Renewing and Updating the Vision for The Duderstadt Center (aka Media Union)

The University of Michigan
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Executive Summary

The opening of the Media Union in 1996 was a significant and tangible commitment by the University of Michigan, in partnership with the State of Michigan, to provide all members of this learning community free access to some of the most sophisticated and transformational tools of the emerging digital revolution. Conceived as a model for the Library of the Future, the building architect for the Media Union project captured the challenge of creating a physical environment to meet needs when we cannot anticipate the changes still to come as "…designing a building full of unknowns." [1]

That building full of unknowns has, in the last 15 years, become the home for a large and evolving collection of new information and communications technologies far beyond the resources of any one school or college to acquire and maintain. As part of a top research university library, the Media Union's collection of digital assets and resources required constant renewal with the latest versions of software and hardware, and an expert team of professionals who enabled U-M users to get up-to-speed and use them productively for innovative research, teaching and learning.

Rationalizing significant investments in cutting-edge resources by enabling free access to a shared, expertly-supported collection of assets has enabled a widespread culture of innovation in digital technologies at the U-M. Students and faculty are free both to envision and to lead, hands-on, change in disciplines being transformed by the digital revolution – from engineering, the performing and design arts, and medicine, to economics and government.

Today, the Media Union (aka Duderstadt Center or DC) has become one of the most active learning spaces in the University, providing thousands of students with 7x24 hour access to rich resources including libraries, advanced technology, workshops, performance venues, and high quality study and community gathering spaces. Yet, perhaps because of its high level of student use, its mission today is more one of providing learning services than its original vision as a source of innovation and creativity. It is time to refresh this successful model of shared investment and open access to the next generation of resources that will enable the U-M learning community to meet the challenge of the "new unknowns."

To restore its original intent, we suggest a new vision of the DC as a generalization of the library itself, adding to the traditional library role of providing access to objects (books, archives) that facilitate inquiry and learning new technology-based resources functions that enable creativity, innovation, demonstration (e.g., performance) and impact on society. More specifically, beyond its current role as a gathering space for student learning activities:

- The DC would become an innovative center for discovery, learning, invention, innovation, demonstration, and deployment utilizing state-of-the-art technologies and facilities and assisted by expert staff. It would provide the resources to support a community engaged in the creative transition from concept to technical realization.

- It would serve as a new form of public good, an *innovation commons*, where students and faculty would come to work together with expert staff mentors to develop the skills and tacit learning acquired through studios, workshops, performance venues, and advanced facilities such as simulation and immersive environments. It would encourage experimentation, tinkering, invention, and even play as critical elements of innovation and creative design.

- It would invite and enable the creation of highly interdisciplinary teams of students and faculty from various academic and professional disciplines, providing a Greek agora, where people could come to network, exchange knowledge, and create new ideas with experienced staff.

- Beyond providing a platform for learning, discovery, creation, and innovation, it would also be a place for studying new paradigms for these activities and propagating them to the rest of the University. In this sense it would serve as a "skunkworks" for the future of learning and discovery, a "do tank" rather than a "think tank", where new paradigms could be created, explored, and launched to serve society.

- As such, the DC would reaffirm its original vision of serving as a change agent exploring new visions for the future of the library as a public good that provides rich resources that enable students and faculty "to know" (inquiry, discovery, learning), "to do" (skills, experience, mentors, tacit knowledge), "to become" (team building, communities of practice), "to create " (workshops, studios, tinkering, intuition, invention, innovation), and "to spinoff" (intellectual property, entrepreneurship, economic impact).

A "word cloud" of the themes of the Duderstadt Center

Introduction

> *"Open to all those who dare to invent the future…*
>
> *For students, faculty, staff, and even our far-flung community of alumni, the Media Union offers a radically new environment for learning, teaching, and performing.*
> *Both a physical commons for the North Campus and a virtual commons for the entire campus–open twenty-four hours a day, seven days a week–the Media Union will initially house:*
>
> *An on-line library of the future*
> *A laboratory for virtual reality*
> *Interactive multi-media classrooms*
> *High-tech theater and performance spaces*
> *Cutting-edge design and innovation studios*
>
> *But the most important part of this project is its unpredictability. Creative people will continually reshape its mission and determine its impact."*
>
> *(1996 Dedication Brochure for the Media Union)*

The opening of the Media Union in 1996 was a significant and tangible commitment by the University of Michigan, in partnership with the State of Michigan, to provide all members of this learning community free access to some of the most sophisticated and transformational tools of the emerging digital revolution. Conceived as a model for the Library of the Future, the building architect for the Media Union project captured the challenge of creating a physical environment to meet needs when we cannot anticipate the changes still to come as "…designing a building full of unknowns." [1]

While the Media Union (aka Duderstadt Center or DC) was sometimes portrayed as a library for the University's North Campus, in reality the design team of deans, faculty, and staff responsible for the design of the new facility envisioned it as more akin to the MIT Media Lab for students and faculty of the North Campus academic programs. It was designed as a high-tech collection of studios, laboratories, workshops, performance venues and gathering and study space for students. Its original program statement in 1993 (see Appendix A) portrayed it as an Internet portal to the world (since the Internet was still rather new at that time). Although it was designed to provide space for the library collections of the College of Engineering and Schools of Art and Architecture, its function as a "traditional" book-based library was never a major part of the vision. Instead it was a place intended for collaboration and innovation in teaching and learning, a place where students, faculty, and staff could access a technology-rich environment, a place open to all "who dared to invent the future".

That building full of unknowns has in the last 15 years become the home for a large and evolving collection of new information and communications technologies far beyond the resources of any one school or college to acquire and maintain. As part of a top research university library, the Media Union's collection of digital assets and resources requires constant renewal with the latest versions of software and hardware,

and an expert team of professionals who enable U-M users to get up-to-speed and use them productively for innovative research, teaching and learning. Rationalizing significant investments in cutting-edge resources by enabling free access to a shared, expertly-supported collection of assets has enabled a widespread culture of innovation in digital technologies at the U-M. Students and faculty are free both to envision and to lead, hands-on, change in disciplines being transformed by the digital revolution – from engineering, the design arts and medicine, to economics and government.

Today the Media Union (aka Duderstadt Center or DC) has become one of the most active learning spaces in the University, providing thousands of students with 7x24 hour access to rich resources including libraries, advanced technology, workshops, performance venues, and high quality study and community gathering spaces. Yet, perhaps because of its unusually high level of student use, the DC has increasingly taken on a more operational character providing learning services based on commodity technology rather than its original vision as a source of innovation and creativity. In a sense, production has driven out much of the innovation that characterized the DC during its early years. Furthermore, while the facility has become one of most heavily used student facilities in the University as space for study, computer access, and gathering ("Meet me at the Dude!") it has lost much of the deeper engagement of faculty and graduate students characterizing its early launch with state-of-the-art technology and activities. Although many academic programs continue to view its unique faculties as absolutely critical for their activities–particularly in the performing arts–many other faculty members know it only as a welcoming place to meet colleagues for a cup of coffee and a sandwich (i.e., MUJO). It is time to refresh this successful model of shared investment and open access to the next generation of resources that will enable the U-M learning community to meet the challenge of the "new unknowns".

Hence, there is a strong need to reconsider the purpose of the DC, reaffirming much of its original vision as an innovation commons capable of providing an environment for developing, demonstrating, and providing the new paradigms of learning, discovery, and creativity enabled by rapidly evolving technologies. Ironically, although not initially intended as a traditional library, it may well be that the new vision for the center can best be framed as a generalization of the concept of the library itself, extending its services beyond the support of inquiry, discovery, and learning to provide additional resources enabling creativity, invention, innovation, and perhaps even enabling newly created ideas and products to be transferred into broader society. After all, throughout history, the library has been the place to obtain access to resources one cannot acquire on their own, objects that support inquiry and learning such as books and artifacts. This "public good" nature of the library can easily be extended to include similar institutions such as museums. Hence, it is natural to suggest that it might be generalized even further to include resources such as high-tech studios, workshops, performance venues, immersive environments, and gathering spaces where creative activities such as tinkering, invention, design, and innovation can occur. And, in a society increasingly dependent upon the wealth generated by new knowledge, one might even suggest that adding services that enable creative students, faculty, and staff to transfer the fruits of their creative activities into the marketplace would be appropriate.

To be sure, such a generalization of the library might be disturbing to some, since in such environments books would likely disappear "into the cloud" (as they already have for most of the students who utilize the resources of the DC today). Yet, there is already a growing sense across the campus that the time has come to invest in just such a public good.

There have been recent suggestions that just such a generalization of the library might be the best place both to develop and test new paradigms for learning and discover and then propagate these more broadly across the university. All of these goals embrace the philosophy: To know → To create → To demonstrate → To propagate. They are both consistent with and reinforcing the vision recently unveiled by Provost Phil Hanlon:

> *"Beyond our traditional skills…" [he lists several including quantitative reasoning, critical thinking, scientific method] "On top of that, we are going to have to layer-on new skills. These are going to be skills like having the confidence to take risks, to innovate, being lifelong learners, being able to reinvent yourself - throw away your old skills and learn new ones. Being able to work with people very different from yourselves - in situations you've never encountered before.*
>
> *"It's going to be our challenge to embed these skills in our graduates. What's interesting about this challenge is that these kinds of skills are not ones that you learn very well by sitting in a classroom and having someone talk to you. It's hard to sit in a classroom and have someone talk to you about having the confidence to take risks. It doesn't work very well. The way you learn that is by doing it, by doing things. And so what I see as an important trend as we reposition ourselves is that we, on-balance, replace our traditional lecture format with experiences where our students are engaging the complexity of the world directly.*
>
> *[Next he mentions several ways we do this already, including creative performance and entrepreneurial activity]. "…All of these are situations where you engage in an activity and you don't know what the outcome is going to be. Unlike doing a problem set in a course where someone knows the answers, there is not going to be any big surprise, nothing is going to change all of a sudden. These kinds of experiences are ones where you really don't know what the outcome is going to be. That's the kind of experience that is going to be more of our bread and butter going forward – small teams of people engaging complicated problems, together."*

Furthermore, the unique character of the academic programs on the University's North Campus, Music, Theater, and Dance; Art and Design; Architecture and Urban Planning; and Engineering, is the degree to which all involve disciplines heavily involved in creativity. Providing a "commons" facility, a place that supports interdisciplinary activities in "making things", responds to a growing need for these programs, as evidenced already by the emergence of new programs such as ArtsEngine, campus-wide entrepreneurial programs, and the Integrated Systems and Design programs. In fact, recapturing the original vision of the Media Union as an *innovation commons* or *creation space* where students, faculty, and staff from multiple disciplines

gather to create, invent, design, and even make things reinforces the "Renaissance Campus" themes of the 1990s.

Such a generalized library would provide an extraordinary opportunity of the study of the activities of learning, discovery, and creativity themselves. Its unique facilities for inquiry, creativity, innovation, performance, and launching new ideas would provide the University with a laboratory to test, develop, and perhaps implement entirely new paradigms for learning and discovery.

Over the past several months a small ad hoc group[1] has been tasked with exploring such possibilities for the future of the Duderstadt Center. Both students and faculty have been invited to weigh in with their own ideas–their wish lists–for activities that could make use of DC facilities. This report draws on these discussions to provide both suggestions concerning an expanded vision for the center, as well as a path toward achieving this vision.

The Challenges of a Changing Environment

> *We are entering a second revolution in information technology, one that may well usher in a new technological age that will dwarf, in sheer transformational scope and power, anything we have yet experienced in the current information age. We are already intimately familiar with the first revolution, now well under way. Information, computer, and communications technologies have transformed nearly every aspect of our lives, creating entirely new opportunities and challenges, and trailing some inevitable surprises in their wake. (Arden Bement, NSF Director, 2010)*

The information and communications technologies enabling the global knowledge economy—so-called *cyberinfrastructure*, the current term used in the United States to describe hardware, software, people, organizations, and policies—are not only evolving exponentially, doubling in power every year or so, but changing dramatically in character. For example, information and communications services are increasingly delivered as a utility, much like electricity, from remote data centers and networks. Both data and applications are now moving into massive network "clouds" managed by providers, such as Google, Amazon, Microsoft, and Apple. They provide not only global connectivity to organizations (e.g., corporations, governments, and universities), but also to individuals in rapidly changing forms, such as instant messaging, televideo, crowd sourcing, and affinity communities. It is becoming increasingly clear that we are approaching an inflection point in the potential of these technologies to radically transform knowledge work (Atkins, 2003; Bement, 2007). Many leaders, both inside and beyond the academy, believe that these rapidly changing technologies will so transform our educational institutions—schools, colleges, universities, learning networks—over the next generation as to make them unrecognizable within our current understandings and perspectives.

