenses or use agreements. Prior innovations from Institute participants protected as trade secrets may also be subject to specific agreements appropriate to an owner's desired protection. The repository will also hold third party IP licensed by the Institute on behalf

[14] Kewanee Oil Co. v. Bicron 416 U.S. 470 (1974)

[15] Y. Liu, M. O'Reilly-Allen, Z. Zantout, "The Welfare Effects of the National Cooperative Research Act (NCRA) of 1984 and the National Cooperative Production Amendments (NCPA) of 1993.".*The American Journal of Economics and Sociology*, Vol. 66, No. 5 (Nov., 2007), pp. 985-1004. Available: http://www.jstor.org/stable/27739681

of the participants in order to maintain records necessary for any accounting associated with licensing. Finally, the repository will hold the innovations produced from participant collaboration and must provide a mechanism for allocating uses and benefits associated with the fruits of collaboration.

Management of this asset will be a core responsibility of the Institute management team. The portfolio will provide Institute participants, management, and others with clear and transparent data regarding the broadest scope of IP artifacts. This data must include an inventory of:

a) the core Institute projects engaged in, resulting inventions, identity of Institute participant and partner team members on each project, and the proportion of their contribution,[16]

b) proprietary IP brought in and licensed to the Institute by partners, and

c) collateral IP developed, such as articles published reflecting Institute affiliation, any patents applied for or granted, and licenses of IPR from third parties which may be contained in Institute work products.

## 4.4 Dedicated Management Role

In view of the central role that intellectual property and associated issues of rights, royalties and licensing will play in the Institute, the presence of a full-time subject matter expert is essential. While this need not be a full time permanent member of the Institute staff, it should be a role recognized by the management team and participants as senior, decisional, and authoritative.

Such a role may be staffed on a rotating basis from among contributed resources of Institute participants, but that approach has inherent conflict-of-interest dangers. A professional resource could be shared among several institutes or established as an honorific, such as a fellowship to an accomplished recent law graduate; but, however staffed, it should be readily available in support of Institute activities. Qualification as an intellectual property expert could also be made a selection criteria for one of the Institute management positions. However staffed, by closely affiliating with the Institute, the costs of episodic retention of outside counsel are likely to be substantially avoided.

## 4.5 Participant Terms and Conditions

Among the activities necessary to take full advantage of a trade secret environment will be the development of basic agreement templates among participants. An important concern will be mitigating the risk of sharing intellectual property with competitors.

It is not necessary that precisely the same affiliation agreement be utilized for every party associating with the DMDII, but every similarly situated entity (large manufacturer, private university, individual investigator, non-contributing party) should be associated under the same terms and conditions, and those terms should be transparent to *all* parties. There are rational

[16] Governing documents and affiliation agreements should establish valuation methodology regarding professional staff levels, contributed know-how, resources, space, material and other in-kind, and cash relying on GAAP.

bases to require more complex and elaborate conditions for the affiliation of employees of a large public company already enjoying complex benefits packages and subject to pre-existing non-disclosure requirements and other constraints, as distinct from a self-employed individual contributor, or an investigator who holds an appointment as a faculty member at a public university. Language to accommodate these differences may be necessary in the Institute affiliation agreements and may affect any licensing rights or royalty distributions.

Obligations regarding non-disclosure of innovations developed as part of DMDII teams should similarly be consistent across all participating entities; however, the ultimate obligee and beneficiary of these terms will of course be different if the participating entity is a corporation or individual, and language should appropriately account for such differences.

# 5 A Contractual Framework for a Collaborative Organization

Though not specifically identified in the NNMI documentation or DMDII Solicitation beyond "membership and governance agreements," operating documents in the nature of an entity charter or articles and by-laws or operating rules will document a significant number of the mechanisms and define the methods for handling issues raised in this white paper. These documents will include terms to insert in standard licensing agreements, describe the structure of the IPR portfolio, and identify the duties of an intellectual property subject matter expert.

The Institute should establish a process to review proposed affiliation language prior to first utilization. A panel of experts, designated participants or agency Office of General Counsel staff, a committee of participant legal officers, or similar mechanism should review and, if required, propose revisions to the general contractual framework. Intellectual property subject matter experts should conduct a separate review of the specific language regarding intellectual property, both contributed and collaboratively developed.

## 5.1 Legal Status of the Institute

Achieving the IPR licensing objectives of the various participating collaborators will be challenging even if there is consensus among them. In the event that normal business concerns result in divergent interpretations, approaches or strategies, the achievement of consensus will be more difficult and may require consensus-building strategies or even voting among project participants.

