A Formative Evaluation of Personal Learning Networks for Professional Development in the Architecture and Design Industry

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ABSTRACT

This research is a formative evaluation of personal learning networks to determine their applicability for professional development in the architecture and design industry. The researcher seeks to find a catalyst toward discipline-wide realization of integrated design practices. This research initiative was spurred by leaders in the field who indicate that a swift transformation to integrated design practice is required in the discipline in order for the practice of architecture to remain effective in today's global economy. The AIA knowledge community has designated this issue a primary focus for professional development, yet innovative solutions for timely and effective knowledge transfer at a discipline-wide scale do not currently exist. Concurrently, there is active research in computer-based organizational learning within the social sciences, education and the human computer interaction disciplines, indicating its potential as an effective method for the dissemination of knowledge. The research strategy draws upon the human computer interaction discipline's user-centered design philosophy to harness the disciplines knowledge by actively engaging experts in a formative evaluation of personal learning networks using the Delphi method. The survey engaged an expert panel in an industry specific professional development needs assessment. Then, through a process of structured conceptualization, the panel identified and prioritized the specific characteristics required for personal learning networks to be an effective professional development method. The aim of the survey was to develop expert consensus and validation that the learning needs of the industry professional can be met through employing personal learning networks. The deliverable is a rich description of personal learning networks as an agile and effective framework for professional development in the Architecture and Design Industry.

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“Design is not just what it looks like and feels like. Design is how it works.”
-Steve Jobs

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CHAPTER 1

INTRODUCTION

"Destiny is not a matter of chance, it is a matter of choice; it is not a thing to be waited for, it is a thing to be achieved."
-Winston Churchill

Architecture and design are rapidly changing as a result of advances in technology and a highly competitive global market. A customer oriented business climate is making innovation within these disciplines a necessity for survival. The most successful businesses in the information technology industry, such as Apple Inc., have remained agile, learning that cross-functional teams produce the best products. The architecture, design and construction industry must adapt to a similar way of doing business. Industry professionals are in need of continual learning to stay relevant in the field and to successfully move toward an integrated design process that utilizes collaborative technologies and encourages knowledge sharing to advance the profession.

Leading architects believe that revolutionary change can be achieved through integrated design practice, deeming it a primary focus for the field. In 2004 the Construction Users Round Table (CURT) asked the American Institute of Architects (AIA) to address the extensive problems found with the construction drawings and in the field with claims during and after construction. These problems were not entirely new; however, the studies were done from an owner's perspective. As an owner driven request for change the AIA took it to heart. As a call to action the AIA conducted a six-month study and found that the problem laid more in the process then with the construction drawings. AIA and CURT formed a productivity group to determine how to optimize process resulting in the newly released guide to Integrated Project Delivery.

Through collaborative efforts supported by the American Institute of Architects, the task force began to define and create a vision for integrated design practice. Architecture

and design practice and education is fundamentally experience-based and rooted within the project process. As a result, the profession lacks an archival body of knowledge to collectively draw and learn from. Therefore, the dissemination and acceptance of this new vision of integrated design practice is bound to take time. The American Institute of Architect's has realized this as well, recently adopting a strategic plan to become a knowledge driven organization. According Norman Strong, a former AIA Vice President, "we have a very small window to change the trajectory of the profession, and to best ensure its continued relevance." (Strong, 2007)

1.1. PROBLEM STATEMENT

Architectural practice as we know it today is being challenged in the new global market. Leaders in the field have indicated that a radical transition to integrated design practice is inevitable for the discipline, the construction industry and the multiple stakeholders invested in the built environment, yet the profession lacks sufficient ability for knowledge transfer at a discipline-wide scale. Concurrently, there is active research in computer-based knowledge sharing within the social sciences, including personal learning networks, indicating its potential as an effective method for the dissemination of knowledge and individual professional development. Design practice requires interdisciplinary collaboration and as such, is inextricably linked with social and organizational dynamics. Knowledge sharing in the industry is done through stories of practice and prototypes, yet there are few mechanisms that exist that capture this knowledge. This research draws upon the existing skill of architects and designers to communicate their ideas through their communities of practice, to extend their reach and potential beyond the project level and directly contribute to the changing conditions of practice.

1.2. HYPOTHESIS

Personal learning networks can provide architects, designers and industry professionals with a model for self-directed professional development that enables collaboration and knowledge sharing within the community of practice toward adoption of integrated design practices at a discipline wide scale.

1.3. RESEARCH OBJECTIVE

This research is a formative evaluation of personal learning networks to determine their applicability for professional development in the architecture and design industry. The overarching learning objective is the adoption of integrated design practices. The American Institute of Architects (AIA) knowledge community has designated this issue a primary focus for professional development; yet current professional practices create a barrier to implementation.

There is active research in computer-based organizational learning within the social sciences, education and the human computer interaction disciplines, indicating the potential for personal learning networks to be an effective method for the dissemination of knowledge and collaborative practice. The goal of the research is to cultivate social networking and knowledge sharing in the field as a catalyst for integrated design practices.

The objective of this research initiative was to conduct a formative evaluation with the intent of generating a self-directed technology-supported professional development model utilizing personal learning networks. This model can be developed through an integrative literature review and user-centered design methods including a needs assessment and a survey to understand the attributes required to support self-directed

learning within the architecture and design industry. These matrices could be ‘captured’ using the Delphi method; a structured series of surveys conducted with a panel of independent experts. The experts were carefully selected from industry stakeholders with expressed interest in advancing the field and developing and implementing integrated design practices. This iterative process allows the expert panel to identify and come to consensus on the important connections and factors required for professional development, with the assumption that they would apply to most industry professionals. The convergence of the literature review, the needs assessment and the results of the Delphi survey, provides for a structured conceptualization of a personal learning network model for the industry. The deliverable is a rich description for implementation of personal learning networks as an agile and effective framework for professional development in the architecture and design industry.

1.4. SCOPE OF RESEARCH

1.4.1. Goal of Research

This research is intended to investigate the potential for personal learning networks to serve as an agile and effective model for professional development in order to provide the catalyst required for discipline-wide adoption of integrated design practices. The goal of this initiative is to assess the perceived needs of the discipline and to provide recommend model for an innovative yet appropriate professional development capable of facilitating:

1) The dissemination of new integrated design practices at a discipline wide scale;

2) Creating a collaborative knowledge-sharing venue for professional development that encourages and supports the existing and emerging community of professional practice, and;

3) Providing the foundation for an accessible repository of knowledge for the profession.

1.4.2. Methodology

This research uses a mixed method approach drawing standards for comparison from social science and human computer interaction research and design methodologies. The study is a formative evaluation based upon an integrative literature review, a needs assessment and a Delphi survey toward the development of a structured conceptualization of personal learning networks for professional development in the AEC industry.

As a contributing element to a broader research methodology, the integrative literature review for this research is limited to synthesizing the literature of the intersections of the three domains of knowledge to generate new knowledge about the topic and to inform the needs assessment, the research design and the conceptual framework.

The Delphi method is a form of survey that is effective in facilitating a structured group communication process allowing a group of diverse individuals, as a whole, to deal with complex problems and collectively develop a forecast around an issue of which there is little information (Linstone & Turoff, 1975) It has been extensively used in the field of science and technology to combine expert opinion on developing new technologies. A web-based version of the Delphi survey allows for dynamic, timely anonymous and asynchronous interaction between remote members of the selected group. A Delphi Survey is achieved through a series of questionnaires and controlled feedback to develop consensus between experts anonymously in innovative areas such as technology where current knowledge does not exist. The scaling method is used to rank factors that need to be considered to achieve the goal of obtaining group consensus. The survey is conducted in three or more rounds (not to exceed 6 rounds) until consensus can be gained within a group of a dozen or so experts (Rowe et al. 1999). Consensus is gaged using Kendall's W coefficient of concordance. The value of W ranges from 0 to 1 with 0 indicating no consensus and 1 indicating a perfect consensus.

A W value of .7 or greater indicates strong agreement. The questionnaire is conducted with an on-line Qualtrics-created survey over the course of several weeks. The researcher's professional experience as an architecture and design practitioner familiar with business project management is drawn upon to effectively direct and facilitate the Delphi survey. The results of each round are interpreted by the researcher and presented to the expert panel to facilitate consensus building. The researcher presents the consensus to the Delphi survey expert panel in the final round for confirmation to ensure the validity of the results.

1.5. RESEARCH LIMITATIONS

1.5.1. Boundaries of the Study

This research has the following limitations:

Systems:

- Due to the unlimited scope of potential collaborative sets in an integrated design process, this research will focus primarily on the AEC industry. The focus will be at the intersection of the three domains of knowledge addressed in the literature review; Architecture and Design, Professional Development and Personal Learning Networks.

Subject:

- Due to the extensive amount of potential representatives, the subjects for the Delphi survey will be limited to no more than 20 professionals chosen specifically because of their expertise in the field and interest in advancing technology-supported collaboration and knowledge sharing in the industry with a specific focus and interest in BIM (Building Information Modeling).

Demonstration:

- Due to limited time and scope, the researcher will provide a conceptual framework of a personal learning network for professional development based on analysis of the literature, a needs assessment and the consensus of the expert panel. Personal learning networks are, by necessity, designed by and for the individual and therefore specific examples are not included in the scope of this research. The conceptual framework and rich description serves as a model for implementation of personal learning networks for professional development in the industry. This model will serve as a basis for future work for the researcher to develop a strategy, a course and instructional tools for industry professionals to develop personal learning networks. As such, this research is limited to the planning phase for implementation of personal learning networks for professional development in the industry.

1.5.2. Researcher Background

In order to both show the researcher's abilities to conduct this research as well as to identify any potential bias, a brief discussion of the researcher's background is offered here. The researcher has more than 25 years of commercial design experience ranging from new construction projects to tenant improvements as an owner representative. As a project manager she encouraged multidisciplinary collaboration and integrated design practices when managing project teams. Her understanding of organization behavior was acquired working as an in-house facilities project manager for 10 years for a company which underwent a thorough corporate restructuring and re-branding initiative. She was a participant and a developer in the process, including contributing to the surveys, leading new intranet knowledge sharing initiatives and implementing new corporate design standards facilitating improved communication and business operations. The researcher investigated integrated design practices and the integration of technology into the built environment as part of her master of science in architecture, resulting in three publications and one peer reviewed paper (Appendix E). The researcher has stayed abreast of the developments in the industry through participation in professional organizations, serving on research consortiums and as the president of the Building Smart Alliance Virginia Tech Interest Group. This experience in project management and business practice paired with extensive literature review provides the researcher with the background and leadership skills required to conduct a Delphi survey. It is expected that any potential bias in the analysis of the findings will be balanced by validation of the results by the expert panel lending a degree of impartiality to this research effort.