Consider, for example, the changing nature of communication. When we think of digitally mediated human interactions, we generally think of the awkwardness of e-

[1] Laurie Alexander, John Williams, Paul Killey, Dan Atkins, Dan Fessahazion, Panos Papalambros, Thomas Zurbuchen, Jim Duderstadt, and Paul Courant

mail or televideo conferences. Yet it is only a matter of a few decades before exponentially evolving information and communications technology will allow human interaction with essentially any degree of fidelity we wish, perhaps even totally immersive in all of our senses. (Wulf, 2010)

For planning purposes, we can assume that by the end of the decade we will have available infinite bandwidth and infinite processing power (at least compared to current capabilities). We will denominate the number of computer servers in the billions, digital sensors in the tens of billions, and software agents in the trillions. The number of people linked together by digital technology will grow from millions to billions. We will evolve from "e-commerce" and "e-government" and "e-learning" to "e-everything," since digital devices will increasingly become predominant interfaces not only with our environment but with other people, groups, and social institutions.

Ironically, while we generally think in terms of terabit/sec networks and petaflop supercomputers, the most profound changes in our institutions may be driven not by the technology itself but rather the philosophy of openness and access it enables— indeed, imposes—on its users. Of particular importance are efforts to adopt the philosophy of open source software development to create new opportunities for learning and scholarship for the world by putting previously restricted knowledge into the public domain and inviting others to join in both its use and development. MIT led the way with its Open CourseWare initiative, placing the digital assets supporting 2,200 courses into the public domain on the Internet for the world to use. Today, over 1,000 universities have adopted the OCW paradigm to distribute their own learning assets to the world, with over 15,000 courses now available online. New resources, such as Apple's iTunes U, are providing access to such open educational resources. Several universities have extended the OCW paradigm to offer free online courses comparable in quality to campus-taught offerings to hundreds of thousands of students (e.g., Stanford's AI sequence, and MIT and Harvard's EdX). In early April, the University of Michigan announced a partnership with Coursera, a Bay Area startup company designed for wordwide dissemination of courses. It did so in partnership with five top universities, signaling a transition towards free dissemination of some of the best UM course materials.

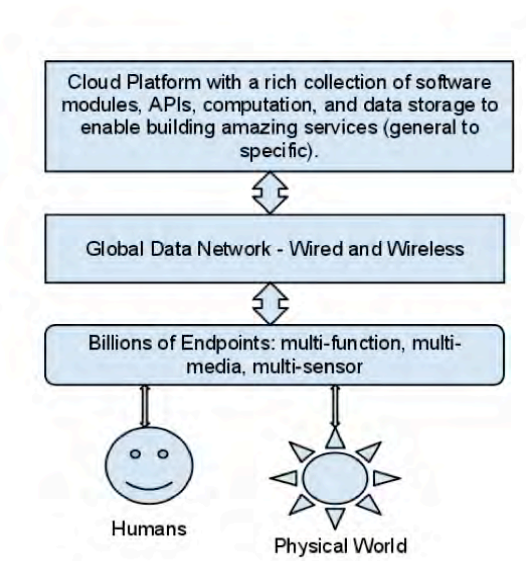
Universities and corporations have joined together to develop open-source middleware to support the instructional and scholarly activities of higher education, already used by hundreds of universities around the world (e.g. Sakai, Moodle, and Blackboard). Others have explored new paradigms for open learning and engagement, extending the more traditional, yet highly successful, models provided by open universities to include sophisticated technologies for distribution (e.g. networks and clouds) and use (e.g., Carnegie Mellon's intelligent tutor technology). There are increasing efforts to open up both data collection and scholarly publication by both individual institutions and university organizations. More recently, major federal research agencies, such as the National Institutes of Health and the National Science Foundation, have implemented new requirements that both the data and publications resulting from their research grants be placed in the public domain on a timely basis.

To this array of open educational resources should be added efforts to digitize massive quantities of printed material. For example, the Google Book project (Google, 2011) is currently working with a number of leading libraries (30 at last count in 35

languages) around the world to digitize a substantial portion of their holdings (20 million volumes in 2012, with a goal of 30 million by 2020), making these available for full-text searches using Google's powerful internet search engines. Led by the University of Michigan, a number of major universities and libraries (60 thus far) have pooled their digital collections to create the Hathi Trust ("Hathi" means "elephant" in Hindi), adding over 400,000 books a month to form the nucleus (already at 10 million books, including 2.7 million with full-text access of what could become a twenty-first century analog to the ancient Library of Alexandria. While many copyright issues still need to be addressed, it is likely that these massive digitization efforts will be able to provide full text access to a significant fraction of the world's written materials to scholars and students throughout the world within a decade.

Finally, it is important to note how dramatically communication activities are changing, with mobile technologies, social networking, and immersive environment. We all know well the rapid propagation of mobile communications technology, with over four billion people today having cell-phone connectivity and 500 million with broadband access. It is likely that within a decade most of the world's population will have some level of Internet connectivity. Furthermore, rapidly evolving forms of social networking such as Facebook, Twitter, and Google+ are facilitating the formation of large social communities with ubiquitous, always-on connectivity and interaction.

Yet how do we keep pace with each new wave of cyberinfrastructure technology as it sweeps over us? Today the new ICT paradigm based on utility computing, cloud technologies, and four-quadrant activities will transform learning and discovery just as 30 years ago the emergence of personal computers and networks replace time-sharing mainframes.



More specifically, we need to develop a vision of learning and discovery environments based on four pillars:

- Social: collaboration, sharing
- Mobile: with many Internet appliances with multimedia and sensory ability

- Cloud: (Infrastructure, programs, software) as a service
- Big Data: storing and operating on data with unlimited storage and processing

An important role of the DC is to expose both students and faculty to this rapidly changing technology environment while sustaining the University's leadership role achieved in earlier initiatives such as CAEN (the Computer Aided Engineering Network), NSFnet (evolving into the Internet), and most recently, the Google Book project and the HathiTrust. Our challenge is to develop a vision that enables us to anticipate not just the next impending technology-driven revolution, but a way to create spaces, infrastructure, and organization models to support innovation pointing a path to the future but not predicting an endpoint. We need to do as much as possible to enable that potential to be realized and to support some range of (surprise) changes in the course of innovation. That's been part of the success of the DC so far – it was designed to accommodate activities we couldn't describe at the time, but made some reasonably informed guesses about what would drive them.

A Fundamental Design Goal

The current pervasive digital revolution and cyberinfrastructure has enabled radical transformation of technological, economic and social environments. In the past single mode technologies such as broadcast TV, music and magazine publishing, have dominated, where the entire workflow, from talent recruiting, production, delivery, financing (e.g., selling ads), and even feedback (Nielsen ratings) were constrained to a narrow range of expensive resources. There was a narrow point of entry and a single mode of consumption.

Today, the dominant paradigms are modeless. The digital revolution and new CI have removed so many of the constraints that today hundreds of millions of individuals, with modest investment, can turn almost any content into a public artifact accessible by billions of people at any time, in any place, on a wide range of devices. With digital infrastructure, the inputs and the outputs are virtually modeless.

The communications revolution was relatively easy. Content didn't require moving lots of "atoms". What's next? Manufacturing, medicine, scientific exploration, political, economic and social liberation are emerging vectors enabled by the new five pillars model– what's beyond. The DC could support these modeless transformations. The DC should provide a modeless environment, characterized by the most robust and flexible technological and social infrastructure we can imagine and fund:

- "Unlimited" network throughput, computational and storage resources, network topologies, connections to collaborative sites on campus, with peer institutions, with non-education sector partners (commercial and public)
- Accommodate the tools and artifacts of modeless transformation (within code, safety, etc,): machine tools? Fabrication systems. Electronic and materials collections and inventory, etc.
- Remove the barriers to access across disciplines for students and faculty (funding models tie to home unit)

- Flexible collaborative spaces, a variety of sizes, reconfigurable rooms and studios, modeless inputs and outputs, access floors. Ceilings and walls.
- Churn policies and empty spaces – always have room for the next thing.
- Spaces with memory - that sense, record and preserve the activities and provide analytics of what goes on in them for user reference and for research and assessment.

This suggests a new social contract: to be intentional about engaging all disciplines that affect and will be affected by the modeless revolution – create alignments that can help anticipate and begin to create practices and policies that maximize legal, social and economic freedom – modeless society. It also transforms the learning experience into more of the constructionist models of John Dewey and Seymour Papert.

Extending the design principle of the Duderstadt Center should lead us to avoid placing obstacles in path of the unexpected, what "could be," just as much as we plan resources to anticipate what is "likely to be." Planning for the likely, while removing the obstacles to that which could be, is a simple interpretation of what designers are calling modeless environments.

We can see clearly an emerging context for the next expansion of knowledge creation and transfer characterized by:

1. Social - computing environments and culture that free learning communities from the constraints of space, time, and demography.
2. Mobile – ubiquitous access to people, information and computing resources.
3. Cloud – access to computing infrastructure, software and services independent of the resources owned by the user.
4. Big data – storing and operating on data with essentially unlimited storage and processing capacity.
5. Cyber-physical – collecting, processing and distributing sensor/activator data across billions of endpoints – human and environmental.

Modeless environments give the user access to the most tools and resources to support their activities with the fewest interruptions to the process. What the digital revolution has done with network, software and device design we must do with physical space. We've made great headway in freeing the digital space from constraints of access, time, capacity (what are the descriptive nouns here?) The limitations of the physical space – infrastructure, availability, size, flexibility, access.

Our goal, as we envision the Duderstadt Center future, is to build on our strong tradition of innovation; to make the most of emerging opportunities created by technology; to span the missions of knowledge, learning and creating; to invest in the ways in which new information technologies and media are changing; to advance team rather than individual activities, and to go beyond to demonstrate and deploy creations. The same principles should apply to spaces, tools and infrastructure we create for these new learning activities. Specific objectives in support of transformative learning:

- flexibility to expect and accommodate change

- promote seamless intellectual inquiry; increase excitement of the learning experience
- strengthen Invisible Infrastructure (e.g. networks, software, cloud)
- balance modeless and commodity computing
- empower users to define their work space
- facilitate research and learning by making, doing, & collaborating
- ensure space basics support creativity (e.g. lighting, electrical outlets)

The Wish List of University Faculty

To illustrate the potential of expanding the activities of the Duderstadt Center to embrace more of the original vision as an innovation commons and creation space, we have solicited several exciting proposals from faculty and staff:

The Innovation Union (Panos Papalambros)

An *Innovation Union* would be housed within the DC to provide a general resource for the University to build a community for the creative transition from concept to technical realization. This facility would serve as a central hub of the wheel of innovation. It would aid people to make the critical connections, give them the necessary tools, resources and guidance to achieve their creative inspirations to better society. Spin-off benefits would include a "can-do" entrepreneurial spirit, development of side skills, and identification of purpose in life for student searching for their path. It would inspire and facilitate cross-communication for atypical collaboration for radical innovation and engagement critical for the IU to realize true synergism.

Key aspects:

- Latest state of the art equipment for wide community use
- Teaming of human resources with different skills, level of expertise, interest for common purpose
- Guided experience with expert mentors
- Advancing levels of skills and safety training for the life-long learner
- Safe sandbox for people to come and play, explore, experience and evolve to a higher personal, team and societal level.