The Institute itself must have standing in order to participate fully in any decision making process. Further, in at least one situation, it may be essential. Where an invention is the work product of a single participant who might otherwise be inclined towards a patent protection approach for the invention, the Institute must assert its role in all projects. There should never be a situation where resort to an individual inventor patent model in preference to other collaborative IP protection models, such as trade secret protection, seems preferable.

Accordingly, it is recommended that the Institute be identified in Institute governance documents as a legal entity and a full party to all collaborations with its own rights to all licenses on terms equivalent to members of the Institute.

## 5.2 Governance Framework Elements

To assure its success, the collaboration will require enforceable documentation of the commitments of participants. This documentation will establish acceptance of the structure and rules of the overall organization as expressed in the governance as well as specific commitments made individually by affiliated entities and their collaborating representatives.

In general, sanctions for failure to abide by commitments made in these documents should be of three types, expulsion from the collaboration, monetary fines, and exclusion or loss of privileges of membership. Whatever the penalties, they must be sufficient to assure all participants of the protection of their contributed and developed intellectual property.

### 5.2.1 Governance Documents

It has been a working assumption of this analysis that the Institute will have an operating framework consisting of both formal governance documents and affiliation agreements between it and the individual participating collaborators. The governance documents should typically include two major documents as previously described: (1) "Articles" or "Charter" as required by the jurisdiction in which the legal entity is established and (2) "By-laws" or other operating rules, establishing specific procedures for the handing of events and occurrences anticipated in the operation of the entity and for the resolution of problems.

In addition to the typical sections of an articles of incorporation or charter document on mission, membership, governing board structure, finances, committees and other governance matters required by the state, there will be substantial value in language that specifically declares the importance of intellectual property rights and their protection to the success of the Institute and its realization of its mission. There should also be acknowledgement of the delegation of certain rights by members to the Institute, including the calculation of remuneration entitled under licenses, reference to any rules for such calculation being enumerated in the by-laws and referenced in affiliation agreements. There may also be a declaration of the role of the Institute as a party to all agreements involving IPR trade secret and patent licenses.

In the by-laws or operating rules document, in addition to (1) procedures for the calculation of licensing revenue, or reference to a formal document setting out those procedures, there may be a (2) specific reference and detail provided for the default approach of reliance on trade secret protection for the protection of Institute innovations, (3) a template (or reference to one) for the language of NDAs for collaborators and licensees and (4) reference to the language in affiliation agreements regarding IRP issues including importation of protected know-how by participants, and (5) agreement to be bound by the dispute resolution process in any disputes arising over IPR.

The Institute governance plan should establish procedures for managing the marketing and licensing of portfolio technologies guided by the IP rights vested in the Institute, its members, and the US government as set out in the Bayh Dole Act. It should also address treatment of spin-off companies, equity, and other business arrangements between the members.

### 5.2.2 Contractual Commitments of Institute Participants

The unique relationships being established among collaboration participants are sufficiently different from normal business operating models that prudence suggests they be memorialized in affiliation agreements between Institute participants and the Institute. Not only is this true for the general relationship of collaboration partners, but it is especially true with regard to the assertion, allocation, and distribution of royalties associated with intellectual property resulting from collaborative activity.

#### 5.2.2.1 Affiliation Agreement

Collaborators should execute affiliation agreements with the Institute to be bound by common terms and conditions that explicitly identify their participation in the trade secret mechanism, and set out their agreement to, among other things, their use of the IP repository for collaboratively developed inventions. These agreements should contain their general non-disclosure and secrecy obligations regarding trade secrets of the collaboration, the covenants not to compete individually with the commercialization resulting from the collaborations, and an inventory of prior patented and copyrighted IP brought in to the collaboration for use among collaborators.

Additionally, the affiliation agreement should allow at any future time the contribution of additional property and specify procedures for withdrawing contributions and leaving membership.

#### 5.2.2.2 Standardized Agreements

In addition to standard language in affiliation agreements for Institute participants of various categories, specific licensing agreements will be required for Institute participants in at least two key areas: non-disclosure agreements relating to innovations resulting from Institute collaborations, and grants of limited use licenses of protected IP brought in to the Institute by participants.

As recognized by the NNMI, an essential attribute of these provisions is that to the extent possible there be one common set of language agreed to in advance by all collaborating participants, and utilized by them consistently, to remove concerns regarding inconsistent or conflicting terms that may be applicable to one participant but not applicable to another[17].