CHAPTER 2

LITERATURE REVIEW

The research involves three domains of knowledge; Architecture and Design, Professional Development and Personal Learning Networks. As a formative evaluation, the researcher seeks to determine the applicability of personal learning networks for professional development in the architecture and design industry. As such, the literature review focuses specifically on the intersections between domains; Integrated Design Practice, Communities of Practice and Social and Organizational Learning (Figure 2.1) toward the development of the research design.

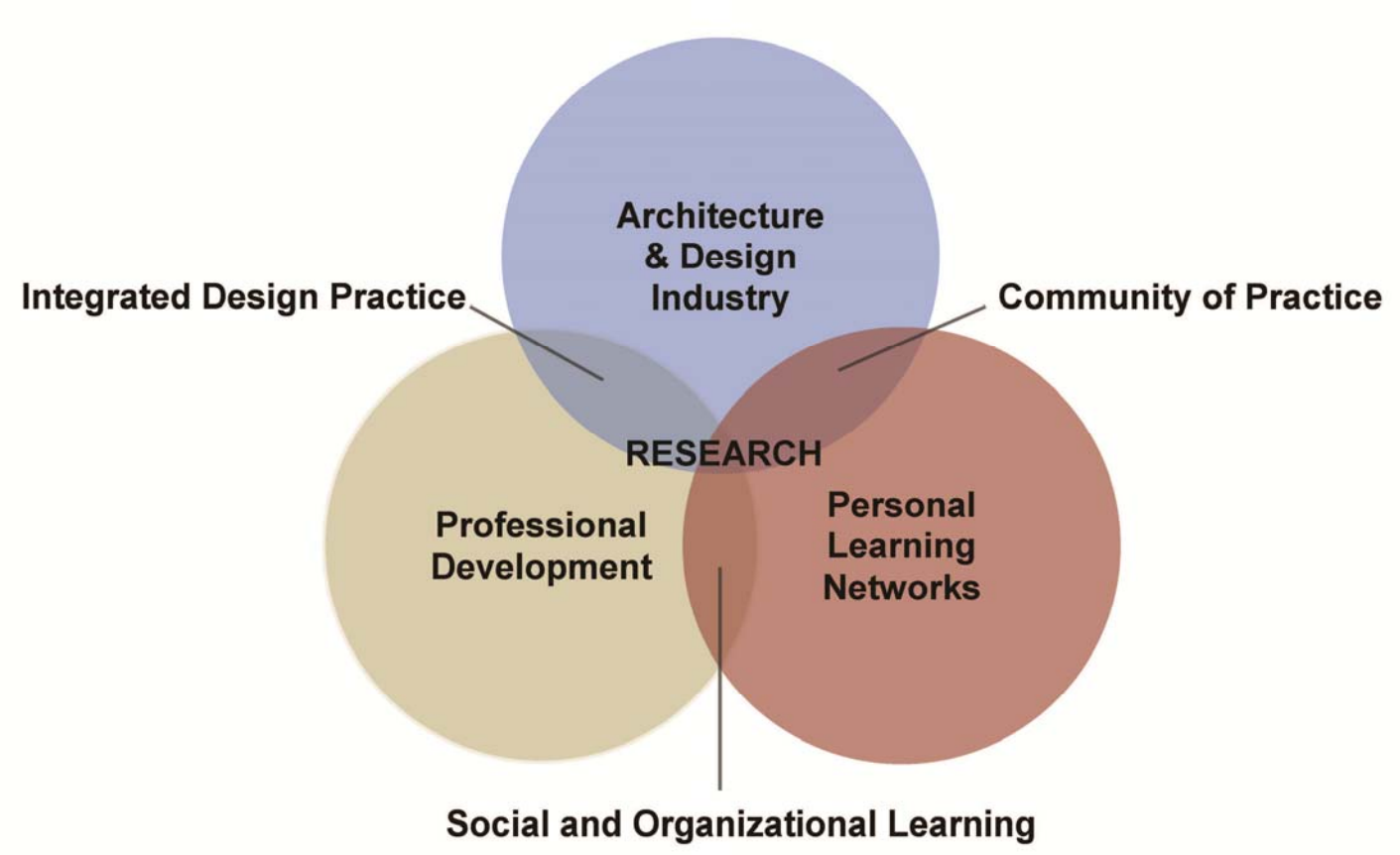


Figure 2.1

Domains of knowledge reviewed toward the development of the research design.

2.1. ARCHITECTURE AND DESIGN

"This revolution is already changing my firm, and it will change yours…Our profession will be utterly different, transformed, within the next 5-10 years."
-Norman Strong, FAIA

2.1.1. Rethinking the business of architecture

Architects have traditionally held a degree of professional ethical responsibility for shaping the future for human beings through the manifestation of the built environment. In order to succeed in the current market of *better, faster, cheaper*, and now *greener*, firms have had to redefine themselves to provide a full array of services as well as innovative design practices. Meanwhile, futuristic scenarios describing the implications of pervasive technology are being written about and publicized to a degree in which there is an acknowledgment in the profession that it will significantly affect the future of architectural practice. The former American Institute of Architects Executive President/ CEO and co-chair of the Design Futures Council, Joseph Cramer, is one of the leading foresight advisors in North America. He reports that the focus of discussion in the profession today revolves around new and emerging models of collaboration. The Design Futures Council conducted research that indicates design collaboration shifts in the industry, (Table 2.1).

Table 2.1. Design Collaboration Shifts [fair use]
(adapted from Design Intelligence, 2007)

MOVING FROM:		MOVING TO:
Centralized control	⇨	Hybrid collaborative networks
Solo Artist	⇨	Design teams
Solving discrete problems	⇨	Managing ongoing dilemmas
Stable design professionals	⇨	Dynamic entrepreneurial professions
Monolithic infrastructure	⇨	Lightweight, smart, ad hoc infrastructure
Anecdotal design star	⇨	Integrated delivery team
Linear processes	⇨	Simultaneous and overlapping processes
Mixed media technology	⇨	BIM and 4-D dynamic sharing
Design for average clients	⇨	Design with expert clients

We are experiencing a time of transition, from solo artist to highly talented collaborative teams, re-designing processes and project management success. Today design leaders and their organizations are challenging the artist's function and making collaboration a top priority. This is often not an easy decision or direction…..The decision-making process in some professional practices is accomplished in silos or through semi-private separate functions without much thought to the new benefits realized from collaborative processes. The cultural DNA of the professional practice often has to be re-formulated, and the tremendous gravitation forces of tradition can be difficult to overcome…..The solution to collaboration success is for firms to discover their optimal DNA teaming process and differentiate it for their own hybrid success, discovering a structure that emphasizes a prime accountability to clients, not inefficient old outmoded habit designers that, at the very best, serve theory. (Cramer 2007)

2.1.2. A Definition of Integrated Design Practice

Integrated Design Practice-

Integrated Project Delivery leverages early contributions of knowledge and expertise through utilization of new technologies, allowing all team members to better realize their highest potentials while expanding the value they provide throughout the project lifecycle. At the core of an integrated project are collaborative, integrated and productive teams composed of key project participants. Building upon early contributions of individual expertise, these teams are guided by principals of trust, transparent processes, effective collaboration, open information sharing, team success tied to project success, shared risk and reward, value-based decision making, and utilization of full technological capabilities and support. The outcome is the opportunity to design, build, and operate as efficiently as possible. (AIA/ AIA CC 2007)

Architects, designers and industry professionals are being charged with learning how to employ Integrated design practices and collaborative design methods emphasizing knowledge integration in the development of a holistic design. The underpinnings for integrated design practices are in the “whole building design” approach. By viewing a building system interdependently as opposed to its separate elements (site, structure, systems and use), this approach facilitates sustainable design practices. The integrated design process requires multidisciplinary collaboration, including key project life cycle stakeholders and design professionals, from conception to completion. Decision making protocols and complimentary design principles must be established early in the process in order to satisfy the goals of multiple stakeholders while achieving the overall project objectives. The understanding of integrated design has evolved in conjunction with the rise of multidisciplinary design firms and is now being used as a term to describe a collaborative design process, also referred to as integrated project delivery.

Phillip Bernstein, Vice President of Autodesk, portends that the focus is not technology driven, but market driven:

Traditional methods are too costly, too wasteful, and don't take into account the full life cycle of a building. Traditional industry practices do not provide sufficient access to sufficient information for everyone involved to make crucial decisions under today's pressures of time, budget, and accountability. Traditional methods do not deliver the outcomes clients demand in today's business climate.

What the industry faces can be summed up as a demand for greater insight *into the increasingly complex collections of information that make up what we call a design. It's crucial that this insight be available as early in the creation process as possible—that's when there is the greatest potential to affect the building's cost and function with the least cost in dollars and time.*

Integrated Practice is as much a philosophical change in the business of architecture as it is a method or a process…..it creates the platform that makes it practical and efficient for architects and everyone else involved in the creation of a building to do business under this new set of rules. (Bernstein 2005)

2.1.3. The American Institute of Architects and Integrated Design Practice

The American Institute of Architects, as part of their strategic plan, has become a knowledge driven organization seeking to enhance the development of applied knowledge within the profession through generation and dissemination of knowledge. The AIA board has focused on Integrated Practice as the primary emerging issue in the discipline. In a newly released report, Norman Strong, AIA Vice President and Chair of the Integrated Practice Discussion Group shared his vision for the future:

Imagine a world *where all communications throughout the process are clear, concise, open, transparent, and trusting; where designers have full understanding of the ramifications of their decisions at the time the decisions are made; where facilities managers, end users, contractors and suppliers are all involved at the start of the design process; where processes are outcome driven and decisions are not made solely on first cost basis; where risk and reward are value-based, appropriately balanced among all team members over the life of a project; and where the profession delivers higher quality design that is sustainable and responsive.* ***This is the future perfect vision of Integrated Practice****.* (Strong 2007)

The AIA National and AIA California Council held meetings, formed a task force and ultimately published a guide to Integrated Project Delivery (AIA/AIACC 2007). This guide defines integrated project delivery, discusses expected benefits and challenges and provides guidance on delivering an integrated project. The goals of the AIA for Integrated Project Delivery include:

1. Collaborate with industry leaders to facilitate the dialogue, share knowledge, and accelerate the rate of change for all those seeking to improve the industry's current practices by utilizing integrated approaches to the design, construction and operation processes;
2. Communicate the benefits of collaborative approaches to public and private sector clients, and promote changes to the design and construction procurement process to allow early information sharing;
3. Promote the benefits of developing a virtual model of a project using available technologies, built with interaction and input from an integrated and collaborative team of project stakeholders – owners, designers, consultants, constructors, subcontractors and suppliers;
4. Develop and promote the integration of collaboration techniques and technology into education curricula for architects and architectural students to enhance their design and team collaborative skills;
5. Engage the legal profession and the insurance industry in preparing contracts that support the integration of collaborative models and technology into the design and build industry and offering insurance coverage's responsive to IDP; and,
6. Promote documentation of the measurable contributions resulting from implemented integrated project delivery approaches to stakeholders and promote the value and achievements of increased use of integrated project delivery methods. (AIA/ AIA CC 2007)

In order to achieve these goals, the AIA is focusing on defining new business models toward a collaborative framework for the integrated project team. This includes development of industry wide standards and interoperability platforms, such as the Building Information Management (BIM) system. Additionally, the AIA holds webinars and Integrated Design Practice events on the day before the Annual National Convention as a way to disseminate knowledge of the new disciplinary practice.