The IU would consist of several centralized core facilities to support the innovation process. The core facilities envisioned at this point includes:

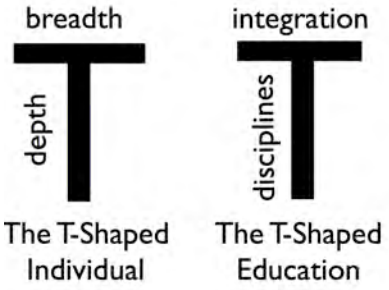
- Ideation Hub
- Detailed Design Hub
- Realization Hub
- Assessment Hub
- Entrepreneurial Hub
- Team Hub

Each of these hubs would provide users with varying degrees of expertise and the resources necessary to achieve that stage of the innovation process. Each hub would have expert staff responsible for guiding users on that process of the innovation cycle. This would include advancing training through short sessions responsible for safety and use of basic equipment and building up to certification on the most sophisticated state of the art equipment. It would also include advising on their project, what resources, staff, tasks, steps that are next for them and helping them to make the proper connection to continue progression. This expert staffing of the hubs are critical for the success of the IU (analogous to librarians). A more detailed description of each hub and a detailed case study of how this might work is given in Appendix C.

A Power Ball Machine to Achieve Dreams (Panos Papalambros, BlueLab Team)

Today's technology frontiers are characterized by advances in nano-, bio- and information technology —systems that are faster, smaller, more complex— and challenges in the macro world, such as energy, environment, vulnerability to human and natural threats, health care, manufacturing production, communications, logistics — problems that are larger, more complex, and socially relevant. The nation's economic vitality is closely tied to innovation and entrepreneurship. Design and production of engineering systems and products and is closely associated with innovation and wealth creation. Our students' success in meeting the economic and technological "grand" challenges depends on our ability to bridge these multiscale frontiers through system and design education programs informed by knowledge from the social sciences and the professional engineering practice. While single disciplines are critical in advancing our knowledge, the required intellectual and practical integration is difficult to achieve within existing disciplinary frameworks.

As Nick Donofrio, former Vice-Chairman of IBM, puts it this way: "The kind of people who will be best able to seize these opportunities are those I call "T-shaped" as opposed to "I-shaped." I-shaped people have great credentials, great educations, and deep knowledge—deep but narrow. The geniuses who win Nobel prizes are "I-shaped," as are most of the best engineers and scientists. But the revolutionaries who have driven most recent innovation and who will drive nearly all of it in the future are "T-shaped." That is, they have their specialties—areas of deep expertise—but on top of that they boast a solid breadth, an umbrella if you will, of wide-ranging knowledge and interests. It is the ability to work in an interdisciplinary fashion and to see how different ideas, sectors, people, and markets connect. Natural-born "T"s are perhaps rare, but I believe people can be trained to be T-shaped. One problem is that our educational system is still intent on training more "I"s. We need to change that. But even the most brilliant "T" will find it difficult, and perhaps impossible, to innovate entirely on his or her own. There are so many variables in our infinitely complex and diverse world that even the best-read, most up-to-date, and most knowledgeable "T" can't possibly know even a fraction of what it is useful to know."



The figure on the left above indicates the classic view of the T-shaped individual who possesses depth of knowledge in a chosen domain combined with the requisite breadth of knowledge to execute the domain work successfully within the larger professional and social context. But we need a broadening of this concept for path-breaking innovation as illustrated by the figure on the right. While academic departments are highly successful in imparting domain knowledge to our students, it is challenging to provide integrative experiences in systems and design. This requires both a place where the disciplines can converge to enable creativity and innovation.

The Duderstadt Center was designed to provide just such neutral spaces that help foster and facilitate interdisciplinary collaboration. But this mission should be enhanced further, converting even more of the building into multiuse spaces where people with differing ideas, experience, and cultures merge, an educational "power ball" machine, where people can collide with others who can do what they cannot.

It would be great to have a place where the departmental limitations not only are checked at the door, but where there are trained professionals that can point students not just to operate equipment (the ME model) but to make connections with resources material and human. Perhaps it could even become a portal to collisions with central campus and the rest of the world as well using some of the communications technology already there (and making it more accessible).

It will be important for this to be a general resource that anyone, especially those without the formal training, can come in and utilize properly. It needs to be a "connection" for those that have ideas or just a desire to make them reality even though they may not have all the required skills or knowledge.

The key objective is to make sure that we can establish the resources to support the dreams. We will need several forms of resources - physical space, mentors/trainers (i.e. people, staff), virtual resources (computer tools, webpages, etc), connection resources (may be rooms to meet but also computer tools - skype, blog, facebook, social media, etc.), creative resources (computer programs like Adams, cad, etc, shop facilities, electrical facilities, art facilities, testing facilities, etc)

Some of these are fairly doable, such as anything connected to the computer we would either have via CAEN or should be able to get out there. Others are more difficult to come by. The hardest but most important is the proper people. We need to have people (staff mostly) in shops and in creative spaces that are experts so when a student comes in and has a vague idea, that they could be mentor and trained on the spot to be able to do what they need to make it happen. The quality of these helpers will

define the success. While it is is difficult to get staff lines, this is needed for sustainability. Similar concept to a librarian. Some types of people needed would be: shop like a Bob, electrical helper, artist or industrial designer, business/financial to help entrepreneur, computer help of course, perhaps a librarian type to help with researching. I think staff resources will be a must.

We envision a space / infrastructure where students and student teams have access to every conceivable resource (within practical limits) and guidance that they need to take their idea to practical realization. This is analogous to the role of a library which presently provides "information"; however, the new space would provide information + material resources + domain expertise + prototyping capabilities + human interaction.

The vision for this possible future of the Duderstadt Center is simply to state (if challenging to achieve): A place where people can find the resources to support their dreams. A place characterized by convergence, innovation, and creation. An innovation commons.

A Space for the Center for Entrepreneurship Activities (Thomas Zurbuchen)

An important thing that we need to think about for this new initiative is the education of entrepreneurial talent, teams that put ideas (based on UM intellectual property or otherwise) into action.. The role of the university of this is to 1) be a deep pool of innovation, 2) train entrepreneurs in relevant skills, and 3) accelerate ideas towards entrepreneurial outcomes. If it is very successful, then it is possible for students to come in with great ideas that become products, companies, etc. The CFE has provided such resources, including training, legal advice, mentorship, etc. With its partners, it currently teaches 2500 students university-wide in entrepreneurship focused classes each year and nearly 100 student-based entrepreneurial projects or companies are being accelerated each year.

One possibility would be to put the entire Center for Entrepreneurship - the student traffic, mentorship and key advising of campus-wide entrepreneurial programs - into the DC. This would attract some of our best student projects, hackers and student company founders, and also tie these activities to DC spaces and opportunities often unknown to campus-wide innovators and entrepreneurs. Right now, the Center is spread out with 12 people in two offices in Chrysler and three in the Lurie Building. By relocating these offices and associated meeting rooms into the DC, along with other CFE activities such as the Entrepreneurs in Residence, we would achieve the synergy of close proximity to the innovation commons activities as well as industry recruiting activity. There is an activity afoot to create a CFE on Central Campus which would split advising and mentorship among two campus-wide resources. Estimates are that the CFE in the DC would be advising about 800-1000 students each semester and launching about 100 companies and projects. CFE could also make use of the instructional facilities in the DC to conduct some of its practicum classes, which are project-focused capstone classes.

The intellectual property team could create a storefront here with the philosophy that "We're here to help you!", providing advice, linkages, evaluations, space to think and dream, etc.

CAEN II (Paul Killey and Dan Atkins)

So, what is the role of a physical entity like the DC in a Cloud-driven world? It enables one to apply such "virtual technologies" to actually build things, to do things, to create things. This is where groups come together not only to learn but to do things. But it is also necessary since even in a 4-Quadrant world (same time/different time – same place/different place -- same time/same place) activities become the most valuable of all. This is one of the signature advantages of location-based collaborative learning of the university as place. Driven by innovation in digital sensor and activator technology the world is also increasingly a blend of cyber and physical. The DC can be a place to explore this world.

The Innovation Commons should be a place where not only cyber-physical technology enables groups to create things but also have workshops for physical creation. It should facilitate the formation of highly interdisciplinary groups (engineers, artists, performers, software developers) to not only "do" and "create", but even explore spinning products out into the marketplace through entrepreneurial activities.

Much as CAEN appeared to provide the UM with leadership into networked IT and positioned for its role in building the Internet, the DC innovation commons is appearing at just the right time to take advantage of the emerging Google vision of Cloud Platforms, Global Data Networks, and Billions of Endpoints. Note that the Innovation Commons vision would also be a real benefit to the evolution of CAEN since it would take its role back to its pioneering days of the early 1980s! It would require CAEN to reassume its role as a pathfinder and trailblazer in the acquisition and utilization of emerging technology, with the MU-DMC/UML as the home of innovative communities of practice.

We need to get back to the spirit of the 1980s when CAEN was an experiment to expose students to the next generation of IT with state-of-the-art technologies, e.g., workstations, CAD, etc. Thirty-years on, what is the new experiment to leverage the paradigm shift in the four-quadrant model for knowledge creation and knowledge transfer?

Software is one important asset we might focus on. Could we specialize in providing access to expensive software? We might also extend the paradigm of using software tools to design electronic products that would then be fabricated in "silicon foundries" (e.g., the VLSI design tools for MOSIS) to include the software design of mechanical products that would be fabricated in automated manufacturing cells (i.e., "digital manufacturing").

We could put the DC in the Cloud…or better yet, link DC to the Cloud:

i) to create facilities that are too expensive, unique, and experimental

ii) to provide tacit knowledge and experience

iii) to provide space for communities to form

Note that the Innovation Commons vision would also be a real benefit to the evolution of CAEN since it would take its role back to its pioneering days of the early 1980s! It would require CAEN to reassume its role as a pathfinder and trailblazer in the acquisition and utilization of emerging technology, with the MU-DMC/UML as the home of innovative communities of practice.

We might even view the Innovation Commons as the analog to a "university

hospital" for a professional school of interdisciplinary design, engineering and entrepreneurship involving professors of practice as the key instructors. For example, collaborations with groups like InterPro (Panos Papalambros) and the Center for Entrepreneurship (Thomas Zurbuchen)?

A Vision for the Future of the Duderstadt Center

Today, the Media Union (aka Duderstadt Center or DC) has become one of the most active learning spaces in the University, providing thousands of students with 7x24 hour access to rich resources including libraries, advanced technology, workshops, performance venues, and high quality study and community gathering spaces. Yet, perhaps because of its high level of student use, its mission today is more one of providing learning services than its original vision as a source of innovation and creativity.

It is straightforward to conceive of the DC as a 21st century version of a "library" providing not only unique knowledge resources for learning and scholarship but also tools for making things. In fact, this was an important part of its original design. But the DC might go further and provide resources not only for knowing and making but also demonstrating and spinning off innovative "products" into society through entrepreneurial activities. We need to build a program around this. How would we build links to business? What environment do we want students to experience?

To restore its original intent, we suggest a new vision of the DC as a generalization of the library itself, adding to the traditional library role of providing access to objects (books, archives) that facilitate inquiry and learning new technology-based resources functions to enable creativity, innovation, demonstration (e.g., performance) and impact on society. More specifically, beyond its current role as a gathering space for student learning activities:

- The DC would become an innovative center for discovery, learning, invention, innovation, demonstration, and deployment utilizing state-of-the-art technologies and facilities and assisted by expert staff. It would provide the resources to support a community engaged in the creative transition from concept to technical realization.

- It would serve as a new form of public good, an *innovation commons*, where students and faculty would come to work together with expert staff mentors to develop the skills and tacit learning acquired through studios, workshops, performance venues, and advanced facilities such as simulation and immersive environments. It would encourage experimentation, tinkering, invention, and even play as critical elements of innovation and creative design.

- It would invite and enable the creation of highly interdisciplinary teams of students and faculty from various academic and professional disciplines, providing a Greek agora, where people could come to network, exchange knowledge, and create new ideas with experienced staff.

- Beyond providing a platform for learning, discovery, creation, and innovation, it would also be a place for studying new paradigms for these activities and propagating them to the rest of the University. In this sense it would serve as a "skunkworks" for the future of learning and discovery, a "do tank" rather than a "think tank", where new paradigms could be created, explored, and launched to serve society.