#### 5.2.2.3 Non-Disclosure of Jointly Developed Innovation

If the proposed approach of using trade secret protection as a default method of protecting jointly developed innovations becomes practice, then non-disclosure agreements covering the various types of innovations and various collaborative configurations within the Institute must be developed and used consistently. As recognized by the NNMI Reports, and as with the agreements to contribute participant proprietary IPR, below, consistency of language and usage across all participants is essential to alleviating ambiguity.

While the NDA document form is described briefly here, it may evolve to be one of the cornerstones of the entire program. If trade secret protection for jointly developed innovations is adopted as the primary method for protecting, licensing, and monetizing Institute innovations, the use of consistent NDA and related contractual language among participants to achieve predictable, reliable practice and transactional outcomes will be seen as an essential element supporting a core measure of the success of the Institute. The importance of the IPR management role in assuring careful drafting and consistent application and enforcement of NDAs and related contractual terms and conditions cannot be overstated.

#### 5.2.2.4 Contribution of Existing Proprietary Artifacts

Institute participants may wish to bring know-how, tools or other protected intellectual property into the Institute in support of their collaborative efforts on projects, or as a matter of familiarity or convenience for their participants. Language must be developed based on generally acceptable licensing terminology to reflect a participant's grant of a limited use license to the Institute and its members for any specific artifact for a specific duration at a specific declared value, supported

[17] This "uniformity" should be subject to the institutional flexibility described in Section 4.5

by appropriate evidence of valuation. These should be recorded in the IPR portfolio described above.

Among the detailed data helpful in making such disclosures meaningful and useful are the specifics of the IPR grant (patent or copyright) including grant date, grantee/holder, whether the DMDII participant is the original recipient or a successor in interest/acquirer, any collateral agreement(s) already burdening the artifact and any other material information about the contributed IP.

### 5.2.3 Other IP Management Plan Elements

Several other IP related management and process issues are identified in the solicitation document for the Institute, and while appropriate for response by applicants, are typically routine.

#### 5.2.3.1 Patent and Copyright Applications

We have suggested that while neither Federal statutory mechanism is a preferred approach for the protection of the collaborative work product of the DMDII, there may be instances where patent or copyright protections are the most appropriate mode. The act of presenting applications to the U.S. Patent and the U.S. Copyright offices require formalities that involve legal and financial commitments of the Institute as well as individual participants. The framework for proceeding in such circumstances should be specified in the governance documents, and recognized by participants in the affiliation agreements. As a rule, the Institute should be directly involved and represented in each decision to proceed. Indeed, in the case of patent filings related to inventions from Institute research, the Institute should be a named applicant on the patent filing.

Adopting a trade secret approach for protecting Institute innovations should avoid the belt-and-suspenders of filing both a copyright application and a patent application for key processes. Since the operational details of any secret process would not be disclosed, the process patent issue and *State Street* dilemma of concern with applying for a patent for a process embodied in software need never be reached. It is a rational and manageable approach when the licensee population is limited and constrained by a non-disclosure agreement incorporating a strong commitment to secrecy.

#### 5.2.3.2 Publication Process

The public release of information related to collaboration research through publication, conference presentations and similar professional activity should be subject to careful management review in order to safeguard trade secrets. Beyond that critical protection, in the interest of disseminating useful know-how the Institute should support publication. Institute management should establish a public release and publication review process that is flexible and expeditious. Recognizing the professional status of contributing investigators and their preexisting professional relationships will certainly redound to the benefit of the Institute.

#### 5.2.3.3 Dispute Resolution

A number of the activities of collaboration participants may result in controversy or dispute rising to a level requiring formal resolution. At the most severe level are issues arising from the allocation of revenues from the licensing of innovations to third parties and the associated issues of distribution of revenues to non-inventor participants in the collaboration. There may also be issues arising from other economic issues, such as valuation of contributions, and from issues regarding the boundaries, application, or valuation of intellectual property brought into the collaboration or claimed as such by a participant.

This list of potential controversies is clearly not exhaustive, but merely suggestive, and indicative of the basis for recommending that an alternative dispute resolution (ADR) mechanism be established for the collaboration in its governance documents and acknowledged by participants. Along with avoiding resort to polarizing litigation, ADR has the benefits of lower cost and typically, much more rapid resolution than formal legal proceedings.

The process may be divided between matters that are subject to compulsory ADR and those for which it is merely available. It may be tiered beginning with staff member review prior to escalation to a more formal process or to professional mediation. Tiers may be appropriate for licensing disputes involving amounts above a specified level.