The AIA's focus on project delivery guidelines and the development of the interoperability platform is critical for the success of Integrated Project Delivery, or Integrated Design Practices at the project level. However, the traditional broad dissemination of knowledge at a discipline-wide scale through AIA professional membership meetings and the National Convention that is offered does not provide for inclusion of the collaborative team of project stakeholders, nor does it support the rapid change that is required.

This research proposes that personal learning networks for professional development can be the catalyst required for integrated design practice to take hold in the industry. According to George Siemen's theory of Connectivism (Siemens 2005), 'the network is the learning", meaning that knowledge spreads exponentially as each new node (individual) is added to the network. It requires that architecture and design professionals take the initiative to facilitate their own professional development through intentional engagement in personal learning networks. The expectation is that in doing so the community of practice would continually evolve resulting in collaboration and knowledge sharing within the profession.

2.1.4. Comparison of Traditional vs. Integrated Project Delivery

Integrated Project Delivery leverages early contributions of knowledge and expertise through utilization of new technologies, allowing all team members to better realize their highest potentials while expanding the value they provide throughout the project lifecycle. At the core of an integrated project are collaborative, integrated and productive teams composed of key project participants. Building upon early contributions of individual expertise, these teams are guided by principles of trust, transparent processes, effective collaboration, open information sharing, team success tied to project success, shared risk and reward, value-based decision making, and utilization of full technological capabilities and support. The outcome is the opportunity to design, build, and operate as efficiently as possible. (AIA/ AIA CC 2007)

In a truly integrated project, the project flow from conceptualization through implementation and closeout differs significantly from a non-integrated project. Conventional terminology, such as schematic design, design development and construction drawings, creates workflow boundaries that do not align with a collaborative process. In the integrated project, design will flow from determining project goals and what will be built, to how the design will be realized. Input from the broader integrated team, coupled with BIM tools to model and simulate the project, enable the design to be brought to a higher level of completion before the documentation phase is started. Thus the Conceptualization, Criteria Design, and Detailed Design phases involve more effort than their counterparts in the traditional flow. These differences in practice from traditional project delivery to integrated project delivery are highlighted in Table 2.2.

Table 2.2 Differences in traditional and integrated project practices [fair use] (AIA/ AIA CC 2007)

Traditional Project Delivery		**Integrated Project Delivery**
Fragmented, assembled on "just-as-needed" or "minimum-necessary" basis, strongly hierarchical, controlled	TEAMS	An integrated team entity composed of key project stakeholders, assembled early in the process, open, collaborative
Linear, distinct, segregated; knowledge gathered "just-as-needed", information hoarded; silos of knowledge and expertise	PROCESS	Concurrent and multi-level; early contributions of knowledge and expertise; information openly shared; stakeholder trust and respect
Individually managed, transferred to the greatest extent possible	RISK	Collectively managed, appropriately shared
Individually pursued; minimum effort for maximum return; (usually) first-cost based	COMPENSATION/ REWARD	Team success tied to project success; value-based
Paper-based, 2 dimensional; analog	COMMUNICATIONS/ TECHNOLOGY	Digitally based, virtual; Building Information Modeling (3,4, and 5 dimensional)
Encourage unilateral effort; allocate and transfer risk; no sharing	AGREEMENTS	Encourage, foster, promote and support multi-lateral open sharing and collaboration; risk sharing

In general, integrated project delivery will result in a greater intensity with increased team involvement in the early phases of design. This higher level of completion allows the Implementation Documents phase to be shorter than the traditional CD phase, and early participation of regulatory agencies, subcontractors, and fabricators allows shortening of the Agency review and Buyout phases. The combined effect is that the project is defined and coordinated to a much higher level prior to construction start, enabling more efficient construction and a shorter construction period. To provide a basis for comparison, the AIA demonstrated the differences in integrated and traditional project delivery (Figure 2.2) highlighting the phases from concept to realization (AIA/ AIA CC, 2007).

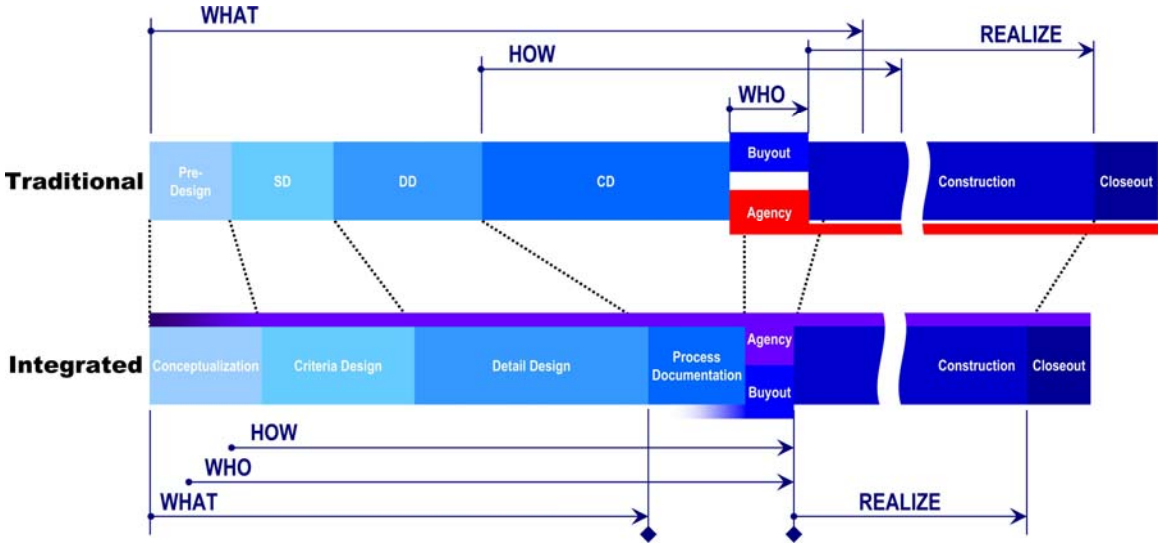


Figure 2.2 Differences in integrated and traditional project delivery [fair use] (AIA/ AIA CC 2007)

2.1.5. Benefits of Integrated Design Practices

The benefits of integrated design practice could be most dramatic in the construction industry. As the only non-farm industry to decrease in productivity since 1964, it suffers from inefficiencies and waste that can be attributed to lack of collaboration with architects and designers and to insufficient use of technologies. The employment of new technologies, paired with collaborative business practices, indicate increases in productivity and efficiency. For example, The United Kingdom's Office of Government Commerce (UKOGC) has seen continuous improvement and cost savings of up to 30% over a series of construction projects led by integrated project teams and estimates that a single project can achieve savings of up to 10%. (AIA/ AIA CC 2007)

In addition to overall cost savings, the industry has realized that collaborative practices facilitate sustainable design and construction. With the implementation of sustainable rating systems such as the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, integrated design practices have become synonymous with green building. It is possible to achieve basic credits toward LEED certification with a traditional building practice; however LEED plans to increase the level of performance required as Green building practices become mainstream. As a driver for change, LEED encourages integrated design by necessity. For example, in order to optimize energy performance (the largest category of available points), early collaboration is required with the mechanical engineers in specifying the building energy systems. This is in contrast to a traditional project whereby an architect designs a building before engaging a mechanical engineer, often resulting in an overbuilt system and higher lifecycle costs. As another incentive, LEED provides credits for innovation and design process or integrated design practices. (USGBC 2006)

This movement toward multidisciplinary collaboration and sharing of knowledge in the design process has manifested by necessity in architecture and in other design fields over the past decade. Innovative companies, such as IDEO, (providers of products, services and environments), have built their reputation in the marketplace as leaders

based on their hands-on, innovative, and participatory design methodologies, including interaction design, broadening the definition of integrated design beyond 'green'. There are similar design methodologies in the development of new technologies within the Human Computer Interaction discipline. Both fields are rooted by social and physical context-based objectives such as *user-centered design*, *interaction design* and designing for *effective use*.

An *effective use* approach to implementing personal learning networks for professional development in the industry considers benefiting the entire community irrespective of access to technology. Information Communication Technology (ICT) is increasingly ubiquitous, both mobile and built into the environment, but can people effectively use it? The mal-distribution of opportunities resulting from the implementation of information communication technology has made it a focus at the World Summit on the Information Society (WSIS). This has brought attention to the need for an ‘effective use’ approach (Gurstein, M. 2003), which ensures that the economic and social opportunities of technology benefit the entire community. This can be achieved by actively involving community leaders, architects and planners in the rapid development of these technological initiatives. By expanding integrated design practices to include ICT, we can effectively incorporate technology into the built environment. Designing personal learning for effective use requires a flexible methodology that can adapt to an individual’s access to technology.

User-Centered Design is both a design philosophy and a process intended to ensure that the technology is designed around how people need or want to work instead of requiring that they adapt their work to accommodate the platform or system. It is a multi-phased iterative process involving the end user at all stages of the design and including multiple tests of the interfaces to see both how the users think they will use the technology compared with actual use. This design process serves the researcher’s objective to engage potential users in the planning stages of development of the model for personal learning networks to ensure that it meets the needs of the industry.

Interaction design developed from interface design and is now used by multiple disciplines interested in the usability and experience of an object or a system. IDEO, a global design firm specializing in innovative solutions for organizations, is a leader in the practice of interaction design. Interaction design follows a process of iterations in which design solutions can be generated quickly and tested with the users. Similar to community design for ‘effective use’, interaction design requires design research and concept development, storyboarding and schematics as well as concept testing with the stakeholders prior to implementation. With the advent of computers, technology has become the only truly interactive product. This human-centered design process serves as a guide for the researcher in the research design process.

The field of human computer interaction practices social computing techniques such as interaction design, usability engineering and interface design methodologies with a focus on usability. They follow analogous design paths including the identification of the project goals, the stakeholders and the specific project requirements. There are many similarities in the process of designing the built environment and designing technology that can facilitate a user-centered approach for ‘effective use’ of technology. Therefore, the researcher determined that these design methodologies could inform the research design.