- As such, the DC would reaffirm its original vision of serving as a change agent exploring new visions for the future of the library as a public good that provides rich resources that enable students and faculty "to know" (inquiry, discovery, learning), "to do" (skills, experience, mentors, tacit knowledge), "to become" (team building, communities of practice), "to create " (workshops, studios, tinkering, intuition, invention, innovation), and "to spinoff" (intellectual property, entrepreneurship, economic impact).

Achieving the Vision

To achieve the vision proposed for the Duderstadt Center, we need to address an array of specific issues, including strategic, organization, reporting lines, financial, operational, and promotion:

Strategic Issues

The proposed vision of the DC identifies it as a new form of public good, similar to libraries and museums, but adding additional resources such as studios, workshops, performance venues, skunkworks, and commons space. Together these will support not only the traditional library and learning activities (e.g., "to inquire" and "to know") but more general functions such as discovery, invention, design, innovation, demonstration, and deployment.

The DC has also been described as an innovation commons, where people will come to network, exchange knowledge ideas, and exploit the unique resources of the facility in imaging, creating, testing, and deploying new concepts, productions, and products. The DC should embrace an ever evolving mission as a hub of innovation shaped by visionary thinkers both from within and external to the University.

It is very important to do a needs assessment. What do we need to keep and what can we replace? For example, the use of the facility as the primary student center for the North Campus meets an urgent need. So, too, the definition and administration of the DC as part of the library system also gives it a safe harbor from administrative mischief. What are the space needs for new activities such as design and entrepreneurial efforts? How would we reconfigure the DC to provide this? In particular we need to create a wish list of resources needed to equip the DC for this role, much as we did in the initial design and equipping of CAEN and the Media Union when we gave the deans $70 M to "play" with. We should be bold at this stage. (We'll worry about how to raise the necessary funding later.)

It is also very important to create an executive/advisory committee of faculty and staff with experience and engagement in DC activities to provide strategic guidance for the further evolution of the facility

Management Issues

As a generalization of the public good character of the library, we support the continuation of a reporting line to the Dean of the University Libraries system as the "public goods czar" of the University. However, the highly innovative and rapidly changing nature of this technology-intensive facility will require much more flexible, responsive, and entrepreneurial management than traditionally characterized library operations. How would we manage this generalized concept of a "library"? Its reporting line would likely still fit well in UM Library organization (particularly as a "safe harbor")? But what management characteristics would the innovative character of this vision require, particularly in approval of budgets, acquisitions, space assignments, etc.?

To some degree this has been achieved for the diverse activities currently located in the facility: library activities by UML, computing and networking activities by CAEN, performance venues and the Digital Media Commons by professional staff. Yet, there continues to be ongoing concerns about how to sustain the flexibility and responsiveness of the resources and staff available here in order to be an effective incubator of "the unknown". An element of risk is involved in finding successful models for the library of the future, e.g., the risk associated with scarce resources originally intended to support innovation that can be easily re-justified to support ongoing, commodity services.

Financial Issues

These new roles will require new resources, both in terms of equipment acquisition and installation and in ongoing support of staffing and maintenance. Although these will be in support of the public good roles of the DC, these must demonstrate their value to academic programs to earn this core support.

While we will need to devise core funding to keep the place functioning, renewal will require one-time external funding from time to time. In this sense we need a hybrid model consisting not only of sustained core support by the University but also sponsored research and philanthropy. This will require a concerted and intensive effort to attract sponsored research and gifts for DC activities.

Visibility Issues

Clearly, there will be a communications challenge to articulate the changing nature of the DC and both the opportunities this affords students and faculty, but as well its importance to the University more generally. In particular, rekindling strong support by the North Campus programs of the proposed vision of the DC as an innovation commons will depend upon more active engagement of faculty and graduate students requiring significant outreach efforts.

Operational Issues

It is straightforward to conceive of the DC as a 21st century version of a "library" providing not only unique knowledge resources for learning and scholarship but also tools for making things. In fact, this was an important part of its original design. But the DC might go further and provide resources not only for knowing and making but also demonstrating and spinning off innovative "products" into society through entrepreneurial activities. We need to build programs to support these functions. We already have the complete package for the performance area. How do we build comparable capabilities (space, facilities, mentors) for the other key missions?

The Duderstadt Center has always been a neutral space that helped foster and facilitate interdisciplinary collaboration. The mission would be enhanced further, if more of the spaces in the building became available as multiuse spaces, with specialized tools and expert staff. The other key component would be enhancing the technological investments in the building.

Operating principles for the facility should include the following guidelines:

1. Projects would be invited to set up term-limited operations in the building. Participants would work in a fishbowl environment and they will share their work openly in exchange for getting access to cutting edge technology and infrastructure. This will encourage serendipitous learning and collaboration. Projects could require NDA agreement from the community, if deemed necessary.

2. Develop innovative spaces for experimenting with the integration of new instructional technology into teaching spaces. Spaces that will be used for a limited time and the results could end up getting adopted by the wider university community. Possible subject would be the use of mobile devices, visualization, big data and CI in a classroom setting.

3. Develop a system that manages an inventory of leading edge equipment and make it available to the DC community. The inventory needs to be funded at an aggressive replacement cycle, though with prudent oversight.

4. Invite groups from around campus to a "Show and Tell" event. This will help identify future projects that could be invited to the DC or folks will be able to make connections with members of the DC community.

5. As books move out of the building, access and expertise for retrieving and manipulating large data sets can move in. Data would be made available either over fat pipes or on the local working storage in the DC datacenter. The Library's SANDS (Spatial and Numeric Data Services) lab maintains some large data sets that can be made available to the DC community in compelling and engaging ways.

Configuration Design

We suggest that the DC consist of a variety of "space profiles":

Dock (Pod): 1-3 users

Purpose: Individual and/or small group collaboration

Description: Walk up or workstation intended single user to use a personal mobile device (laptop, tablet, etc.) with ability to accommodate a small group

Features: Large display, equipped for distance collaboration, input devices, some with thin client access to advanced software, CPU, GPUs in the UM cloud space

Location: Both active and quiet spaces

Cove: 4-6 users

Purpose: Open collaboration and computing space

Description: Students may gather to work on projects, instructors with small groups, faculty come together for brainstorming and collaboration.

Features: Built on Dock model, moveable screens and walls, pod-like, some with commercially installed modules, flexible seating, various work surfaces, video-conferencing, presentation capability, whiteboards

Location: Both active and quiet spaces

Creative: 20 users

Purpose: Collision space with equipment and flexibility top various peer-to-peer and instructor-learner interactions around the tools and processes of a creative work

Description: Social interaction between users if high priority with emphasis on sharing knowledge and skills across the community, course lab space and individual student projects

Features: Built on Cove model, software and device rich to support changing curriculum needs, defined space that is open at times and controlled access at others, easily reconfigurable, staff on occasions

Location: Visible so that people can see in and be drawn in.

Project: various sizes

Purpose: Dedicated for a set period of time (term, academic year) to be home to a curriculum-based project, solving real-world problems

Description: Vary in size for various groups, secure space, transparent walls, user is by application and competitive award

Features: Core equipment and infrastructure, but individual group bringing additional resources to equip the space

Location: Dedicated space

Service Amenities

- Expert staffing and support
- "Store Front" service desk, for advice, technical support, how-to

- Materials, tools equipment check-out (I need to check-out the Arduino kit box #12)
- Some spaces would need shallow raised floors
- Alternative output "islands" for large format, 3D or other modes could be available throughout the building (as we now have current printers)
- Everything on wheels
- Every public seat with power and lighting
- Short-term lockers adjacent to work areas with internal charging stations
- All areas served by multiple modes of wired and wireless net access including high-speed cellular
- All spaces include access to a DC-end-user-environment: easy to use control panels and workflows that enable users to connect to campus and external services (e.g., job submission to HPC, rendering farms, 3D printing, applications and database servers, videoconferencing).

To move this configuration forward, we suggest the following steps:

1. Describe space use, support and management informed by user communities but also distinguished from specific programs. That is, defined well and staff properly, new space in the DC should serve well the needs of programs like the CFE and the Design Science degree programs, but not be owned or governed by them. Staffing should be a collaborative activity, with programmatic uses supported by program staff and infrastructure and tools support by DC staff.
2. Design a first iteration space that includes at least one instance of all three space types: Docks, Coves and Labs. Do this in a part of the DC that has:
    a. high visibility
    b. attracts students and faculty
    c. a showcase
    d. easy access to support, tools and infrastructure
    e. nearby programs that will help populate early use.
    f. Not lock into a design solution for additional spaces until we have experience in this
3. Make transparent connections (not just capability, but "dial-up" ease to get at content) to local and global infrastructure for research, teaching and learning, public databases, digital repositories, remote (high performance) computer resources, storage environments.
4. Continue to redefine CAEN staff roles to be a lead in the development of infrastructure, compute resources.
5. Create model for providing user input to shape the modeless environment
6. Iterate new installations of the space models and infrastructure based on user input (no, really)

7. Align needs and timing of Design Science degree programs and the Center for Entrepreneurship programs with the initial space development

Some Practical Issues

1. Time needed to roll-out new spaces and needs of CFE probably implies the need for a surge space for CFE starting fall 2012. This looks like it could be the Third Floor Suite 3350 (formerly used by CTools developers).
2. Funding and timing of funding for the above work
3. Conversations needed with NC user-groups (e.g., students and deans) to assess the trade-offs between general-purpose computing resources and the more high-value resources we are describing.
4. (More …)

Space Availability

We should move rapidly to "open up" the facility both by removing unnecessary constraints and implementing aggressive demonstrations of its activities (e.g. through the Transparency Project and further Internet-based communications). The library security systems designed for book circulation should be removed or redesigned to remove the sense of being a "barrier" to the core facility as the need diminishes for physical book circulation. The escalators should be quickly modified to allow two-way access.

In the near term it is important to establish footprints ("beachheads") for the new activities we are proposing for the DC, such as the innovation commons workshops and studios and the entrepreneurial center. This might be achieved by replacing obsolete or little used space such as the reference area on the 2nd floor and the 3rd floor area formerly used by the CTools group.

It is also important that even at this early stage that we give highest priority to utilization of space for student-faculty activities. For example, preliminary examination by librarians has already identified older collections of reference material that could be relocated to free up significant space for higher priority student activities. We should make it a priority, wherever possible, to relocate materials into low-cost space (e.g., in under-utilized space in NCRC) to free up space for high priority use as workshops and studios for the design and fabrication areas of the innovation commons. High density storage on the lower level might be such a candidate for relocation, freeing up space for such innovative student-faculty activities.

In addition to low-use reference materials, even commodity computing space could be reallocated for critically needed student use such as dedicated student project and group collaboration.

Floor plans with square footage and timing of availability are suggested in the next several pages.