The ultimate objective should be the prompt resolution of disputes at the lowest possible cost while preserving relationships among collaborators.

#### 5.2.3.4 Specific Project Commitments

Because of the operation of law, certain commitments made by collaborators are fundamental to the success of the collaborative effort, particularly where trade secret protection is invoked. Any breach of candor in the act of affiliation or misrepresentation of fact could impact not only the offending party, but put at risk the efforts and investments of every other participant. Accordingly, specific commitments regarding prior engineering practice in any area underlying a shared trade secret is of the greatest significance to the collaboration.

a) No prior activity in subject invention

Essential to the operation of trade secret protection are collaborator declarations that each has individually and through any employee *no* prior activity in a subject invention covered by a trade secret agreement. Lack of candor in this regard could, upon discovery, defeat the agreement and render an invention open to patenting by a third party.

b) Non-disclosure of collaboration activity

Closely related to the attestation of no prior activity is the commitment by collaborators to maintain absolute secrecy about the nature and operation of the invention. This secrecy lies at the heart of trade secret protection, and, as with prior investigation, any failure of the commitment could defeat the protection and open the invention to patenting by a third party.

The duration of the secrecy obligation is significant; it applies in the present and the future, for the entire period of the trade secret agreement, even if that exceeds the participation of the collaborator in the collaboration or the existence of the collaboration. The obligation persists without regard to whether the party remains affiliated with the Institute or any member, affiliate, or sponsoring activity.

c) Individuals; Individual Insurance

Individual investigators participating in the Institute not affiliated with a corporate or other institutional entity must be bound by the same commitments of candor and secrecy on an individual basis supporting the trade secret structure that corporate, educational, and other institutional entities are bound. However, in the event of a breach of their commitment, their ability to respond to sanctions may not be the same as institutional members; the collaboration may wish to engage insurance to protect itself in the event of a breach of a commitment by an individual who is unable to respond to sanctions.

#### 5.2.3.5 Agreements among Participants

As a general rule of procedure of the Institute, there should be no separate agreements regarding intellectual property rights between individual entity-members of the collaboration in their capacity as participants in the collaboration. All arrangements within the Institute involving participants should be open and transparent, and should include the Institute itself as a party to the arrangement. Of course, the collaborators may not be constrained from making independent business arrangements unrelated to their participation in the collaborative organization; however, in the interest of transparency, any such arrangements should be the subject of notice to Institute management, and it is recommended that the governance documents incorporate a requirement of this disclosure, including any executed for a period of time after any organization's departure from membership.

# 6 Commercialization of Innovations

The Institute's research will lead to innovations that strengthen the existing manufacturing base and build new ecosystems in advanced manufacturing. To accelerate the adoption of innovations, the Institute can bridge the gap between applied research and marketable products by reducing the risk and the cost of commercializing new technologies developed by its member organizations, and providing a mechanism for bringing these innovations to market. Supporting technology commercialization and spin-offs will contribute to the competiveness of U.S. manufacturers and benefit many sectors of the economy.[18]

## 6.1 Commercialization Process

Each case of technology commercialization has its own objectives, requirements, and timeline. Even innovations with clear commercial potential may require additional resources to address gaps typically presented by emerging technologies. Commercialization starts with a selection of candidate technologies, assessment of their commercial feasibility, determination of the appropriate form of IP protection, and development of a commercialization strategy. Within the Institute model, several steps in this process are "home-grown": know-how development is the essence of the Institute's mission, and promotion of marketplace awareness of innovations through conferences and publication are a mainstay of the programs of these incubator institutions.

Considerations in developing valuation strategy include licensing terms, exclusivity, fields of use, fees, and export restrictions. Attracting qualified licensees, among small and medium-sized businesses, as well as large entities, is an essential phase in the process. Due diligence on potential licensees' ability to carry out commercialization objectives will improve prospects for an effective licensing program. Stipulating development milestones that lead to the technology's availability will contribute to reaching commercialization goals of the Institute.

Monitoring the progress of licensees' commercialization efforts ensures that resources invested by the Institute in core technologies yield economic and societal benefits to the country as a whole. Revenues and royalties resulting from commercial license fees will be shared among Institute and members as agreed in the governance plan. Over time, revenues will contribute to the Institute's financial sustainability. However, that is not the only measure of success the Institute should monitor. Other methods of technology transfer like publication and open source contribution could lead to commercial use and may have a positive impact on industry and the economy as well.

## 6.2 Valuation Process

A critical question confronting Institute management, participating collaborators, and the marketplace is how to assess the value of collaboratively produced innovations. There are many complexities in employing valuation methodologies.