When Vienna was being built at the turn of the century, its leaders and planners were attributing its future greatness to qualities of "Memory and Prophecy." Their hope for a great future city was to be realized by melding the comfort of their traditions with the excitement of the new. In any content rich environment, communication has to occur by referencing exiting knowledge, engaging one's audience and mutually exploring and discovering new ground. (Foy 2006)

2.2. PROFESSIONAL DEVELOPMENT

Professional development has traditionally been handled at the organizational level. Companies typically provide professional development opportunities for their employees often including required real-time classes or online courses. Professionals are typically provided with the support and funding to attend 'lunch and learn' seminars and annual conferences, and in the field of architecture, earning CEU's to maintain licensure. While organizational support is inherent to the professional development process, this research shifts more of the responsibility for professional development learning goals to the individual. The development and management of a personal learning network for professional development requires an understanding of social and organizational learning and knowledge management.

2.2.1. Social and Organizational Learning

There are several complimentary learning theories that influenced the researchers approach to developing a model for personal learning networks for professional development. Social and organizational learning theories that emphasize the sociocultural context in the construction of knowledge and are rooted in social constructivism include; connectivism, activity theory, and organizational learning.

Social constructivism, similar to social cognitive theory, emphasizes the importance of collaboration and social interaction in the construction of knowledge (Vygotsky 1978). George Siemens theory of connectivism (Siemens 2004), greatly influenced by social constructivism, is a theory of knowledge and learning that focuses on emerging technologies and emphasizes the importance of the tools and network connections in human learning. The principals of connectivism most relevant to this research include;

- A multidisciplinary, multi-literacy approach to knowledge generation is a core to human learning.
- Fostering and maintaining connections is critical to knowledge generation.
- The capacity to know more is more critical that what is currently known.
- Dynamic learning is a process of connecting ‘specialized nodes’ (individuals or groups), ideas, information, and digital interfaces.
- Decision making is both action and learning.
- Learning and knowledge rests in diversity.
  (Siemens 2004)

Activity theory (AT) is a theoretical framework developed and advanced by Engestrom (Engestrom 1999) that has been used to investigate and evaluate educational innovations including learning venues and technologies. It is rooted in social constructivism with the tenant of conceptualizing both individual and collective practices in the context of human activity. First developed as a theory for expansive learning (Engestrom 1987), the activity system model (Figure 2.3) represents the components of an activity system whereby the subject (individual) utilizes tools (PLN) to interact with the object (objective) to achieve desired outcomes. This activity is mediated by the social elements of the activity systems situating learning in a broader context to include rules, community and division of labor. As such, this activity theory framework provides a social and organizational basis required for the development of a personal learning network and has provided a foundation for new scientific analysis (Attwell et al. 2011) and conceptual frameworks on the subject.

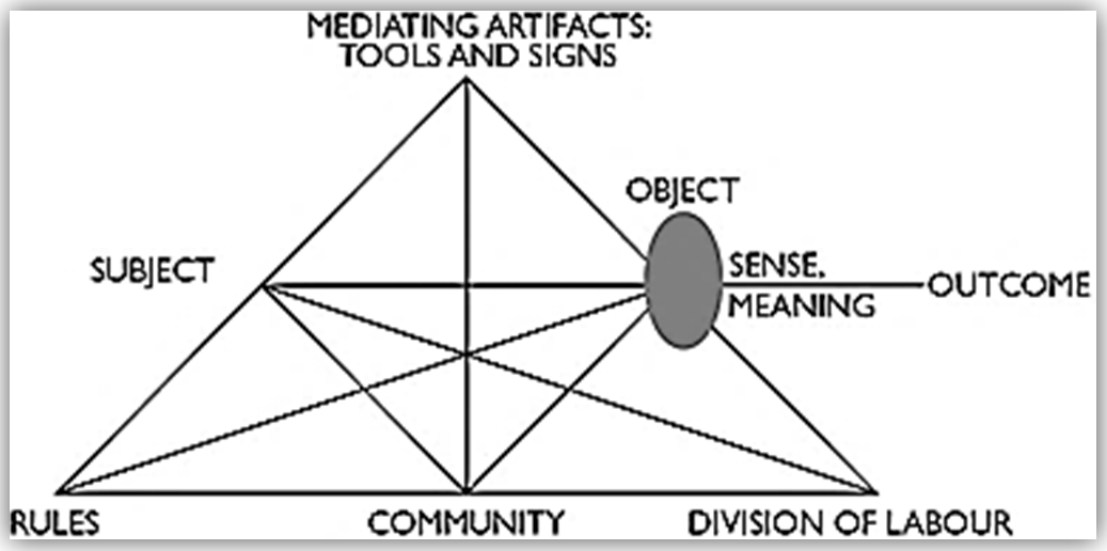


Figure 2.3

Activity System Model [fair use]

(Engestrom 1987)

Organizational learning is an area of study within the discipline of organizational theory that focuses on the ways in which whole organizations learn from experience and incorporate knowledge into continued development of the organization. Within the context of this research, the term knowledge is used in relation to how knowledge is created, used and shared within and between organizations. This includes the evolving perspective of knowledge management as it relates to knowledge exchange and networked communities of practice.

2.2.2. Knowledge Management

Knowledge has increasingly become the most valuable resource for organizations making knowledge management a top priority. Businesses consistently conduct research and development in order to better understand their operations and their customers and must disseminate this knowledge. The need to manage knowledge is a result of the new 'knowledge worker' paired with new communications technologies and learning organization tools. The World Wide Web has broadened the access to knowledge beyond face to face and paper-based communications yet the existing documented knowledge is not readily available for dissemination. Business processes for improvement and knowledge sharing do not readily exist beyond the workplace team level. (HCi 2001) These are the types of issues that require knowledge management in order to harness the potential for technology to be used effectively for knowledge sharing within an organization. Knowledge management is a systemic approach to classifying, organizing and disseminating organizational knowledge to increase the organizations performance and value. Knowledge management research has been grouped into three schools of thought; synthesis school, technology school and behavior school. (Li, et al. 2007) However, knowledge ecology supports a conceptual framework in which these independent areas of research merge creating a holistic system of people and their communities of practice communicate and share knowledge supported by enabling technologies. The term *knowledge ecology* has manifested as an

outcome of the evolution from knowledge management to information management over the past several decades. An interdisciplinary field of theory and practice, it focuses on creating and utilizing knowledge from an organizational, behavioral and technological perspective. Ultimately, knowledge ecology becomes a self-sustaining, self-organizing learning organization which allows a community to improve its collective intelligence. It is compared to a natural ecosystem in that it is a holistic framework for knowledge processes and resources within a multidimensional context.

By acknowledging the social nature of learning and the key role that technology can play in bringing people together, knowledge ecology bridges the gap between the static data repositories of knowledge management and the dynamic, adaptive behavior of natural systems. (Por 2000)

2.2.3. Communities of Practice

The term 'communities of practice' was first developed by Jean Lave and Etienne Wenger in 1991 at the Institute for Research on Learning in an effort to redefine learning in terms of social participation in the process. A community of practice is a self-organizing group of people brought together because of a common interest. We all belong to them, whether peripherally or as core members. They form around areas that are of interest to people and can include membership in a band or leadership of a volunteer organization as well as a venue for keeping on top of your game in your field. Participants continually engage and contribute in the community fostering a shared identity and reflecting the members own understanding of what is important.

People belong to communities of practice at the same time as they belong to other organizational structures. In their business units, they shape the organization. In their teams, they take care of projects. In their networks, they form relationships. And in their communities of practice, they develop the knowledge that lets them do these other tasks. This informal fabric of communities and shared practices makes the official organization effective and, indeed, possible. (Wenger 1998)

Over the past ten years, the concept of communities of practice has become associated with organizational development and knowledge management as a way of nurturing social capital and knowledge sharing at the organizational level. When change is required in an organization it involves the process of learning and is best facilitated when the change of process is designed with the communities of practice in mind. Wenger designed a model for practice that requires alignment of two components, reification and participation, in order to coordinate perspectives and align actions toward a common purpose. Reification involves taking abstract organizational goals and documenting them in order to create mutual understanding. Participation requires active involvement by the learner to recontextualize the goals within the context of their job in order for it to be a meaningful learning objective. Wenger maintains that these elements are interdependent in order for the process of learning to occur effectively. He further states that expert 'brokering' or facilitation is required if dealing with change and learning between multiple practices and perspectives which challenges the way each community defines its practice. (Wenger 1998)

Inter-Organizational Communities of Practice have recently gained greater significance as large corporations seek new ways for the members of their global operations to innovate in response to increasing market demands and rapid technological change. Within an organization, a community of practice can provide a social structure that fosters learning and allows people to develop their abilities and create a shared collection of resources to support their particular field of interest. Organizations are motivated to support communities of practice because of their value in transferring knowledge between people, including IBM, Hewlett Packard and Unisys that refer to them as 'knowledge networks'. Employees of the new knowledge economy, or 'knowledge workers', are expected to draw upon all knowledge available in order to provide innovative solutions to remain competitive in the global market. This requires that individuals be able to participate in the exchange of knowledge with others who have experience in their field.

The Ford Motor Company Best Practices Replication Process (eBPR) utilized communities of practice as part of a strategy to increase efficiency through widespread adoption and standardization of best practices from around the world. It used the company intranet to develop upon existing groups of people who did similar types of work. The communities were supported by the organization in terms of technology and guiding principles but the community sets its own guidelines for collection, sharing and valuation of best work practices. (Kwiecien & Wolford 2001)

According to Van Winkelen's Community of Practice Key Design Elements, in order to have a successful community of practice there are several key design elements that need to be met:

- *An appropriate subject area,* which generates shared interest
- *Fulfillment of certain roles,* which provides for expertise or facilitation as required
- *A culture of trust and openness,* which encourages personal exchanges to help build relationships
- *A clear purpose*, which results in tools to work more effectively
- *Appropriate organizational support,* which includes technology, coaching and on-line resources
- *Organizational acquiescence,* which demonstrates commitment at the corporate level through active participation of the leadership.

(Van Winkelen, 2003)

The St. Paul Companies is an example of a global organization that successfully employed these key design elements. The insurance organization required extensive knowledge sharing capabilities in order to develop a consistent level of expertise in all countries. They launched an intranet site called the Knowledge Exchange that allowed the virtual communities to share expertise and to provide access to tools and practices to solve work problems. Most notably, the Chief Knowledge Officer of the Knowledge Exchange observed that "inter-community collaboration is the mark of a truly powerful knowledge exchange system". (Owens & Thompson 2001)

The most significant challenge for the development of inter-organizational communities of practice revolves around building a culture of trust and collaboration. The traditional organization protects its knowledge capital as a means to prevent potential loss of competitive advantage. However, in order to compete in today's connected global economy, organizations must overcome this mistrust and develop cooperative relationships which allow for knowledge and information exchange through appropriate technologies. (Braun 2002)

Communities of practice have evolved and expanded with the advent of the world-wide-web to become electronic networks of practice, a form of social networking focused on the voluntary exchange of practice-related knowledge (Wenger, et al. 2008). Networks of practice can broaden the audience beyond the co-located community of practice to encompass the remote collaboration and the multi-disciplinary nature of the integrated design process often through third-party organizations such as professional associations. As an electronic network of practice, this is achieved through computer-mediated communication providing a service that connects people through shared interest in information.