Duderstadt Center – Media Union

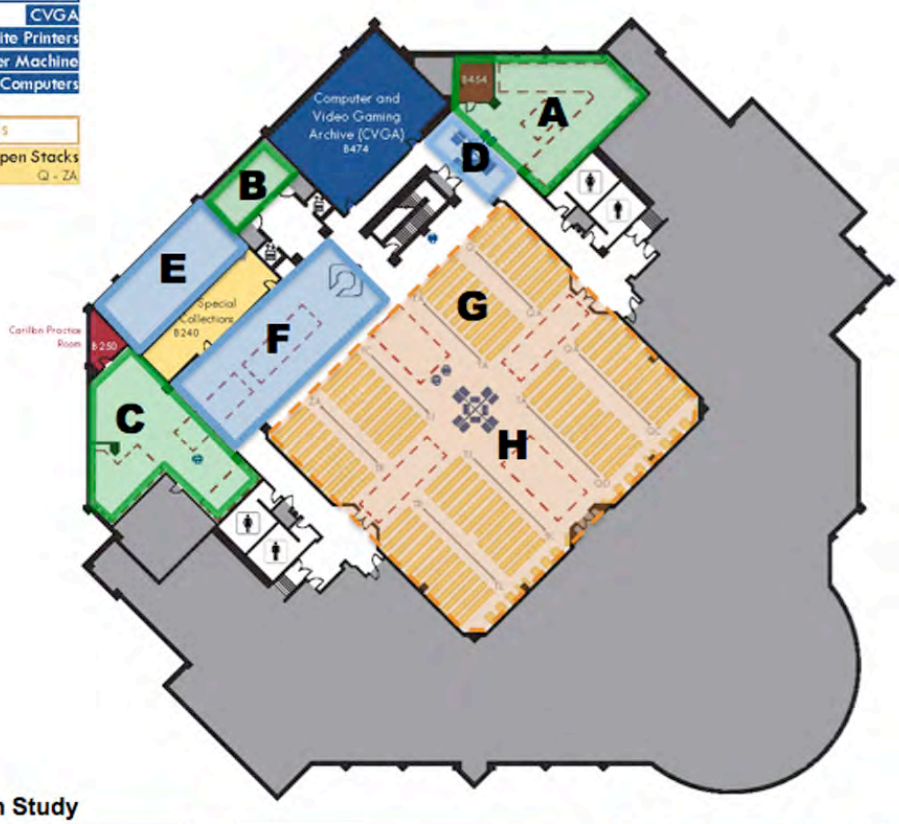
LOWER LEVEL (BASEMENT)

Current Use

Study Space
- Study and Groupwork Area
- Group Study Room
- Piano Practice Room

Computing
- CVGA
- 3 Black/White Printers
- 1 Copier Machine
- 24 Computers

Books & Journals
- Open Stacks Q - ZA



Reallocation Study

Area of Opportunity (Phase 1?)

A. 1,600 ft²
Computer/Study Carrels (network-no computers) + 1 Group Study Rm.

B. 480 ft²
Shared Storage Room

C. 1,800 ft²
Combination: open Study Carrels, Reading Tables, Circulation Processing Area

Area of Interest (Phase 2?)

D. 300 ft²
12 CAEN-managed public wkstns.

E. 1200 ft²
Special Collections Archive Storage

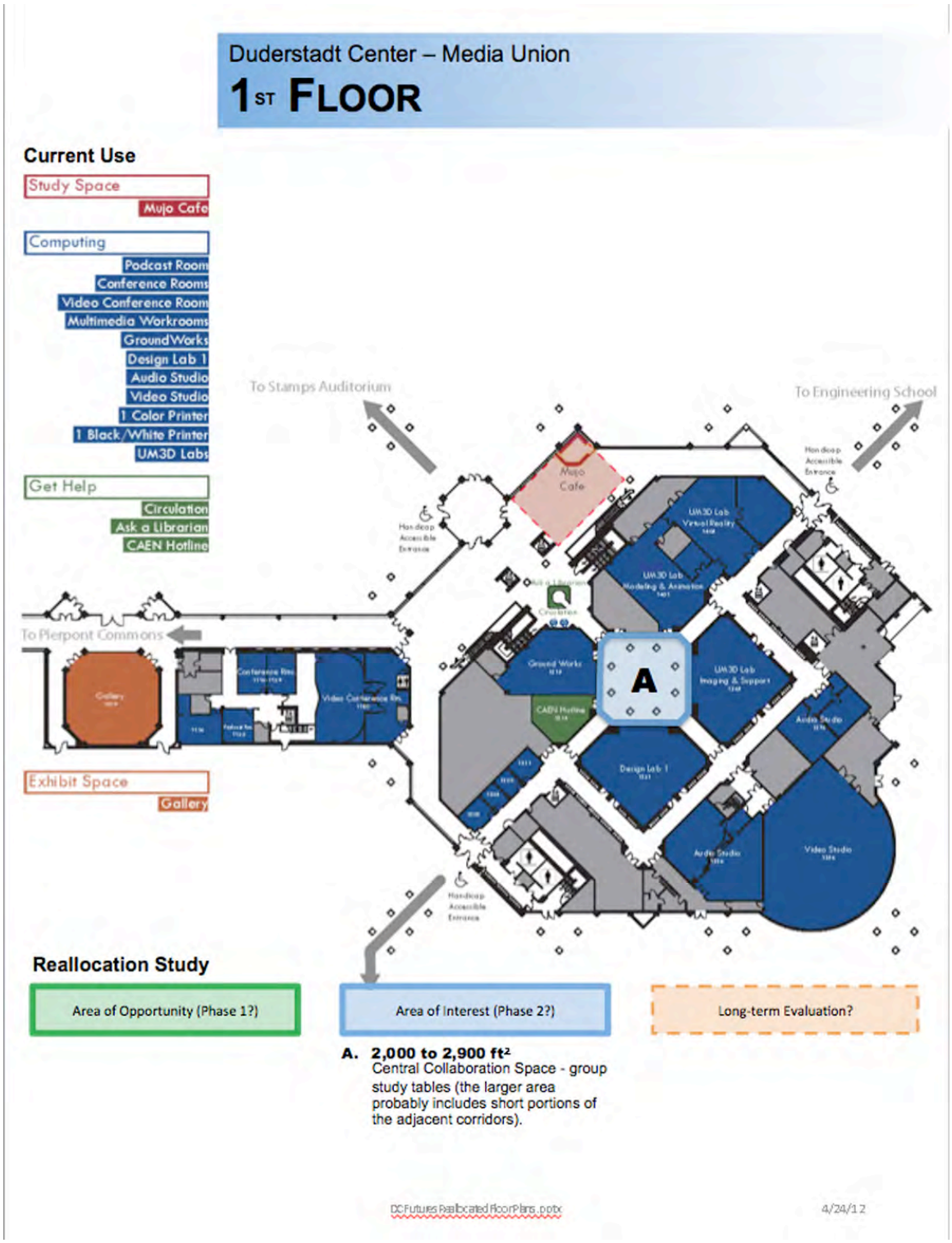
F. 2,200 ft² (rough estimate)
Combination: Casual Reading, Reading Tables, Circulation Desk

Long-term Evaluation?

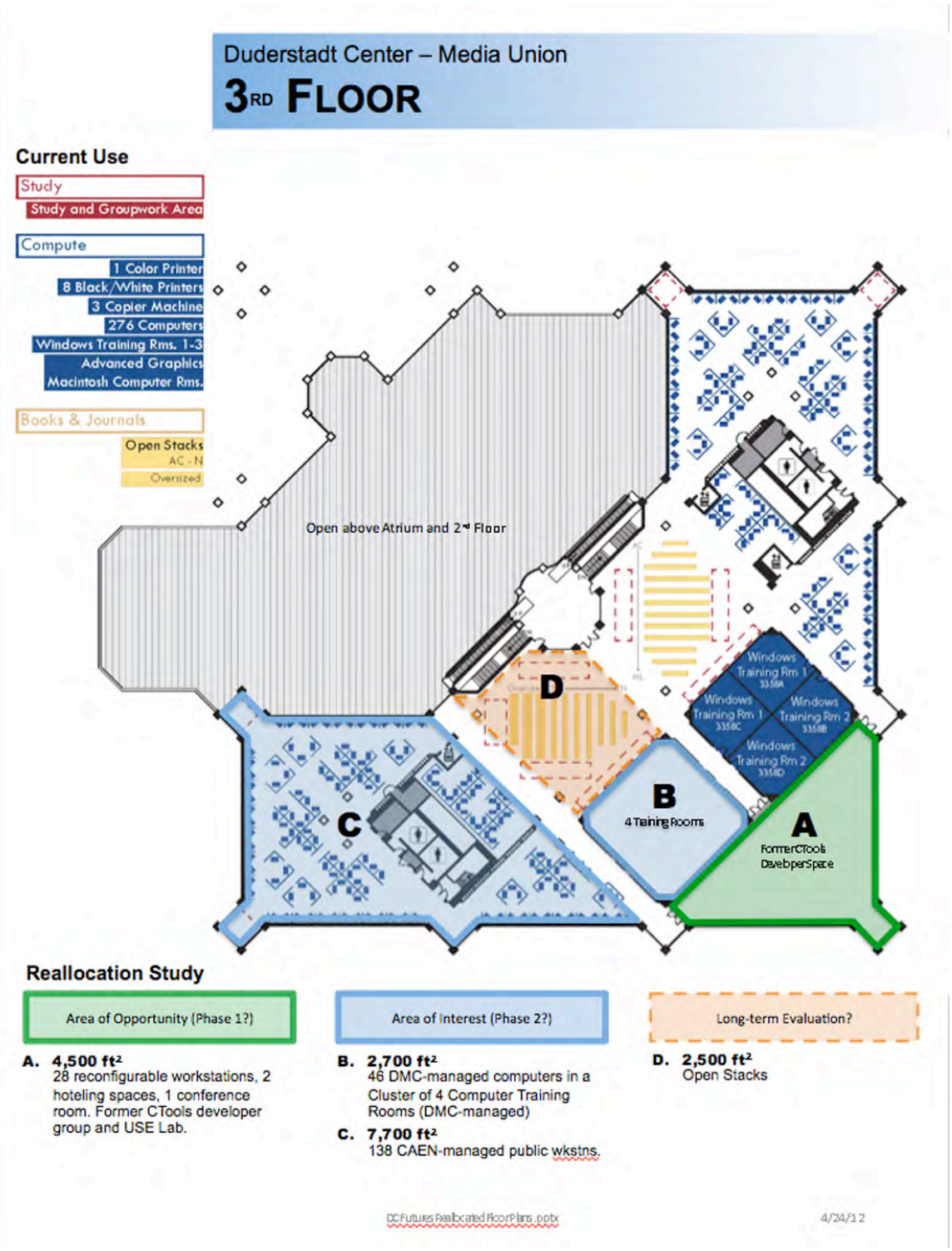
G. 11,000 ft²
Combination: Compact Shelving and Reading Tables

H. 900 ft²
12 CAEN-managed public wkstns. and Library Reading Tables

DCFutures Reallocated FloorPlans .pptx 4/24/12


Duderstadt Center – Media Union
1ST FLOOR
Current Use
Study Space
Mujo Cafe
Computing
Podcast Room
Conference Rooms
Video Conference Room
Multimedia Workrooms
GroundWorks
Design Lab 1
Audio Studio
Video Studio
1 Color Printer
1 Black/White Printer
UM3D Labs
Get Help
Circulation
Ask a Librarian
CAEN Hotline
Exhibit Space
Gallery
To Stamps Auditorium
To Engineering School
To Pierpont Commons
Mujo Cafe
A
Reallocation Study
Area of Opportunity (Phase 1?)
Area of Interest (Phase 2?)
Long-term Evaluation?
A. 2,000 to 2,900 ft²
Central Collaboration Space - group study tables (the larger area probably includes short portions of the adjacent corridors).
DCFutures Reallocated FloorPlans .pptx
4/24/12


Duderstadt Center – Media Union
2ND FLOOR
Current Use
Study Space
18 Group Study Rooms
Study and Groupwork Area
Computing
Image
Digital Scan Stations
8 Black/White Printers
2 Color Printers
4 Copier Machine
70 Computers
1 Ergopod Computer
Get Help
Circulation
Ask a Librarian
CAEN Reference
Library Reference
Books & Journals
Periodicals
Open Stacks
NA - PZ
Reference
AE - Z
Recreational Reading
Microfilms
Open above Atrium
B
DMC, CAEN, ORCI, AAEL Shared Admin.
A
Library Reserve and Circulation
Image 2957
Art, Arch, Eng. Library Admin
CAEN
Millennium
C
CAEN, FLUX
Open above Video Studio
Reallocation Study
Area of Opportunity (Phase 1?)
Area of Interest (Phase 2?)
Long-term Evaluation?
A. 7,000 ft² (rough)
1) Library Reference Island shared with CAEN Hotline Satellite desk, (CAEN space now used by SITES)
2) Open stacks
3) 15 Library-managed public workstations, including 5 for PTO
4) Study tables
5) 32 CAEN-managed public wkstns.
B. 4,100 ft²
Open Stacks (including microfilm and microfiche collections)
C. 650 ft²
16 CAEN-managed public wkstns.
DCFutures Reallocated Floor Plans .pptx
4/24/12