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[18] Paraphrased from text in AMNPO, National Network for Manufacturing Innovation: A Preliminary Design, 2013, p. 3.

### 6.2.1 Overview of Valuation Methods

Economic value is normally defined as what a willing seller and a willing buyer agree to as the basis for exchange. Valuation is the process of estimating a price acceptable to both seller and buyer.

Different approaches to valuation serve different purposes, and licensors and licensees will likely use differing methods. The need to determine present value for a future technology also adds additional complexity to the valuation process. Most agreements are negotiated at an early stage in the development of a technology, not later when the technology is closer to a final product and projections can incorporate an understanding of the production system and where the technology fits in the marketplace. As a result, value can change significantly over time.

The final complication is that the Institute's participants will be drawn from industry, academia, research, and government. They form a diverse ecosystem of theorists and conceptualizers, developers and designers of software and hardware components, and manufacturers from varying industries. With no universally accepted valuation method to apply, the Institute is sure to face differences that require harmonization during the initial period of its existence.

### 6.2.2 Valuation Methods

Commonly used methods of valuing technologies include the following:

- Income Method. This method is based on future cash flow generated by IP. It is necessary to forecast an accurate income stream, assess the useful life of the IP, understand risk factors related to patent protection or other types of IP protection, and select an appropriate discount rate.

- Discounted Cash Flow Method (DCF). This method is used to determine the value of IP based on present value of cash flows during the life of the property. A discount rate used to arrive at net present value is the company's market-based rate of return.

- Market Comparables Method. This method uses market data for comparable commercial arrangements to provide fact-based indicators of the value of IP within a range of probable values.

- Royalty Rate Method. This method relies on standard rates recognized within an industry or negotiated rates.

- Real Option-based Valuation Method. This method uses present value of projected cash flows discounted by the opportunity cost of capital for the IP owner to manage and maintain the IP.

- Monte Carlo Method. This method uses probability distributions to develop a new probability distribution.

- Cost Method. This method aggregates incurred costs to indicate the value of IP. The premise that research and development dollars invested indicates market value can create unrealistic expectations.

- Replacement Cost Method. This method estimates the dollar cost associated with developing the IP to its current state to support a buy-versus-build analysis.

Recognizing these options and the potential for disagreement over different valuation approaches, the Institute needs to select its course and make that decision clear. We recommend a hybrid solution based on consensus that retains flexibility in valuation approach. Rather than mandating a single valuation technique, the governance documents and affiliation agreements should state that a valuation selection process exists and spell out the specifics of that selection process in individual project agreements. This will allow a uniform, consensus based approach, but a flexible case by case application in individual projects. It does not preclude a single valuation method from becoming a preferred approach based on practice over time. In any case, it is important to refer disagreements to the resolution process.

## 6.3 Export Control Compliance

Closely related to the IPR issue, and frequently involving the same material is the issue of Export Control compliance and the sharing of sensitive information between the Institute and its participants and non-U.S. entities (both individuals and organizations); these export situations pose additional, potentially complex considerations. Not only will the formalities of the Export Administration Act/International Traffic in Arms Regulations (EAA/ITAR) structure be the subject of scrupulous compliance for any technology or data physically transmitted outside the U.S. or shared with non-U.S. persons under the "deemed exported" rule, but the risks associated with any access by non-U.S. citizens to sensitive technical information in the course of the Institute's activities or resulting from its efforts will have to be addressed in a manner consistent with U.S. national security interests, including controls in place through DARPA's security processes, as set out in DoD Information Security Guidance (DOD 5200.01 v1 (2012)).

For many situations, formal compliance with the EAA/ITAR structure should provide adequate review and control to manage any risks associated with the sharing of sensitive Institute data and work product.

The Institute and its members must comply with all applicable export control laws and regulations of the United States, including, but not limited to, the International Traffic in Arms Regulations (ITAR), and the Export Administration Regulations (EAR). No member shall export, transfer, or re-export any information, data, technical know-how, products, goods or related services (controlled items) in violation of the ITAR or EAR. Some work undertaken by the Institute may involve controlled items that are expressly subject to the ITAR or the EAR and that may not be released to foreign persons, as defined in 22 C.F.R. § 120.16, (including any U.S. persons acting on behalf of a foreign person) inside or outside of the United States without proper export authority. In addition, Institute members shall not disseminate any controlled item to a party identified on a U.S. Government trade compliance watch list (*e.g.*, the U.S. Commerce

Department's Denied Persons, Entity, and Unverified Lists, and the U.S. Treasury Department's Specially Designated Nationals and Blocked Persons Lists).