The type of technological platform that works best for communities of practice is actively being investigated by leaders in the field of Communities of Practice. Etienne Wenger's report and guide (Wenger, et al. 2008) for selecting and building a technological platform to support communities of practice across a large organization considers;

1. *What makes communities of practice different from garden-variety online communities?*

   Every group that shares interest on a website is called a community today, but communities of practice are a specific kind of community. They are focused on a domain of knowledge and over time accumulate expertise in this domain. They develop their shared practice by interacting around problems, solutions, and insights, and building a common store of knowledge.

2. *What categories of community-oriented products exist and what are they trying to accomplish?*

   The ideal system at the right price does not exist yet, though a few come really close. But there are eight neighboring categories of products that have something to contribute and include good candidates to start with. Analyzing these categories of products yields not only a scan of products, but also a way of understanding the various aspects of a knowledge strategy based on communities of practice.

The recommended framework for analysis of community technology developed in *Technology for Communities* considers the existing as well as the potential of the technology and the community of practice:

- The existing configuration of technologies that the community utilizes
- The platforms which developers and vendors provide
- The tools required to support specific activities
- The user-friendly features that the platforms and tools provide

Communities are diverse and their members have different levels of experience and exist in different types of environments. It is important to consider the high level needs of the dynamic community while also considering the day to day practice and use of specific tools and platforms by the practitioner:

- Design for evolution
- Design for 'closeness at hand'
- Design from a user's perspective

In Wenger's book, *Technology for Communities,* (Wenger, et al. 2008) he and his colleagues investigates what kinds of platforms currently exist that support communities of practice. These venues include:

- *Facebook* and *Twitter,* which are free social networking sites,
- *Moodle,* which is a free software e-learning platform designed to create online courses with opportunities for rich interaction,
- *Q2Learning,* which is a private-label e-learning platform,
- *Web Crossing,* which is a private-label social network geared toward building organizational relationships.

Some organizations have adopted these platforms or developed their own amalgamation such as CIARIS, a learning resource center on social inclusion, which uses a custom made platform based on a web application framework, Ruby on Rails. Until an ideal system is developed, most of the products can be a starting point for a platform. However, organizations are left to analyze their needs to make the best

decision in choosing which activities are most important to their community of practice. (Wenger, et al. 2008)

A continuation of the work resulted in development of the Tools Landscape Diagram, by Etienne Wenger, Nancy White and John D. Smith in *Digital Habitats* (Figure 2.4), providing a framework to think systematically about the tools available and how they might work in practice to steward technology for communities.

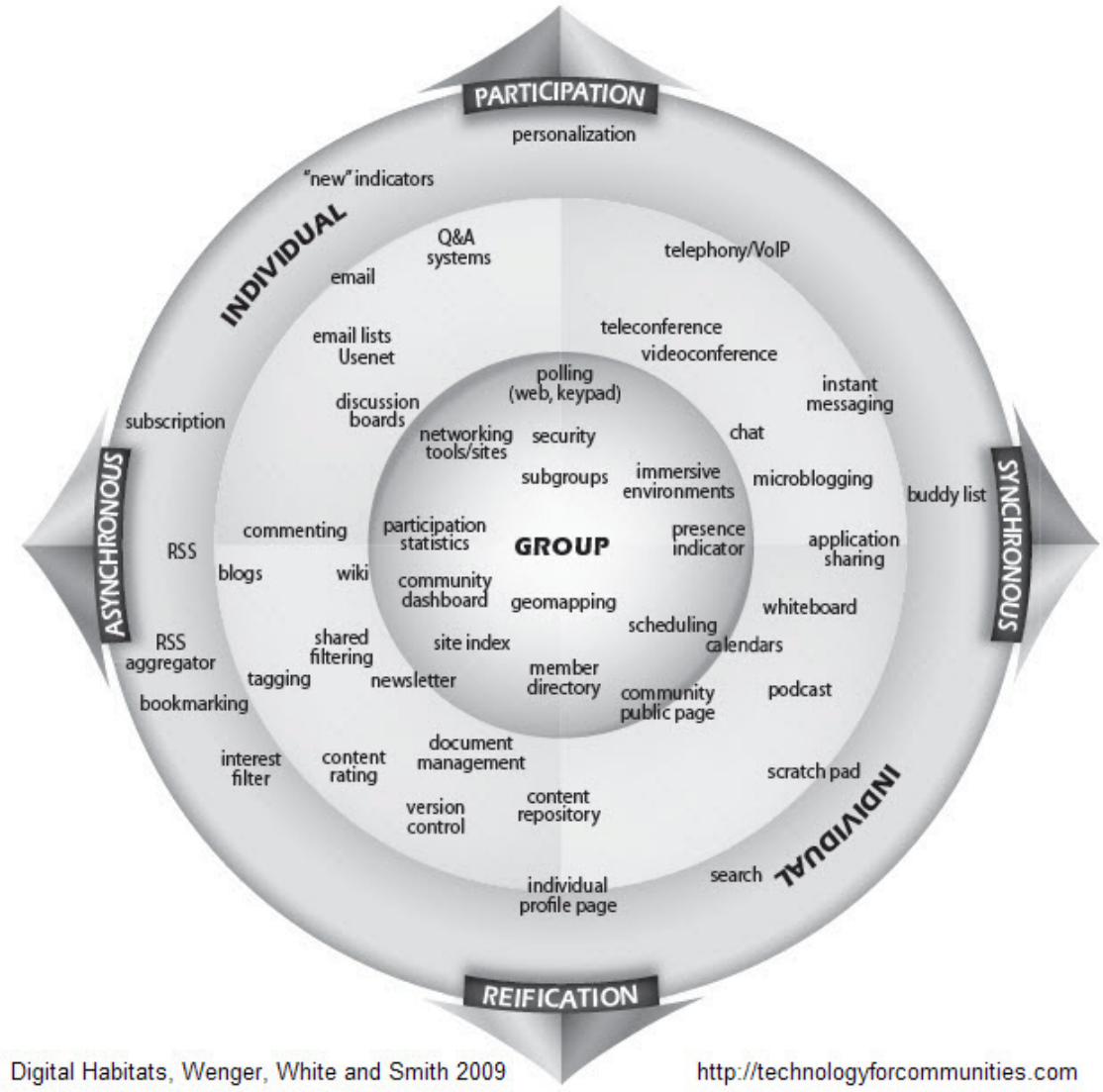


Figure 2.4 Tools Landscape Diagram [used with permission]
(Wenger, et al. 2009)

Identifying what a community needs and how to deliver it is a complex task. It requires collaboration between community insiders and technology providers. Over the long term, the involvement of technology stewards from the membership helps ensure that the technology configuration meets both the initial and the evolutionary needs of the community.
(Wenger, et al. 2005)

2.2.3. Integrated Design as a Community of Practice

By providing an open activity system for individuals interested in a common practice to exchange ideas and stories of practice, learning and innovation can increase rapidly within the applied knowledge community. Ultimately, the effort could result in the ongoing creation of architecture and design artifacts, which are accessible and understandable to all and provide a foundation of knowledge for the practice to reinvent itself for the 21st century. The platform should therefore be able to:

1) Identify and model the process of integrated design by building on the early contributions of knowledge and expertise.
2) Provide an inclusive, open and dynamic conduit for collaboration and knowledge sharing with all stakeholders while accommodating the new types of organizations that are emerging, including remote collaborative networks.
3) Archive knowledge and evolve as new knowledge is amassed.

Foremost, this repository of knowledge requires facilitation of a shared understanding of the definition and principals of integrated design practice. The commitment to these principals is essential for success, according to the report, *Integrated Project Delivery: A Guide,* developed by the Definitions Committee of the Integrated Project Delivery Task Force. (AIA 2007) The committee represents architects, engineers, contractors and subcontractors, owners and attorneys brought together to formulate a definition of integrated design and describe its key elements. In doing so, the differences between a traditional project and an integrated project delivery method emerged indicating that conventional project flow and the terminology contrast greatly with the new integrated

design project delivery methodology. As a work in progress, the Task Force invites comment. Through a professional network of practice, this type of collaborative development of best practices could be readily achieved.

Most importantly, as a social networking tool, an open and inclusive venue would evolve that expands the realm of professional networking and encourages active collaboration, potentially relieving the growing pains as the discipline drastically redefines itself. It should also reach beyond the boundaries of architecture to include all potential partners in the integrated design process. Building an integrated project team that is committed to a collaborative process requires that all stakeholders share common values and goals and are capable of working together effectively. By opening up the network of practice to include the multiple disciplines invested in the design of the built environment, there is an opportunity for architects to lead the integrated design movement as well as to learn from the other disciplines. For example, the development of new technologies is and will increasingly have an effect on the built environment and requires early inclusion and collaboration with professionals and researchers involved in the development of new technologies.

With a trend toward open sourcing and as integrated design projects are realized and lessons learned are shared, a repository for stories of practice could emerge as a new knowledge base for the profession. Over time, an archival knowledge base could readily be developed and utilized by practitioners as they seek insight into the implications of integrated design or new technologies in their own practice. By capturing the profession's knowledge, the discipline will become aware of its vast knowledge capital as a means to support and serve the community of practice.

Every group that shares interest on a website is called a community today, but communities of practice are a specific kind of community. They are focused on a domain of knowledge and over time accumulate expertise in this domain. They develop their shared practice by interacting around problems, solutions, and insights, and building a common store of knowledge.
(Wenger, et al. 2008)

2.2.4. Architecture and Design Knowledge Base

While it may take some time, there is a growing trend to build a knowledge base within the architecture and design profession in response to the unprecedented change taking place. Some may challenge that architects and designers will not be willing to contribute to the knowledge base because firms are guarded against revealing any mistakes that were made and are not willing to share their proprietary design processes. This unwillingness to share trade secrets is likely rooted in the traditional teacher-apprentice model of knowledge transfer through stories of practice. The sharing of project stories developed into the case study, a new tool for documenting project processes, challenges and successes. Thus far much of the efforts are supported by education and research that, by allowing students to become more actively involved in the profession early on, trains our future architects and designers of the realities of architecture practice. There lacks a repository of knowledge within the industry specifically for use by the architect and his/ her integrated design team to use as a resource. Even BIM (Building Information Management), an excellent project tool that can be utilized to facilitate the integrated design process, does not provide the knowledge sharing capabilities to support this rapid re-definition of the practice.