Duderstadt Center – Media Union
3RD FLOOR
Current Use
Study
Study and Groupwork Area
Compute
1 Color Printer
8 Black/White Printers
3 Copier Machine
276 Computers
Windows Training Rms. 1-3
Advanced Graphics
Macintosh Computer Rms.
Books & Journals
Open Stacks
AC - N
Oversized
Open above Atrium and 2nd Floor
D
C
B
4 Training Rooms
A
Former CTools Developer Space
Windows Training Rm 1
3358A
Windows Training Rm 1
3358C
Windows Training Rm 2
3358B
Windows Training Rm 2
3358D
Reallocation Study
Area of Opportunity (Phase 1?)
Area of Interest (Phase 2?)
Long-term Evaluation?
A. 4,500 ft²
28 reconfigurable workstations, 2 hoteling spaces, 1 conference room. Former CTools developer group and USE Lab.
B. 2,700 ft²
46 DMC-managed computers in a Cluster of 4 Computer Training Rooms (DMC-managed)
C. 7,700 ft²
138 CAEN-managed public wkstns.
D. 2,500 ft²
Open Stacks
DCFutures Reallocated FloorPlans.pptx
4/24/12

Concluding Remarks

Today the Duderstadt Center has become one of the most active learning spaces in the University, providing thousands of students with 7x24 hour access to rich resources including libraries, advanced technology, workshops, performance venues, and high quality study and community gathering spaces. Yet to achieve its full potential, we believe the DC should expand its activities to include the themes suggested by the "word cloud" below:

A *word cloud* of the themes of the Duderstadt Center

We suggest that the University should utilize this unique asset to serve as a change agent for exploring new visions for the future of the library as a public good capable of providing the rich resources that enable students and faculty "to know" (inquiry, discovery, learning), "to do" (skills, experience, mentors, tacit knowledge), "to become" (team building, communities of practice), "to create " (workshops, studios, tinkering, intuition, invention, innovation), and "to deploy" (intellectual property, entrepreneurship, economic impact, public service). In doing so, the center would enable the University to explore, develop, and implement the new paradigms for learning, discovery, and innovation that are rapidly changing our world.

Appendix A

The Early History of the Media Union

The Original Pitch to the State (1993)

We have entered an age of breathtaking social and technological change. For the State of Michigan, this new time brings profound dilemmas. Through the twentieth century Michigan industry reigned supreme in the area most critical to economic advance: transportation. But today the engine of progress has shifted to communication and information. The most important products of tomorrow will not be things but rather knowledge itself. To succeed, Michigan must transform its economy to meet this new reality.

At the same time, many feel that this "knowledge revolution" is leading to a parallel shift in our intellectual culture. While the "analytic" professions such as law and business dominated our recent past, there is a great deal of evidence that the "creative" professions, such as art, medicine, literature, and engineering will dominate our future. It is increasingly clear that the driving intellectual activity of our future will be the act of creation itself.

With the development of the Media Union, and with several schools that focus on the act of creation, the University of Michigan is well poised to take advantage of this new economic and intellectual climate. The Media Union will remain a step ahead of us in our technological future, giving us a chance to try out different possibilities before they become widespread realities, helping us avoid potentially expensive or even dangerous mistakes while maximizing the extraordinary capacity of our new tools.

The Early Theme (1996)

> *"Open to all those who dare to invent the future…*
>
> *For students, faculty, staff, and even our far-flung community of alumni, the Media Union offers a radically new environment for learning, teaching, and performing. Both a physical commons for the North Campus and a virtual commons for the entire campus–open twenty-four hours a day, seven days a week–the Media Union will initially house:*
>
> *An on-line library of the future*
> *A laboratory for virtual reality*
> *Interactive multi-media classrooms*
> *High-tech theater and performance spaces*
> *Cutting-edge design and innovation studios*
>
> *But the most important part of this project is its unpredictability. Creative people will continually reshape its mission and determine its impact."*
>
> *(1996 Dedication Brochure for the Media Union)*

An Early Assessment of Impact (2000)

In 1996 the University of Michigan launched a key experiment: a unique new center known as the Media Union. It was designed to be a testbed for developing, studying, and perhaps implementing the new paradigms of the university enabled by information technology. It gave us the chance to try out different possibilities before they became widespread realities, helping us avoid potentially expensive or even dangerous mistakes while maximizing the extraordinary capacities of our new tools.

The Media Union created an environment where students and faculty could join with colleagues beyond the campus, developing and testing new visions of the university, exploring teaching, research, service, extension, and other areas. Even more importantly, the Media Union fostered a new spirit of excitement and adventure. It provided the foundation for a risk-tolerant culture, where students and faculty were strongly encouraged to "go for it," accepting failure as a part of the learning process as they reached for ambitious goals. Organized around dynamic, integrative themes, the Media Union worked to break down the compartmentalized nature of the larger university.

Originally we envisioned the Union as a common connecting point between the four schools on the University's North Campus: Engineering, Architecture and Urban Planning, Music, and Art, all of which are intimately concerned with the act of creation. Although all four facilities operate within close proximity of each other, in the past there had been little collaboration between them. This makes little sense. Increasingly society demands designs that combine aesthetics, efficiency, and durability. As engineers become more like artists, artists and musicians have become more interested in new environments for their creations; and architects are increasingly concerned with the structural integrity and beauty of their designs.

We soon realized, however, that the Media Union must be a resource for the entire University. The need for interdisciplinary collaboration extends beyond the North Campus schools, and as a facility designed in part to bridge the limitations of time and distance, what better place to bring the North and Central Campuses together? The Media Union acts as a catalyst, helping faculty and students from different fields realize their similarities while capitalizing on their differences.

More specifically, this 250,000 square foot facility, looking like a modern version of the Temple of Karnak, contains 500 computer workstations for student use—including Windows and Macs, Unix machines such as Sun, Hewlett Packard and Silicon Graphics workstations. It ubiquitous network jacks for students to plug in their laptops, and wireless connectivity if they wish to work in its surrounding plazas and gardens during the summer. The facility contains a 1.5 million-volume library for art, science, and engineering, but perhaps more significantly, it is the site of our major digital library project, JSTOR. There is a sophisticated teleconferencing facility, design studios, visualization laboratories, and a major virtual reality complex. Since art, architecture, and music students work side-by-side with engineering students, the Media Union contains sophisticated recording studios and electronic music studios. It also has a state-of-the-art sound stage for "digitizing" performances, as well as numerous galleries for displaying the results of student creative efforts. Consequently, the Media Union is

open 24 hours a day, seven days a week, so that students have round-the-clock access to its facilities.

The "virtual" nature of the research teams in the Media Union entice not only campus scholars, but exciting thinkers around the world to participate. While groups may meet physically from time to time, many of the members of these project teams participate through interactive technology. Members do not need to leave their home institution or even their homes to join in close collaboration with other scholars who are thousands of miles away.

Similarly, while libraries will always have books, but the Media Union's library are be judged by the number of volumes. Increasingly, information will be stored electronically, and its data will be dispersed across the globe. We are talking about more than just text; the Internet already contains archives of images and sounds, audio and visual information that scholars can retrieve at the touch of a button. Eventually a researcher will not have to find a VCR to view movies or locate a tape recorder to listen to the score of a symphony. And published "papers" will increasingly include images and sounds as an integral part of their presentation.

The Media Union library eliminates much of the drudgery usually associated with information retrieval. Quasi-intelligent software programs search out data for even the most unique topics, tracing connections within a broad spectrum of research that scholars might have missed using manual techniques. While this will never replace human insight, the wide-ranging character of these searches helps break down the invisible barriers that often separate disciplines today. The most useful resources for a psychologist working on an aspect of "panic" might well turn out to have been written by an anthropologist or an English professor or even an engineer.

Libraries will also increasingly become places where the differences between "researching" and "doing" blur. The new information technology not only supports information retrieval, but also facilitates manipulation of that information. A student can not only read about architecture, but use a computer tool at the same time to try out a design, either building it in a Media Union workshop or fabricating it through the Internet in a "silicon foundry" elsewhere.

For the Media Union to succeed, we must take risks, accepting that we may stumble before we can walk. When we began this project in the 1980s, our challenge was to envision a building that could become a campus "commons," both physically and virtually. We struggled with designing a place that would allow colleagues from very different disciplines and across great distances to collaborate with each other. Ultimately, we had no final answers—just ideas. We knew that we probably would not get it all right from the beginning. In fact, it is clear that stagnation will have arrived if the Media Union ever settles comfortably into any single form.

One of the problems in centers like the Media Union at other universities has been that projects often move in when the facility is built—and then never leave. Limited paradigms take hold and then cannot be shaken loose. Instead of propagating flexibility within the larger university, the reverse often happens; and these centers find themselves infected by the stolid, incremental "disease" of large institutions. Creating a fluid structure that continually embraces new ideas will be a great struggle. A related challenge will be learning to sustain spaces that are truly neutral in their academic orientation.

Another difficulty we have been grappling with is finding ways to let the energy and enthusiasm from the Center's cutting-edge research projects trickle out into the common areas of the building, and ultimately to the entire University. The new interactive library is open to all members of the Michigan community, but much of the rest of the building will be reserved for a wide spectrum of research projects and groups. Researchers and scholars need space of their own to work together, but we worry that if they remain isolated behind closed doors (even glass doors), we could lose the opportunity for our students and colleagues to experience their excitement. Even allowing the outside world "virtual" access to the Union's projects may not be enough. As Architecture Dean Robert Beckley notes, "there are ways in which we would like the building to have the messy, intriguing look of a house for mad scientists." If we expect the Media Union to be a catalyst, changing the common practices of our community, we must find ways for these new practices to move beyond the building's studios.

Appendix B

Conceptual Foundations

Learning in the Digital Age

Today's students are citizens of the digital age. They have spent their early lives surrounded by robust, visual, interactive media—not the passive broadcast media, radio and television of our youth, but rather always on, always connected technologies such as smart phones, iPods and iPads, Facebook and Twitter, immersive games and virtual reality. They are "digital natives", comfortable learning, working, and living in the digital world, unlike those of us who are "digital immigrants" who are struggling to keep pace with digital technologies (Pensky, 2001). This is not an easy task for educators, who for the most part remain reluctant to embrace the new technologies in their teaching and hence are increasingly detached from today's students.

Our students are no longer the people our current educational system was designed to teach. Rather they learn by experimentation and participation, not by listening or reading passively. They are indeed the "plug and play" generation. They embrace interactivity and demand the right to shape and participate in their learning. They are comfortable with the uncertainty that characterizes their change-driven world. These students will increasingly demand new learning paradigms more suited to their learning styles and more appropriate to prepare them for a lifetime of learning and change.

New knowledge media are forcing us to rethink the nature of literacy. We have seen the definition of literacy shift before in history, from the oral tradition to the written word to the images of film and then television and now to the computer and multimedia. Of course there are many other forms of literacy: art, poetry, mathematics, science itself, etc. But more significantly, the real transformation is from literacy as "read only, listening, and viewing" to composition in first rhetoric, then writing, and now in multimedia. Both young, digital-media savvy students and adult learners will likely demand a major shift in educational methods, away from passive classroom courses packaged into well-defined degree programs, and toward interactive, collaborative learning experiences, provided when and where the student needs the knowledge and skills. Emerging technologies that enable social networking to form learning communities and immersive virtual environments for simulation and play facilitate the "deep tinkering" that provides the tacit knowledge necessary to "learn to be", tools already embraced by the young if not yet the academy. In the language of the digital generation, learning has become "hanging out" (knowing), "messing around" (playing), and "geeking out" (creating) (Ito, 2009; Brown, 2009).

From a broader perspective, our society increasingly values not just analysis but synthesis, enabled by the extraordinary tools of the digital age. Learning occurs not simply through study and contemplation but through the active discovery and application of knowledge. From John Dewey to Jean Piaget to Seymour Papert, we have ample evidence that most students learn best through inquiry-based or "constructionist" learning. As the ancient Chinese proverb suggests "I hear and I forget; I see and I remember; I do and I understand." To which we might add, "I teach and I master!