The Institute and its participating collaborators will face more difficult challenges with regard to less clear situations involving individual foreign national and other non-U.S. persons. The Institute will have to provide guidelines for employees of participating entities who may be given access to Institute programs or activities on an episodic or even programmatic basis, transient, seasonal, occasional or intern employees, attendees at conferences or others situations where Institute know-how may be shared with non-citizens. These guidelines should also encompass situations where, while actual licensable export of technology, or transfers to foreign persons present in the U.S. constituting "deemed exported" situations, may not occur, nonetheless more ambiguous exposures and access may occur due to participation in Institute programs, events or third party situations during which Institute know-how is exposed and accessible to these individuals.

Among the mitigation techniques to address these situations are absolute prohibitions, such as denial of participation in Institute research by non-citizens, and employees or affiliates of non-U.S. "person" entities, restrictions on public release of documents and papers in conferences where non-citizens may attend or gain access to proceedings, and the execution of individual event non-disclosure agreements or similar instruments. While it is impossible to assess each potential risk, the understanding of the scope of potential exposures of sensitive data and the risks associated should provide Institute management, counsel and participant management the basis for making well-crafted decisions about appropriate measures to limit unintended disclosures.

# 7 Recommendations and Action Plan

## 7.1 Findings

Protection of Intellectual Property Rights is a critical consideration for the universalization of the innovations pioneered by the AVM program and envisioned for future collaborative efforts.

Among the available tools for protection of inventions and know-how, neither patents nor copyrights are optimal for protecting the complex innovations that are the objective of the AVM program and successor efforts.

Trade secret protection can provide appropriate protection against infringement, including limitations on disclosure, flexible structures permitting licensing, and a basis for allocation of revenues from commercialization.

## 7.2 Recommendations

- Establish trade secret protection as the default mode of protection for inventions resulting from cooperative multiparty research and development activity of AVM technology.
- Establish an affiliation and operational model for all participants in the collaboration based on trade secret protection responsibilities. Develop governance documents, operating rules, subordinate structures, affiliation agreements, and other essential documentation obligating all participants in the collaboration.
- Ensure appropriate IPR expertise is resident in management to provide leadership, guidance, and oversight.

## 7.3 Action Plan

Achieving the outcomes discussed in this paper really requires only two initial actions; first, the clear articulation of the IPR principles and approach in the DMDII chartering documents and participation agreements among the parties, and second, the identification of an individual or role within the collaboration structure with the authority to enforce the provisions of these agreements fairly and aggressively in order to maintain the confidence of all parties.

A third step is then implicit from the first two; the organizational IPR authority must act to assure the execution of the commitments throughout the lifecycle of the collaborative organization. To the extent commitment to such a program of action has not been embedded in the management agreement of the selected Institute operator, it should be done so without delay as a non-negotiable condition of selection pursuant to Section I(b) of the DMDII solicitation.

Finally, the Institute must assess without delay its current governance and affiliation documentation to determine the extent to which it incorporates language reflecting the necessary commitment to a trade secret based approach to managing IPR. Institute leadership should as soon as practicable develop processes for engagement with stakeholders and for review of the issues presented by this analysis. This process should be relied on to surface any further actionable findings and recommendations for action.

# Appendix A Intellectual Property Future for DMDII Collaborators

In considering future IPR paths for participants in the DMDII, it may instructive to look at three areas:

(1) The implications stemming from the unique IPR structures developed to support the collaborative arrangement of the institute that are or will soon be deployed because of their benefit to the participants in the Institute;

(2) the consequences for IPR practice for policy preferences of individual entities based on their experience as participants within the collaboration, and

(3) the emerging intellectual property approaches or requirements supportive of advanced manufacturing, independent of the collaborative context but of interest to participants.

This third element is, of course, purely speculative at this state, but some forecasting is possible.