Architectural Practice is not – and has never been – documented and studied very systematically. Despite the immense wealth of professional expertise embedded in design processes, apart from a few isolated pilot efforts there are not consistent and systematic actions to establish and maintain access to the profession's knowledge, let alone to extend its potential reach. (Heylighen et al. 2007)

A pioneer in writing about architectural practice, Dana Cuff sought "to report extensive empirical data from observation within architectural practice" in her book, *Architecture: The Story of Practice*, 1991. (Cuff 1991) Primarily concerned with characterizing the professional culture, she spent time as a participant and observer in three different firms in the Bay area over a three-month period documenting stories of practice. She suggests that to be most effective in his trade the architect would need to rethink the hierarchical structure and more actively include and recognize all those contributing to

the process. Now, more than twenty-five years later, integrated design practice provides a solution to the difficulties of traditional architectural practice.

Recently, there have been a few initiatives to capture knowledge for the betterment of practice. The majority document stories of practice, manifesting in the form of case studies, and have primarily been created as learning tools for higher education. While research has been limited, there has been active investigation by Dr. Ann Heylighen into the role of case studies with a focus on unlocking the knowledge capital of architectural practice. This research, whose evolution was published over time in multiple journals, provides an in depth study of design knowledge and reinforces the importance of capturing this knowledge. It also provides an excellent resource for identifying the successes and challenges of related efforts to support the design process for developing a repository of knowledge. The outcomes of the research include:

- **Building Stories**, an experimental course offered in the architecture program at UC Berkeley that provided an opportunity for students to engage with professionals and to conduct qualitative research that resulted in stories of practice or case studies. It also allowed the practitioners to see their work from a new perspective, both validating and challenging their methods of practice. (Heylighen et al. 2007)

- **DY*N*AMO**, a web-based design assistant that utilizes Artificial Intelligence techniques and Case-Based Reasoning supporting communication and knowledge sharing. The platform provides student architects with concrete case studies to draw information from and an interactive venue that both develops the user's knowledge and builds a repository of knowledge. (Heylighen & Neukermans 2000)

The creation of stories of practice or case studies can offer insight and perspective encouraging the practitioner to learn and change, especially if there are multiple examples and perspectives to compare and contrast. This has become evident in the new green building movement, a proponent of integrated design methodologies. The

potential for change has been recognized by Rebecca Flora, Executive Director of the Green Building Alliance, who indicates that there is a perceived need for a database which will provide metrics and benchmarks for use in green building analysis and that this could tip the scales of green development beyond the risk takers to the investors. The Green Building Alliance will soon be launching a more extensive database that shows case studies that focus less on the stories of practice and more on the achievement of certain benchmarks. Noting the hesitancy of professional practice to share lessons learned, instead there will be metrics for comparison and bulleted points of achievement, including the use of integrated design practices. (Flora 2007)

The program with the broadest potential reach is the AIA case studies initiative, a nationwide invitation for schools to partner with architectural firms in order to help improve practice education in the United States. With an emphasis on exposing students to professional practice the program states the benefits for the profession and the contribution to the body of knowledge. For example, the Planning Phoebe's Field case study (Addendum E) was initiated by the author as part of her graduate research. The case illustrates a successful example of a course in which a student design team engaged with professionals in the development of an NSF grant proposal. Submissions of case studies must follow a Development Checklist and are peer reviewed prior to publication on the website. The cases are meant to showcase both successes and lessons learned but seemingly come up short on the later, likely due to a participating firm's interest in protecting their business interests. The AIA Center for Integrated Practice (CIP) serves as the online knowledgebase for the integrated practice case studies and resources necessary for collaborative design processes. As the architecture disciplines primary professional organization, the development of this body of knowledge is groundbreaking and promising. (AIA 2007)

In collaborating with the computer science department on the Phoebe's Field™ project, the researcher met Dr. Scott McCrickard with the Center for Human Computer Interaction. His research involves the use of mobile technologies to enable navigation through 'location-aware' notification systems. The researcher began working with Dr.

McCrickard and his team of graduate students to develop mobile technology systems, such as PDA's or smart-phones, for use on the Virginia Tech campus as part of their SeeVT research project. As a participant-observer on the project, the researcher facilitated a case study which provided the underpinnings for the submission of papers involving technology and the built environment (Addendum E).

2.2.5. Self-Directed Learning

"In its broadest meaning, 'self-directed learning' describes a process by which individuals take the initiative, with our without the assistance of others, in diagnosing their learning needs, formulating learning goals, identify human and material resources for learning, choosing and implement appropriate learning strategies, and evaluating learning outcomes." (Knowles 1975)

Self-directed learning in the professional development domain has traditionally meant that the professional is given a choice about in their learning objectives. True self-directed learning allows the professional to formulate their leaning goals and identify resources and strategies to achieve the desired learning outcomes. Problem-based learning, similar to inquiry-based learning, are self-directed approaches to learning spurred by real problems or questions, often through collaborative engagement in the context of professional practice. The pedagogy of personal learning networks for professional development is grounded in the primary theoretical models for online learning. Constructivism, the epistemic engagement view of learning whereby individuals construct knowledge based upon their individual and collective understandings, provides the primary vision for educational technology (Trey, et al. 2010). Connectivism focuses on informal learning that occurs in communities through the connections that individuals make with resources and other individuals- *where the practice of learning is the participation in the community* (Downes 2006).

Self-directed social learning which takes place in the flow of the work day is taking the place of formal scheduled training required by organizations. Knowledge workers learn

on the job and require the tools to help them to better focus and actualize their learning goals into learning outcomes. Workflow learning increases the value of the professional because learning occurs in conjunction with the job duties at the place and time necessary. Recognizing that individuals learn best in context within a community of practice creates the opportunity to engage in an effective workflow learning strategy. (Cross 2005)

The value of a personal learning network increases exponentially with each new member. Networks can be conceptualized as an array of nodes and the connections between nodes. The central nervous system, communication systems, financial systems, the internet and social networks are examples of networks where the value of the system increases exponentially with the addition of each new node and connection. All forms of networks are similar in the way they evolve from unconnected nodes to a hub-and-spoke arrangement around a source of power, expanding to the point that all nodes begin to take on power. The professional is responsible for developing an effective workflow strategy which optimizes their individual ‘node’ of the personal learning network while adding value to the greater community of practice network. (Malone 2004)

A personal learning network requires individual responsibility for self-directed learning. This requires a commitment of continuous improvement and professional development through identifying learning goals, actively engaging in learning to achieve specific learning outcomes and facilitating knowledge retention. As a member of a greater community of practice, (whether it be within a company, as part of a project team, a member of a professional organization or as an industry professional), members are expected to work together to share knowledge to achieve common goals and meet the needs of the client. Collective inquiry allows communities of practice to more readily develop new skills, to build a body of knowledge and ultimately change the conditions of practice. Therefore, to be successful the self-directed learner requires an understanding of their own learning path as well as that of the community of practice.

To me, this is about preserving history and making it available to everyone
-Sergey Brin, Co-Founder of Google

2.3. PERSONAL LEARNING NETWORKS

Personal Learning Network (PLN)-

A personal learning network is an informal learning network that consists of the people a learner interacts with and derives knowledge from that contributes to their professional development.
(Tobin 1998)

2.3.1. Social Networking

Technology, especially the World Wide Web and the advent of social networking, has provided new possibilities for remote collaboration and knowledge transfer resulting in significant research within the human computer interaction discipline. The research ranges from knowledge and information architecture, which is the science of organizing information for accessibility and use, to social architecture including networking and learning communities. The HCI field has branches of research, which investigate both computer-supported collaborative work and knowledge sharing and learning in virtual communities. Much of the work focuses on the research and development of new technologies using user-centered design methods at a personal and organization level surrounding remote and co-located as well as synchronistic and asynchronous communications.

A recent study, *Organizational Knowledge Architecture: in the perspective of Knowledge Ecology,* (Li, et al. 2007), researchers at Nanjing University offer the Organization Knowledge Portal as a solution to manage knowledge in a broad organizational context. It was developed as a knowledge ecosystem from the integration of three components of Knowledge Architecture;

- *Knowledge Resources Architecture, which pertains to the classification of the organizational knowledge into types of knowledge and where it can be accessed.*
- *Knowledge Process Architecture, which involves the dynamic nature of knowledge transfer and of the entire knowledge life cycle.*
- *Knowledge Space Architecture, which is the collaborative context or environment in which knowledge is shared and mirrors the organizations culture and structure.* (Li, et al. 2007)

The proposed knowledge portal is based on internet technology and the development of portals to create a single-point-of access which supports communities of knowledge workers. According to the study, an effective knowledge portal depends upon the three components of knowledge architecture paired with user-centered design to ensure effective use and acceptance by the knowledge community. This research is indicative of the growing interest in understanding and creating a venue for knowledge sharing at a broader scale.

The possibilities for knowledge sharing are growing as a result of the development of the internet. The recent evolution of the World Wide Web has been dubbed 'Web 2.0' and reflects the trends in Web technology including on-line communities that facilitate collaboration and sharing. As a result, the future of the World Wide Web is being called Web 3.0 and has many industry leaders speculating on the next wave of internet innovation. At the Technet Summit in November 2006, Jerry Yang, founder and Chief of Yahoo, stated:

Web 2.0 is well documented and talked about. The power of the Net reached a critical mass, with capabilities that can be done on a network level. We are also seeing richer devices over the last four years and richer ways of interacting with the network, not only in hardware like game consoles and mobile devices, but also in the software layer. You don't have to be a computer scientist to create a program. We are seeing that manifest in Web 2.0 and 3.0 will be a great extension of that, a true communal medium… the distinction between professional, semi-professional and consumers will get blurred, creating a network effect of business and applications. (Farber & Dignan 2006)

Web 2.0 has paved the way for social networks, virtual worlds, and blogs to emerge, all of which allow the user to interact meaningfully with others. Blogs, which continuously provide up to date information on nearly any subject, are growing rapidly. Media companies have realized that consumers would prefer to participate in the news and as a result are following the lead of successful blogs (Castro 2007). One of the earliest and most successful applications of Web 2.0 was Flickr, launched in 2004, which is a photo sharing website in addition to providing an online community platform. Social networking sites such as Twitter, Google and Facebook have also become increasingly popular and are growing by the thousands daily with the advent of a technologically savvy generation.