Learning Ecologies

John Seely Brown suggests that we might think of the contemporary university as an interconnected set of three core competencies: learning communities, knowledge resources, and the certification of knowledge skills (Brown, 2000). Social computing will empower and extend learning communities beyond the constraints of space and time. Open knowledge and education resources will clearly expand enormously the knowledge resources available to our institutions. And immersive environments will enable the mastery of not simply conventional academic knowledge but tacit knowledge. A fundamental epistemological shift in learning is occurring from individual to collective learning; from a focus on development of skills to instead dispositions, imagination, and creativity; and enabling the acquisition of both explicit and tacit knowledge.

In a rapidly changing world, innovation no longer depends only upon the explicit dimension characterizing conventional content-focused pedagogy focused on "learning to do". Rather, one needs to enable an integration of tacit knowledge with explicit knowledge. Emerging ICT technologies that enable social networking to form learning communities and immersive virtual environments for simulation and play facilitate the "deep tinkering" that provides the tacit knowledge necessary to "learn to be", tools already embraced by the young if not yet the academy. In a sense, learning has become a "culture", in the sense of the Petri dish that is in a state of constant evolution. As Brown puts it, "Dewey was 100 years too soon! Today we can do everything he imagined!!!"

Once we have realized that the core competency of the university is not simply transferring knowledge, but developing it within intricate and robust networks and communities, we realize that the simple distance-learning paradigm of the virtual university is inadequate. The key is to develop computer-mediated communications and communities that are released from the constraints of space and time.

Distance learning based on computer-network-mediated paradigms allows universities to push their campus boundaries outward to serve learners anywhere, anytime. Those institutions willing and capable of building such learning networks will see their learning communities expand by an order of magnitude. In this sense, the traditional paradigm of "time-out-for-education" can be more easily replaced by the "just in time" learning paradigms, more appropriate for a knowledge-driven society in which work and learning fuse together.

Creativity

The professions that have dominated the late 20th Century—and to some degree, the late 20th Century university—have been those which manipulate and rearrange knowledge and wealth rather than create it; professions such as law, business, accounting, and politics. Yet it is becoming increasingly clear that the driving intellectual activity of the 21st Century will be the act of creation itself.

> *The winners of this new era will be creators, and it is to them that power and wealth will flow. The need to shape, to invent, and to create will blur the border between production*

and consumption. Creation will not be a form of consumption anymore, but will become work itself, work that will be rewarded handsomely. The creator who turns dreams into reality will be considered as workers who deserve prestige and society's gratitude and remuneration.

Jacques Attali, *Millennium*

A determining characteristic of the university of the 21st Century may be a shift in intellectual focus, from the preservation or transmission of knowledge, to the process of creation itself. Here, the University of Michigan is already very well positioned. On our campus, we already are fortunate to have several schools which focus on the act of creation, in music, dance, and the performing arts; art and design; architecture; and in engineering—which, of course, is the profession concerned with "creating what has not been." But, the tools of creation are expanding rapidly in both scope and power. Today, we have the capacity to literally create objects atom-by-atom. We are developing the capacity to create new life-forms through the tools of molecular biology and genetic engineering. And, we are now creating new intellectual "life forms" through artificial intelligence and virtual reality.

Already we are seeing the spontaneous emergence of new forms of creative activities, e.g., the "maker" fairs providing opportunities to showcase forms of artistic, recreational, and commercial activity; the use of "additive manufacturing" to build new products and processes atomic layer by atomic layer; and the growing use of the "app" culture to empower an immense marketplace of small manufacturing activity. In fact, some suggest that our civilization may experience a renaissance-like awakening of creative activities in the 21s century similar to that occurring in 16th century Europe.

The Media Union (aka Duderstadt Center) on the North Campus is the centerpiece of the University's efforts to respond to this new creative environment. Drawing together aspects of hardware and software, inquiry and discovery, tinkering and invention, and creativity and innovation, the DC can be a tremendous interactive playground for imaginative scholars and students. The tools in the DC are so easy to use that ideally they become natural extensions to everyday activity. For example, an artist and an engineer should be able to think up a new sculpture together, sketch it out in three dimensions on a computer, then show it off and discuss it in real time with colleagues both here and across the world, all without noticing the complex technology that allows them to collaborate.

But here lies a great challenge. As noted earlier, creativity and innovation are key not only to problem solving but more generally to achieving economic prosperity and sustaining national security in a global, knowledge-driven economy. Yet while universities are experienced in teaching the skills of analysis, we have far less understanding of the intellectual activities associated with creativity. In fact, the current disciplinary culture of our campuses sometimes discriminates against those who are truly creative, those who do not fit well into our stereotypes of students and faculty.

The university may need to reorganize itself quite differently, stressing forms of pedagogy and extracurricular experiences to nurture and teach the art and skill of creation and innovation. This would probably imply a shift away from highly specialized disciplines and degree programs to programs placing more emphasis on integrating knowledge. Perhaps it is time to integrate the educational mission of the

university with the research and service activities of the faculty by ripping instruction out of the classroom–or at least the lecture hall–and placing it instead in the discovery and tinkering environment of studios or workshops or "hacker havens". The Duderstadt Center is designed provide just such resources and opportunities.

Appendix C

An Innovation Union (Panos Papalambros)

The purpose of the Innovation Union is a general resource for the University to build a community for the creative transition from concept to technical realization. This facility will serve as a central hub of the wheel of innovation. It aids people to make the critical connections, give them the necessary tools, resources and guidance to achieve their creative inspirations to better society. Spin off benefits include a "can-do" entrepreneurial spirit, development of side skills, and identification of purpose in life for student searching for their path. Inspire cross-communication for atypical collaboration for radical innovation. Engagement is critical for the IU to realize true synergism.
Key aspects:

- Latest state of art equipment for wide community use
- Teaming of human resources with different skills, level of expertise, interest for common purpose
- Guided experience with expert mentors
- Advancing levels of skills and safety training for the life-long learner
- Safe sandbox for people to come and play, explore, experience and evolve to a higher personal, team and societal level.

The IU will centralize core facilities to support the innovation process. The core facilities envisioned at this point includes:

- Ideation Hub
- Detailed Design Hub
- Realization Hub
- Assessment Hub
- Entrepreneurial Hub
- Team Hub

Each of these hubs provides what a user with varying degrees of expertise the resources necessary to achieve that stage of the innovation process. Each Hub will have expert staff responsible for guiding users on that process of the innovation cycle. This will include advancing training through short sessions responsible for safety and use of basic equipment and building up to certification on the most sophisticated state of art equipment. It also includes advising on their project, what resources, staff, tasks, steps that are next for them and helping them to make the proper connection to continue progression. ***This expert staffing of the hubs are critical for the success of the IU (analogous to librarians).*** Please note that the descriptions that follow is only a brief examples of what these hubs could include – it is not inclusive of the full need or training but only to aid in visualization of the hub and purpose.

Team Central Hub:

The Central Hub of the IU will be focused on the team. The primary focus of this hub will be making good connections of human resources throughout the innovation process. The vision is that users with different aspirations can start at this hub, get engaged in a team and be mentored throughout the process through the Hub mentors. Help make a connection to other resources across the University or beyond.

- Facility:
  - Meeting/collaboration space
  - Management/production tools
  - Long distance communication – Skype, video conferences, etc
  - Talent board – virtual forums for global teaming matching up interest, need, idea, skill, resources
  - Virtual environments
- Guidance
  - Team dynamics
  - Social Media Basics
  - Communication skills
  - Field Crash course (a course that gives an overview of a field – like mechanical engineering or industrial design with some of the basics so that different cultures can gain understanding of each other and find the proper home)
- Resources
  - Social media
  - Data bases
  - Forums

Ideation Hub:

The *Ideation Hub* supports the embryotic stage of the innovation process. This open, creative, flexible space is to aid users to fully explore their design space, reaching for non-traditional game changing concepts. Expert mentors will aid users with a wide assortment of techniques (simple brainstorming on white boards, competing product searches, physical ideation, artistic exploration through music, art, different mediums and experience, etc).

- Facility:
  - Break out rooms
  - White boards
  - Visualization tools
    - High tech: 3D printing, Rapid prototyping
    - 3D Virtual Reality
  - Comfortable, open space (perhaps some closed proprietary space?...)
  - Flexible furniture – bean bag, movable white board tables,
- Guidance and Training
  - Creativity
  - Research methods
  - Sensory thinking

    - Downselection Methods
    - IP Generation and Protection
- Resources
    - Low tech – foam core, tape, exacto knife, clay, paper, pen, white boards, musical instruments
    - Construction toys (Legos, erector, etc)

Detailed Design Hub:

The *Detailed Design Hub* provides high-end tools for the team to advance their concepts to the point that they can physically realize them through detailed design.

- Facility:
    - Computer tools
        - Simulation- adams,
        - Computation- linkages, ABAQUS, etc
        - Cad/cam – solid works, unigraphics, etc
        - Equivalent computer tools for other disciplines
- Guidance
    - Model-based Design Process
    - Engineering Project Management: Milestones and Tollgates
    - Training on detailed design software (CAD, FEM, Spice, etc.)

Realization Hub:

The *Realization Hub* is where the team's design gets physically realized. This may range from technological realization to art, architecture, music, or the synergistic combination.

- Facility:
    - Full machine shop (Mill, lathe, drill, sheet metal tools, etc)
    - Arc welder, spot welder, oxy-acetylene
    - Wood Shop (saws, lathes, etc)
    - Rapid prototyping (3D printer, waterjet, laser cutter)
    - Injection molder, vacuum forming
    - Electronics (electronic circuit boarder fabrication, solder flow, , etc)
    - Controller prototyping (arduino, labview, etc)
    - Open assembly area
    - Sound studio
- Guidance
    - Safety training
    - Equipment training
    - Interfacing and Assembly tricks
- Resources
    - Materials – metals, polymers, etc
    - Electronics – resistors, chips, arduino, tools – wire strippers, solder iron, etc.)
    - Tools – hammers, screw drivers, cutting tools, etc.
    - Supplies

- Mechanical Components – fasteners, bearings, pulleys, gears
- Mechatronic components – Motors, motor drivers, sensors

Assessment Hub:

The *Assessment Hub* provides teams an environment to test and evaluate their concepts. This can range from simple performance test to more sophisticated environmental, reliability testing that may be necessary for business case to venture capitalist.

- Facility:
  - Space and benches for test beds
  - Big test equipment
    - Environmental chamber
    - Anechoic chamber
    - Vibration/shaker
    - Drop chamber
- Guidance
  - Safety
  - Training on test equipment
  - Design of Experiments
- Resources
  - Sensors: load, displacement, speed, accelerometers
  - Electrical monitors: oscilloscope, multimeter
  - Safety shields

Entrepreneurial Hub:

The *Entrepreneurial Hub* will aid users to accelerate their ideas to commercialization and technology transfer. This includes aiding in developing business cases, market research, product specifications, protection of IP and exposure to venture capitalist. Mentors would guide users on steps through this process and recommendation in their innovation to refine and improve their product.

- Facility:
  - Tech transfer facility
  - Showcase to display for venture capitalist, exhibits, general dissemination of success stories, wall of patents
  - Business case
  - Standards/regulation advice
- Guidance and Training sessions
  - Psychology and user/focus groups
  - Ethics
  - IP Generation and Protection
  - Business plans
  - Pitches to investors
  - Funding options (SBIR, Grad fellowships, Venture, etc)
- Resources
  - Market research tools

- Business case examples and tools
- General supplies – paper, stapler, folders

An Example to Illustrate the Concept:

- Fred is a business student that has an idea to create a new product for underwater flippers that generate music while he swims and is self-powered by his swimming.
- Julie is an engineer that wants to get involved in something and has interest in both mechanical and electrical engineering and trying to figure out what she wants to do in life.
- Ashish is a music student that loves music and swimming and wants to do something "cool" and has immense artistic energy

All three students come to the central hub. Julie and Ashish sign up on the global talent board (computer based) eager to be involved. Fred visits the team central hub and talks to the team expert mentor who aids him in making the team connection with Julie and Ashish.

The team members meet at the team hub for an informal meeting and agree to give it a try – but they aren't fully sure where to start. They go back to the team mentor who pulls in both the entrepreneurial mentor and ideation mentor. The entrepreneurial mentor advises them to take a workshop on IP generation and protection and to develop a MOU between team members about future IP. The ideation mentor tutors them on conceptualization methods and starts them out.