It is useful to remind ourselves that in the electronic enabled era, there has been an evolution in the structure and application of intellectual property protection both in the United States and the world from the 1960s that continues today. A recognition of the globalization of the marketplace for many innovative products is reflected in legislative measures to address importation of infringing patented goods aggressively,[19] the creation of an entirely new legal mechanism providing 10 year copyright-like protection for semiconductor designs,[20] and an almost continuous stream of amendments of the U.S. patent laws during the decades of the 1980s and 1990s. These amendments led to two major reform statutes in 1999, the *American Inventors Protection Act of 1999*, and in 2011, the *America Invents Act* (AIA), that fundamentally shifted key historical aspects of the U.S. patent system by changing from a permissively "first to invent" to a "first inventor to file" system similar to systems in use throughout most of the rest of the industrialized world.[21]

Patent law is not the only area of IPR policy evolution resulting from technological advances. Not only may the Mask Work provision be seen as a hybrid between patent and copyright, but other copyright specific measures were passed, including the adoption of a fixed 95 year copyright term along with other modifications to address software and electronic media issues. Most recently, trade secret law, discussed in this paper as largely the creature of the state law contractual system, has come under discussion for a federal legislative enactment.[22]

In this context of an evolving Federal and global public policy framework for intellectual property rights, the first of the three future impacts of participation in this collaborative effort can be assessed. It is important to examine both impacts on individual entities and on the manufacturing community, or at least in the IPR "sub-ecosystem," and ask, W*hat enduring IPR policy artifacts are likely to persist beyond the initial collaborative period of the Institute?*

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[19] 19 U.S.C. §1337 (Section 337)

[20] Semiconductor Chip Protection Act of 1984, 17 U.S.C. 900 et seq.

[21] Patent law amendments were passed in 1982 (Patent Law Amendments Act of 1982), 1984 (2 laws), 1986, 1988 (Patent Misuse Reform, amending Sec. 271(d)), 1990, 1992, 1993, 1994 (major provisions to enact Uruguay Round Trade measures), 1996, 1998, and 1999 (Public Law 106-113). The 2011 AIA is Public Law 112-29. The extent and frequency of legislative activity is evidence of an area of inherent instability from a policy perspective, warranting frequent legislative intervention. The AIA represents the adoption of many reform provisions long debated by advocates within the patent community

[22] The Defend Trade Secrets Act (DTSA), introduced in the Senate in April, 2014 would allow individuals and private companies to bring direct civil lawsuits under the Economic Espionage Act.

To answer this question, it may be useful to turn to recent history, the preceding SEMATECH R&D collaboration. Semiconductor companies[23] shared the common business posture of investing massive portions of their revenue in R&D. Many, though not all, were threatened by the dumping of commodity memory products into the U.S. market by integrated Japanese producers.[24] This practice was deemed to be a coordinated national strategy between the Japanese industry and its government, and became the subject of several trade cases between the U.S. and Japan as well as complaints before the predecessor to the WTO. Indeed, the Department of Commerce and the ITC, the U.S. arbiters of these trade practices, *did* make a finding that the Japanese producers were dumping memory products into the U.S. market (that is, selling them at costs below their cost of production in order to win market share). As a result, remedial measures were put in place that included fines and penal tariffs. But, more importantly, the Department of Defense was persuaded to engage with the members of the U.S. semiconductor industry through its U.S. trade association, SIA, to develop a new form of collaborative enterprise enabled by statutory exceptions[25] to the antitrust laws that permitted competitors to share otherwise prohibited information.

Furthermore, while the Japanese trade violations subject to the dumping finding by the Commerce Department and the ITC were commodity memory products, the real impact, due to the pricing and investment structure of the semiconductor industry, was in microprocessors, the high-end specialty products sold to the defense community and used in the emerging PC business. The mission of SEMATECH was thus to regain a lead in microprocessor design and overcome 2-4 years of investment deficiency caused when Japanese memory dumping deprived the U.S. companies of mass revenue from commodity memory chip sales previously used to fund their costly microprocessor R&D pipelines.[26]

A key to lasting market impact would be the ability to assure both the protection of the work product of the collaborative enterprise and the tool-makers' ability to evolve tools that would allow production at scale within a reasonable time frame. While the engineering issue could be addressed through technology and was gated by the laws of physics, the intellectual property issue required legislative action and negotiation with Congressional staff. Indeed, even as Congress was enabling a legal framework for the collaborative R&D enterprise, it also adopted the new protection for chip designs without regard to whether produced by a collaborative group or a single entity.

It took a number of years to persuade other nations to join in the same system of chip design protection in a multilateral régime. The international agreement mechanism has deteriorated over time, but the basic policy fabric laid down to support the SEMATECH collaboration remains as testimony to an integrated vision of new policy rooted in an IPR framework to protect evolving technology.[27] Individual semiconductor companies continue to use mask work

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[23] Some 138 companies at one point during the initial CRADA period in Austin in the 1990s.

[24] Under trade law, "dumping" is an illegal trade practice consisting of selling a product into a foreign market below its cost of production, generally for the purpose of capturing market share at the peril of incumbent host market leaders.