The young adults of today's global generation "Why" culture are effectively changing the world market and the workplace. They are accustomed to a borderless world with almost constant connectivity which they can customize to their particular needs and wants. Seeking unprecedented engagement, this culture is expecting real relationships with their employers and with the brands that they trust and support. They are intensely aware of global social and environmental issues making them the largest most socially aware generation to date, because of the internet. As such, a majority of Gen "Why" ers demand social and environmental commitment from the marketplace adding sustainability to the list of expectations: better, faster, cheaper and sustainable. (Cottinghan, 2008) They have grown up with the benefits of information communication technology and are at ease with accessing and sharing information as part of their collective experience. About 90% of all the data in the world was generated this past year. This surge of information is now being grouped and designated as 'Big Data' and is providing new opportunities for knowledge dissemination as well as research. (SINTEF 2013)

2.3.2. Self-Organized Learning Environments

Educational research conducted by Dr. Sugata Mitra, focuses on the concept of children learning to teach themselves and to learn from each other without direct input from a teacher (Sugata 2013). His work demonstrates that given access to the internet, collaboration with peers and encouragement, children readily learn. He views education as “a self-organizing system, where learning is an emergent phenomenon.” He is working to build a school in the ‘cloud’ based on the evidence that SOLE (self-organizing learning environments) are the future of learning. The concepts of self-directed learning and collaboration are in line with social learning theories and the application of personal learning networks. The studies show the benefits of SOLE include increased motivation to learn and taking ownership of the learning experience, improving problem-solving abilities and integration of new knowledge, and strengthening interpersonal and collaboration skills.

2.3.3. Architecture and Design Industry Knowledge Sharing

Technology-supported knowledge sharing within the architecture and design profession has emerged with the use of the internet allowing for remote collaboration on projects and paving the way for integrated design practice. At the project level, BIM (Building Information Management) is developing as a tool which allows the project team to design more effectively. BIM is information 3-D modeling software which can be used for planning, design, construction and maintenance through the lifecycle of a building. Its advantages lie in the ability to detect design conflicts early on as well as to maximize the efficiency of a building allowing for cost savings and sustainable design practices. It is currently only being used by 5% of the industry, primarily by architects. However, it is being promoted by the drivers of the integrated design movement, the American Institute of Architects, as an integral part of the Integrated Project Delivery Process.

Beyond the project level, the industry has joined the masses in sharing knowledge and expertise through the use of blogs, professional organization websites and magazines.

The typical blog or list serve does not always facilitate the communication or buy-in that is required for community. While communities require organizational support in terms of technology and guiding principles, for a community of practice to flourish it must set its own guidelines for collection, sharing and valuation of best work practices. (Kwiecien & Wolford 2001) An example of a blog which has elements of an emerging community of practice is one recently developed by a Stanford Alumni to follow innovative topics and companies. Intellitech, http://intellitech.wordpress.com, allows for the contributors to develop the site over time to suit their needs including individual ownership and maintenance of subject related content.

Archiblog, (http://archiblog.info/), was developed by Alessandro Ranellucci as a continuously updated review of international blogs about architecture. His aim is to support grassroots communication through the promotion of blogs as an alternative to mainstream sources. In a search of the more than 200 English language sites, the only direct reference to integrated design practices came from the American Institute of Architects website. The American Institute of Architects launched Soloso, (http://soloso.aia.org/eknowledge/index.htm), a branch of their website dedicated to providing a search repository for articles as well as a forum for discussion however it became inactive after two years. AIA Knowledge Net was created as a social networking site to provide connections to other members and a resource and venue for knowledge sharing. Member architects can join with a knowledge community, join online discussions and keep abreast of new topics through web seminars and e-newsletters. Contribution to the site awards professionals with points toward top contributor status. The types of knowledge communities include Contracts, Healthcare, Education, Housing, Interiors, Historic, Project Delivery, Retail, Urban, and Technology with a range of 1- 11.7K members in each category. The most popular communities include Design Excellence, Practice Management, Project Delivery and Technology. (AIA.org 2014)

"For the first time in history, we know now how to store virtually all humanity's most important information and make it available, almost instantly, in almost any form, to almost anyone on earth. We also know how to do that in great new ways so that people can interact with it, and learn from it." (Dryden & Vos 2005)

2.3.3. Personal Learning Networks (PLN's)

The history of personal learning networks stems from the development of personal learning environments created as a learner centered alternative approach to institution-centric learning. Personal learning environments are based on the concept of creating a personally managed space that integrates both informal and formal learning through the use of social networking and connection with a range of resources via the Web. (Martindale & Dowdy 2010). The effects that the ongoing changes to technologies have had on education have been the subject of research and initiatives for the past decade resulting in a variety of acronyms and conceptualizations to describe personal learning in the web 2.0 environment including mPLE (mobile personal learning environment), PWLE (personal work and learning environment), PRP (personal research portal), PKN (personal knowledge networks) and PLN (personal learning network). The concept of a PLN is strongly akin with PLE's yet it extends the learner network from that of a class to include the greater community of practice (Atwell 2011).

Personal learning networks are associated with connectivism, "a learning theory for the digital age' (Siemens 2005). Connectivism has roots in Activity theory (a meta-theory considering the entire work/ activity system) and Social Learning Theory (a perspective that people learn in a social context). Connectivism focuses on learning through social networking. The central concept is that knowledge is distributed across networks and that learning can be achieved through navigating, making connections and expanding the networks complexity.

"The starting point of connectivism is the individual. Personal knowledge is comprised of a network, which feeds into organizations and institutions, which in turn feed back into the network, and then continue to provide learning to the individual. This cycle of knowledge development (personal to network to organization) allows learners to remain current in their field through the connections they have formed." (Siemens 2005)

In the past, an employee could expect a promise of development opportunities and a career with a company. Today, a professional is likely to have a series of employers throughout their career and as such must take responsibility for their own professional development. AEC organizations typically offer a degree of training for their employees to support obtaining and maintaining licensure requirements. For example, architectural firms are recommended by the AIA to implement formal training programs to support the IDP (intern development program) required for architectural licensure. Once licensure has been obtained it is the responsibility of the individual to achieving the required CEU's for licensure. While an organization may provide support and funding for training, professionals must take responsibility for their own career paths.

Personal learning networks have been adopted most readily by K-12 educators to meet their need for continuing education in the field of education. Within this community of practice, PLN's are sometimes referred to as *professional* learning networks since they are centered on field related knowledge and professional development. There is often cross-pollination between the two in terms of social and professional connections however there may be distinct differences in resources. For example, an individual might include a subscription to news or food blogs in their personal learning network whereas they may not include it in their professional learning network. Regardless of the multiple areas of focus of a PLN, ultimately it is authored by the individual. Therefore, as a learner centered model, PLN's are most commonly referred to as personal learning networks.

In the current professional landscape, individuals are responsible for managing their own career paths and learning needs. As an intentional professional development effort, visualizing a PLN provides a road map for learning, allowing individuals to see hidden connections and knowledge resources. A graphic representation of the PLN allows the learner to target areas of professional development in which they are lacking and seek out knowledge building resources. The researcher has provided an example of a personal learning environment to show how an individual might represent their personal learning network from a presentation by Ilona Buchem, Professor of Digital Media Studies at Beuth University of Applied Sciences, Berlin, (Figure 2.5).

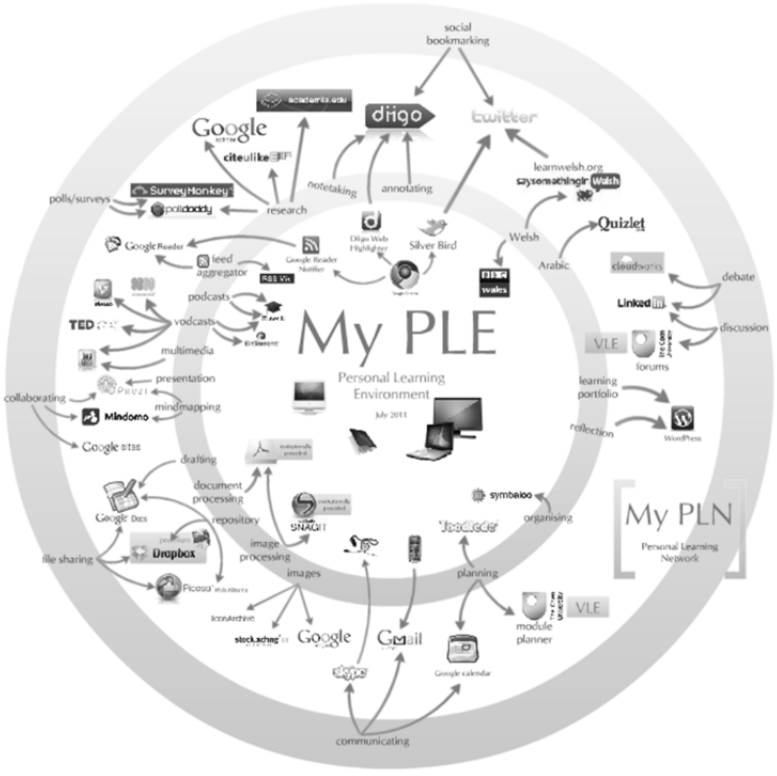


Figure 2.5 Example of Personal Learning Network [fair use]
(Buchem 2014)

The primary purpose and benefit of actively engaging in a PLN is the exponential effect on knowledge building within a networked community of practice. A learner gains knowledge through the connections and resources available within the greater professional learning network and then, through active participation, adds value to the existing knowledge that in turn contributes to the greater professional learning network, elevating the field as a whole. (Figure 2.6)

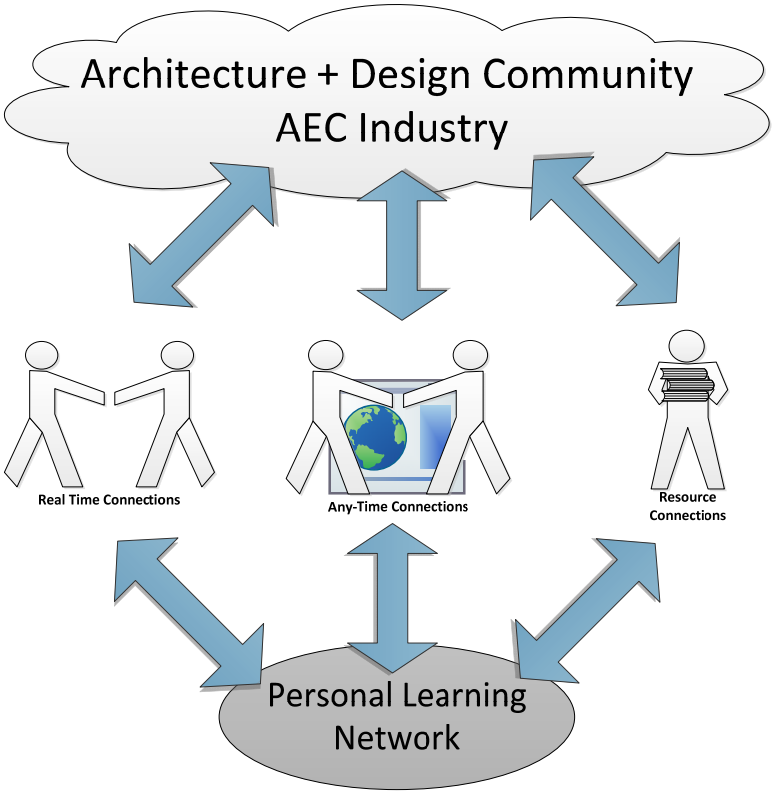


Figure 2.6

Personal Learning Network Representation

"At the heart of every PLN is its members. … Learners become amplifiers as they engage in reflective and knowledge building activities, connect and reconnect what they learn, add value to existing knowledge and ideas, and then re-issue them back into the network to be captured by others through their PLNs. Working your PLN involves a great deal of responsibility because you are almost certainly part of someone else's network."