The team starts rolling and Julie has many ideas on how to generate the sound and Ashish has lots of ideas on what he would want as a potential user. They generate great dreams, but then get stuck on how to do it. Fred looks into the existing market for underwater sound players and finds underwater music players, but nothing that is wearable or self-power generating – this means that there could be an open market for the idea. Their ideation mentor and business mentor works together with them on down-selection methods and market research to select a key idea to develop further.

With their killer-app idea in mind, their team mentor helps them to develop a project management plan and the delegate tasks to accelerate the development. Julie takes on the development of integrating an audio player within a scuba fin. She utilizes some of her course work and gets trained on advanced cad tools in the detailed design to design the form integrated with the speaker. She wants to have energy harvesting but has no background. The team mentor searches the data base and finds a faculty member in Mech. Eng. that conducts research on similar topics. She confers with him and gets tangible advice that enables her to engineer a first proof-of-concept.

Meanwhile Ashish looks into the existing devices that Fred had identified earlier and identified that the music generally played in these devices is of a certain style and frequency content that is more clearly heard underwater. He consults with the detailed design mentor who helps him research into the sound transmission properties of water and together, they identify a journal paper describing signal processing techniques to simulate the sound. Ashish then visits the sound studio and with their help, plays a variety of music and decides on a style of music that would be best to pre-load the

device with. Fred and Ashish together consult with the entrepreneurial mentor to look into music licensing issues and identify a large number of public domain and license free music available in a style that sounds good underwater for no-cost integration into the device.

All three members get trained in the realization hub. They rapid prototype the rubber fin and then machine the energy harvestor in the machine shop and electrically hook up off the shelf underwater speaker into the fin using the electronic workbench.

To determine if it will work – they approach the realization hub noting that there is no "water tank". The mentor aids them in borrowing a fish tank that they bring into the assessment lab. The assessment mentor evaluates their design and notes that the electrical portion is exposed and could be a safety issue. The mentor, along with the faculty member, detailed design mentor and team meet and work to resolve the electrical issues. After modifying their prototype, the assessment mentor conducts another safety check and review of their test plan. Their product is exciting and looks like it will work – so they consult with the entrepreneurial mentor to explore what assessment test will be compelling to investors. All test come out stellar.

Ashish, who is now considering changing his degree to performing arts technology due to this experience, wants to try out the device in the swimming pool. The assessment mentor works with him to insure safety and get IRB clearance to conduct test on swimmers. Ashish develops a synchronized swimming symphony and the you-tube video goes viral. Upon seeing the video, a California investor contacts group and the entrepreneurial mentor aids them in their successful pitch for a start up company that Fred has pivotal role as he completes his business degree. Julie is a consultant and determined through the experience she loves mechatronics and Ashish changes degree to pursue a MS in performing arts technology. They patent the technology and their plaque goes up on the patent wall in the IU showcase.

Appendix D

The View from the BLUElab

We have about a 100 active dreamers in the BLUElab that could not only benefit from the tools that the Design Labs are already amassing – they would benefit even more from a community of people they could collide with that know how to do things they do not.

We find that the chemical engineer doesn't know what the bearing is, the mechanical engineer doesn't know how to mold plastic; the electrical engineer doesn't like moving things, etc. It'd be great to have a place where the departmental limitations not only are checked at the door, there are trained professionals that can point students not just to operate equipment (the ME model) but to make connections with resources material and human… Maybe it could be a portal to collisions with central campus and the rest of the world as well using some of the communications technology already there (and making it more accessible).

So our dream is for a place that acts like one of those "powerball" lottery machines where all the ideas get jumbled together, focused, and come out with the multi-million dollar number!

It will be important for this to be a general resource that anyone, especially those without the formal training, can come in and utilize properly. It needs to be a "connection" for those that have ideas or just a desire to make them reality even though they may not have all the required skills or knowledge.

We think that a key thing is to make sure that we can establish the resources to support the dreams. We will need several forms of resources - physical space, mentors/trainers (i.e. people, staff), virtual resources (computer tools, webpages, etc), connection resources (may be rooms to meet but also computer tools - skype, blog, facebook, social media, etc.), creative resources (computer programs like Adams, CAD, etc, shop facilities, electrical facilities, art facilities, testing facilities, etc)

We think some of these are fairly doable such as anything connected to the computer either we would have via CAEN or should be able to get out there. Others are more difficult to come by. The one I think is the hardest but very important is the proper people. I think it would be necessary to have people (staff mostly) in shops and in creative spaces that are experts so when a student comes in and has a vague idea that they could be mentor and trained on the spot to be able to do what they need to make it happen. The quality of these helpers will define the success I think. I know it is difficult to get staff lines, but it is needed for sustainability. Similar concept to a librarian. Some types of people needed would be: shop like a Bob, electrical helper, artist or industrial designer, business/financial to help entrepreneur, computer help of course, perhaps a librarian type to help with researching. I think staff resources will be a must.

An important thing that we need to think about for this new initiative is protection of ideas. If it is very successful, then it is possible for students to come in with great ideas that become products, companies, etc.

One thing that we should have as part of this is the entrepreneurial and legal advice - especially someone to help the students patent and protect their ideas. It could

be a big "sell" - i.e. helping in the transition.

We envision a space / infrastructure where students and student teams have access to every conceivable resource (within practical limits) and guidance that they need to take their idea to practical realization. This is analogous to the role of a library which presently provides “information”; however the new space would provide information + material resources + domain expertise + prototyping capabilities + human interaction.

Sections / zones within this space could include a:

1. A triage/forum, where folks from the university community and possibly outside bring their engineering problems. This would give student teams access to a range of open/pending/relevant problems, rather than have to come up with their own problems. Since most have not been out in the real world, they may not yet have a good grasp of “problems to be solved”. We could leverage our ME450 project solicitation and management experience here.
2. Mechanical Fabrication / Prototyping / Assembly facility
3. Mechatronics Prototyping / Assembly / Testing facility
4. Product design / innovation / development workshops. Experts show how to take follow time-tested processes and practices
5. The IP Zone: How to create, protect, and manage IP?
6. How to seek funding to take your idea to the next step
    a. NSF I-corps
    b. SBIR/STTR
    c. Investors
7. Inform students of the resources available across the campus

The first 3 points are covered in some form or the other in ME currently. Some of the subsequent ones are currently covered at the Center for Entrepreneurship. This is could involve bringing together complementary expertise, experience, and resources.

For each of the above zones there would resident experts, and a process to create, nurture, and sustain the next generation of experts in each respective area. This pool of experts would a combination of faculty, staff and students. Maybe faculty could get a 1 teaching credit for classes they teach in highly informal, studio style settings.

Appendix E

DC Futures: Infrastructure (John Merlin Williams and Daniel Fesshazion)

We should be looking for a visioning model for the DC that enables us to anticipate not just the next impending technology-driven revolution, but a way to create spaces, infrastructure and the organizational model (social contracts) to support a vector (range?) of innovation without expecting we can actually predict the next endpoint. Now we see a current direction driven by, for example by the five pillars in the next wave of global IT environments (see Dan Atkins presentation). We need to do as much as possible to enable that potential to be realized and to support some range of (surprise) changes in the course of innovation. That's been part of the success of the DC so far – it was designed to accommodate activities we couldn't describe at the time, but made some reasonably informed guesses about what would drive them.

The current pervasive digital revolution and cyberinfrastructure enable radical transformation of technological, economic and social environments.

> Single mode: broadcast TV, music publishing and magazine publishing are examples of industries that have been primarily single mode, where the entire workflow, from talent recruiting, production, delivery, financing (e.g., selling ads), and even feedback (Nielsen ratings) were constrained to a narrow range of expensive resources. There was a narrow point of entry and a single mode of consumption.
>
> Modeless: the digital revolution and new CI have removed so many of the constraints in the above that hundreds of millions of individuals, with modest investment, can turn almost any content into a public artifact accessible by billions of people at any time, in any place, on a wide range of devices.

With digital infrastructure the inputs and the outputs are virtually modeless.

The communications revolution was relatively easy. Content didn't require moving lots of "atoms" (Negroponte) What's next? Manufacturing, medicine, scientific exploration, political, economic and social liberation are emerging vectors enabled by the new five pillars model– what's beyond. The DC could support these modeless transformations. The DC itself be a modeless environment. It would provide the most robust and flexible technological and social infrastructure we can imagine and fund:

- "Unlimited" network throughput, computational and storage resources, network topologies, connections to collaborative sites on campus, with peer institutions, with non-education sector partners (commercial and public)
- Accommodate the tools and artifacts of modeless transformation (within code, safety, etc,): machine tools? Fabrication systems. Electronic and materials collections and inventory, etc.
- Remove the barriers to access across disciplines for students and faculty (funding models ties to home unit)

- Flexible collaborative spaces, a variety of sizes, reconfigurable rooms and studios, modeless inputs and outputs, access floors. Ceilings and walls.
- Churn policies and empty spaces – always have room for the next thing.
- Spaces with memory - that sense, record and preserve the activities and provide analytics of what goes on in them for user reference and for research and assessment.

It would establish a new social contract: to be intentional about engaging all disciplines that affect and will be affected by the modeless revolution – create alignments that can help anticipate and begin to create practices and policies that maximize legal, social and economic freedom – modeless society?

Appendix F

DC Futures: Further Infrastructure Ideas (Group Discussions)

The Duderstadt Center has always been a neutral space that helped foster and facilitate interdisciplinary collaboration. The mission would be enhanced further, if more of the spaces in the building became available as multiuse spaces, with specialized tools and expert staff. The other key component would be enhancing the technological investments in the building.

The following are a list of elements that we think may be critical pieces worth considering and laundry list of projects at the bottom. I haven't developed the numbers to go along with the projects listed.

1. Projects would be invited to set up term-limited operations in the building. Participants would work in a fishbowl environment and they will share their work openly in exchange for getting access to cutting edge technology and infrastructure. This will encourage serendipitous learning and collaboration. Projects could require NDA agreement from the community, if deemed necessary.

2. Develop innovative spaces for experimenting with the integration of new instructional technology into teaching spaces. Spaces that will be used for a limited time and the results could end up getting adopted by the wider university community. Possible subject would be the use of mobile devices, visualization, big data and CI in a classroom setting.

3. Develop a system that manages an inventory of leading edge equipment and make it available to the DC community. The inventory needs to be funded at an aggressive replacement cycle, though with prudent oversight.

4. Invite groups from around campus to a "Show and Tell" event. This will help identify future projects that could be invited to the DC or folks will be able to make connections with members of the DC community.

5. As books move out of the building, access and expertise for retrieving and manipulating large data sets can move in. Data would be made available either over fat pipes or on the local working storage in the DC datacenter. The Library's SANDS (Spatial and Numeric Data Services) lab maintains some large data sets that can be made available to the DC community in compelling and engaging ways.

Specific project ideas:

a) Upgrade and sustain building infrastructure (networks, datacenter, wireless)
b) Enabling specialized technologies such as GPS repeaters, Wi-Fi triangulation systems and 802.11ac Wi-Fi with up to 1.3 Gbps. A must have for research and

entrepreneurial endeavors.

c) Staffing that can support all the different projects that will be coming in.
d) Upgrade all medium to large meeting spaces to support ad hoc sharing and showing with large displays and self managed conferencing systems.
e) Using the resources of the studios to document, capture and publicize all the activities in the building.
f) Specialized equipment check-out system with possible funding participation by resident projects and programs. Equipment would be for in-building use only.
g) Reduce the number of workstations in the building and convert the areas into flexible use space, with specialized collaboration tools and displays.
h) Upgrade all the conference rooms and support more ad hoc systems like Skype and Hangout, besides the hardware based conferencing systems.
i) Explore the potential of converting some of the basement into wet labs.
j) Reduce the number of workstations in the building and convert the areas into flexible use space, with specialized collaboration tools and displays.
k) Fully implement the Transparency project and distribute displays throughout the building. As part of the project, implement a live streaming system for exposing performances, workshops or project demonstrations to the university and the world.

Appendix G

Word Clouds

DC Themes

DC Learning Activities