[25] The Cooperative Research and Development Act of 1984.

[26] Many U.S. merchant chip companies (Intel, AMD, National) invested in excess of 20% of revenue in R&D in the 1980-2000 period; "captive" chip divisions of IBM, DEC, Motorola and H-P typically invested between 5-10% of revenue in R&D. The R&D investment norm for U.S. industrial manufacturers in this period was less than 3% of revenue.

[27] Some point to a third policy prong benefiting the U.S. industry: in addition to the Cooperative Research Act and the SCPA for mask work protection, in 1982 Congress passed the first R&D tax credit, providing for a dollar-for-dollar credit against corporate taxes for INCREMENTAL spending on qualified research expenditures. Investments in engineering such as those contributed by SEMATECH members to the collaboration qualified for the tax credit.

protection to protect their innovations, developed in their own labs, far from the SEMATECH environment.

The Advanced Manufacturing initiative appears no less well-grounded in documented deterioration of the global posture of U.S. competitiveness. Using this experience as a template, it is possible to point to the kind of elements that may survive a successful DMDII venture.

The second area of consideration is *What will individual collaboration participants bring with them back to their commercial practices and how will they behave with regard to IPR protections when returned to their original environments?*

This paper has concluded that there are many benefits providing good reason for preferring a default use of trade secret protection for the inventions and other know-how within the collaborative effort. But as collaborators return to their individual labs and individual business activities, they will in all likelihood revert to their historical zone of comfort and use patent protection for innovations resulting from their individual effort. The participants must first stop and look at the IPR protections available to them as they operate *outside* the collaborative environment.

Their participation in the AVM community should bring a variety of lessons that may suggest additional options. They may now understand the limits of the patent system with regard to certain types of inventions. They may have a heightened sensitivity to the penalty paid in time-to-market due to the complexity of the USPTO patent filing process. They may also understand the benefits of collaborative development and choose to operate with R&D partners to a greater extent than previously; this might result in a preference for trade secret/NDA approaches for innovations otherwise viewed as good candidates for patent protection.

The third question posed here may not be answered until long after the Institute has been up and running and has logged years of experience because it requires reflection on IPR policy measures to be put in place in the future to benefit the mission of advancing manufacturing. *What will be the future IPR policy that results from the measures put in place to support the current effort*?

One of the patent law changes cited earlier, the “America Invents Act,” was under development for over eight years before a critical mass of industrial, academic, and political interests converged to permit its passage. Even though broadly benefitting the entire community, the policy actors actively involved represented a tiny fraction of the number ultimately affected by those changes. Indeed, even though hundreds of thousands of commercial companies experienced some impact from the changes in the patent system, only hundreds were directly involved in the lobbying, debating, and amending of the provisions finally enacted.

A similar situation exists today. We have described an environment in manufacturing where dramatic changes are occurring in the practice of design and production, at the software, tool making, and production levels. The impacts of these are far reaching, and the potential for wider impact is great. Yet the involvement of companies in the collaborative effort is relatively small. As of this writing in June of 2014, fewer than 80 companies have applied and been accepted into the DMDII collaboration, from the thousands who participate in the manufacturing, component, tool, software, and related industries.

But apart from this fact, a policy opportunity may still emerge. The acceptance of trade secret protection by a community of patent-users may encourage participants to engage in discussions about IPR policy and business environments conducive to the protection of innovation and know-how in manners that meet the realities of current manufacturing: the demand for muchcompressed conception-to-production cycles; much greater adaptability for defense and other specialized user environments; and improved security for complex multi-venue and multi-party creative environments. While each collaboration member may not uniformly reach these futures, their participation under this non-traditional approach to IPR protection offers the potential for behavior change that may itself be innovative and lead to unexpected benefit.

# Appendix B List of Abbreviations

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| AMNPO | Advanced Manufacturing National Program Office |
| ADR | Alternative Dispute Resolution |
| AVM | Adaptive Vehicle Make |
| DARPA | Defense Advanced Research Project Agency |
| DMDII | Digital Manufacturing and Design Innovation Institute |
| DTSA | Defend Trade Secrets Act |
| EAA | Export Administration Act |
| EAR | Export Administration Regulations |
| IP | Intellectual Property |
| IPR | Intellectual Property Rights |
| ITAR | International Traffic in Arms Regulations |
| NDA | Non-Disclosure Agreement |
| NNMI | Network for Manufacturing Innovation |
| R&D | Research and Development |
| USPTO | United States Patent and Trademark Office |