- David Warlick, "Grow Your Personal Learning Network"
'Learning & Leading with Technology', March/April 2009

2.4. SUMMARY

Architecture and Design:

The current state of practice in the architecture and design industry suggests that the goals are in place at the professional organization level (AIA/ AIA CC 2007) for adoption of integrated design practices however, the resulting development of industry wide standards and interoperability platforms such as the Building Information Management (BIM) system have only been adopted by about 10% of the industry (NIBS, bSa.org 2014). The AIA KnowledgeNet, webinars and annual conferences have not provided the means to disseminate the knowledge required and there has not been significant development of a community of practice or knowledge base to support the sharing of knowledge.

The methods of architecture and design practice and knowledge base development in the industry required for integrated design practices to evolve must meet the six goals developed by the AIA for Integrated Project Delivery (AIA/ AIA CC 2007):

1. Collaborate with industry leaders to facilitate the dialogue, share knowledge, and accelerate the rate of change for all those seeking to improve the industry's current practices by utilizing integrated approaches to the design, construction and operation processes;

2. Communicate the benefits of collaborative approaches to public and private sector clients, and promote changes to the design and construction procurement process to allow early information sharing;

3. Promote the benefits of developing a virtual model of a project using available technologies, built with interaction and input from an integrated and collaborative team of project stakeholders – owners, designers, consultants, constructors, subcontractors and suppliers;

4. Develop and promote the integration of collaboration techniques and technology into education curricula for architects and architectural students to enhance their design and team collaborative skills;

5. Engage the legal profession and the insurance industry in preparing contracts that support the integration of collaborative models and technology into the design and build industry and offering insurance coverage's responsive to IDP; and,

6. Promote documentation of the measurable contributions resulting from implemented integrated project delivery approaches to stakeholders and promote the value and achievements of increased use of integrated project delivery methods.

A platform that would allow individuals interested in a common practice to exchange ideas, methods and artifacts would require a dynamic conduit for collaboration and knowledge sharing with all stakeholders and the ability to archive knowledge and continually evolve as new knowledge is acquired.

Professional Development:

Professional development in the context of this research draws from social and organizational learning theories with a focus on connectivism and activity theory as they directly support the concept of personal learning networks and the greater community of practice.

A Community of Practice (CoP) is well defined as, "Groups of people who come together to share and to learn from one another face-to-face and virtually. They are held together by a common interest in a body of knowledge and are driven by a desire and need to share problems, experiences, insights, templates, tools and best practices. Community members deepen their knowledge by interacting on an ongoing basis". (Hubert, et al. 2001)

The key design elements required for a community of practice (Van Winkelen 2003) require;

- *An appropriate subject area*, which generates shared interest
- *Fulfillment of certain roles*, which provides for expertise or facilitation as required

- *A culture of trust and openness*, which encourages personal exchanges to help build relationships
- *A clear purpose*, which results in tools to work more effectively
- *Appropriate organizational support*, which includes technology, coaching and on-line resources
- *Organizational acquiescence*, which demonstrates commitment at the corporate level through active participation of the leadership.

In terms of the individual, professional competency, including *professional practice and professionalism, technical and communications skills and knowledge base,* are the consistent overarching metrics indicated by American Psychology Associations standards for learning, (McCombs 1992), education professional development principals (Moorman 1997) and industry professional development guidelines (Valence 2003).

The field of professional development has traditionally been handled by organizations with research providing guidelines for learning success. Organizations are moving toward adopting social learning strategies utilizing the same metrics for learning success. As learner focused concepts, these ideas can be adopted by the self-directed learner to drive the success of their personal learning networks:

- Focus on learning
- Focus on collaborative learning
- Focus on learning by doing
- Focus on results
- Commitment to continuous improvement

Personal Learning Networks:

An individual creates a personal learning network as an intentional learning model to connect with others in order to derive knowledge and meet their learning objectives. In terms of professional development, it is a network of professionals with whom you share knowledge and from whom you gain knowledge. It allows the professional to harness social media tools to connect, contribute, converse and request information according to their own personal learning objectives. Currently, personal learning networks are being utilized within the fields of education and organizational learning.

In the scientific analysis of literature in the field of personal learning environments; *Understanding Personal Learning Environments: Literature review and synthesis through Activity Theory lens* (Attwell, et al. 2011), Attwell used Grounded Theory to conduct an critical analysis of over 100 publications. The research used an Activity Theory framework to identify the primary characteristics of personal learning environments. Activity Theory is a theory of learning that has been used to explore innovative learning technologies and practices and a process of leaning as an individual and collective practice in the context of daily activities (Engestrom 1987). Engestrom extended the basic Vygotskian triangle (Vygotsjtm 1978) of the Activity Theory framework (subject, tools and object) to include societal norms, situating learning within a social context whereby learning occurs in the process of using tools and resources toward learning outcomes, to explore and evaluate learning technologies (Engestrom, Y. 1999). The ‘activity’ and process that a learner goes through to find the tools and resources required to acquire new knowledge results in not only answering the question at hand but in ‘expansive learning’ through the process itself. Attwell operationalized these elements as they relate to community rules and organizational influence in personal learning environments for scientific analysis (Figure 2.7). The goal of Attwell’s scientific analysis of personal learning environments is to provide a knowledge base to inform further research and effective practice.

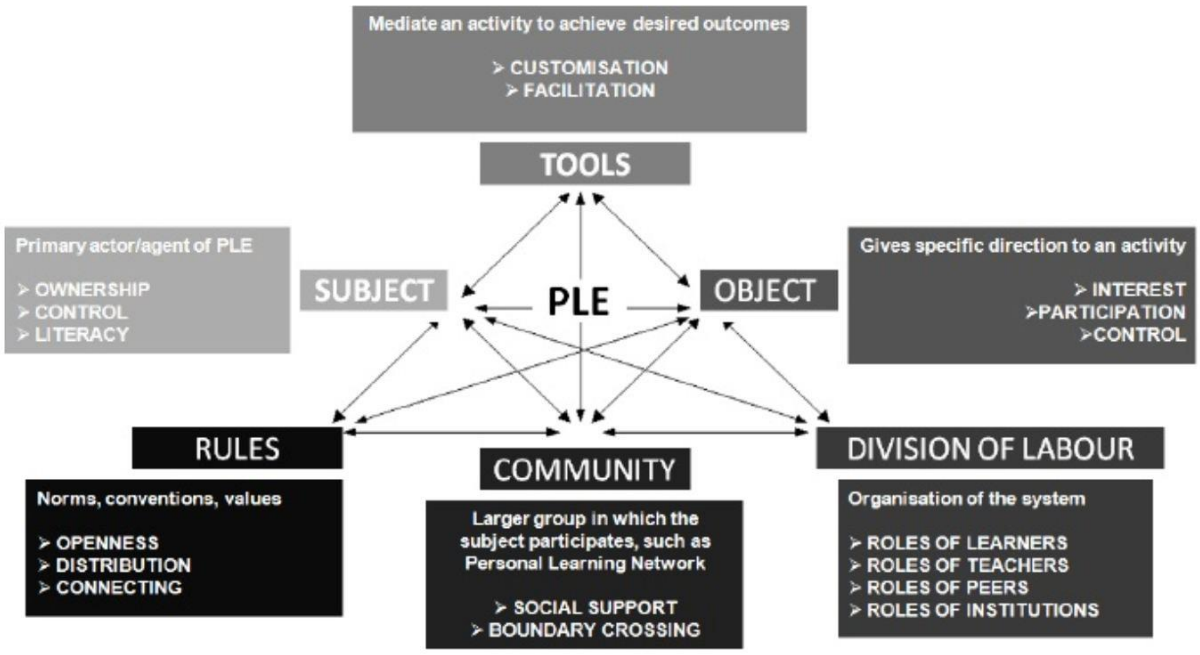


Figure 2.7. Summary of personal learning environment elements and their core dimensions [used with permission]
(Attwell, et al. 2011)

Activity Theory, as a theory of learning and change, provides an integrative framework for examining PLE's as activity systems with the subject as a starting point for analysis.
(Attwell, et al. 2011)

Social and organizational learning theories grounded in social constructivism, indicate that the Actvity Theory (AT) activity diagram provides a framework for personal learning networks that portrays the individual learning goals and learning outcomes while taking into consideration the broader influences involved with learning within the context of the architecture and design industry community of practice.

Human Computer Interaction:

The researcher looked to the field of HCI to confirm that Attwell's activity diagram was sufficiently grounded by the ideas of Activity Theory developed by Engestrom (Engestrom 1999) as they relate to technology use. Considered "the most canonical theory-base in HCI now is sociocultural, Activity Theory", has contributed significantly to conceptual transformation in the field of Human Computer Interaction (Carroll 2011). The tenet is in that there is meaning in the activity of computing itself leading to the integration of information, as opposed to the earlier application-centric view of computing in which each application is distinct from the other. Activity-centric computing has explored organizing information at a higher level into more meaningful tasks for the users since the development of Activity-Based Computing (ABC) at Apple Computer in the 1990's (Norman 1998). Activity-centric computing has developed significantly as a general approach encompassing a variety of perspectives including Activity Theory. However, despite the history and research, application-centric computing remains the paradigm (Bardram 2005). The challenges lie in the variety of approaches and specifically in terms of the adaption from concrete personal activity to a dynamic shared activity. The resulting recommendation is that designers need to customize activity systems specific to the context that they will be used. Ultimately the field of HCI's advancement within the context of computer science is dependent upon their member's (and others) reductionist contributions to the body of knowledge (Kaptelinin & Nardi 2012). Activity Theory provides a foundation for collaborative development of research practices and theory based upon history and culture that allow for a "collaborative historical becoming" (Stetsenko 2008).

CHAPTER 3

RESEARCH DESIGN

My vision for social networks is participatory, visual, based on dialogue.
-Tom Anderson, Co-Founder of MySpace

3. RESEARCH DESIGN

This chapter reviews the methods of data gathering, organization and analysis chosen specifically for use in developing a formative evaluation as a proposition for intervention. This research serves to inform the planning phase for the proposed adoption of personal learning networks for professional development in the architecture and design profession.

3.1. Research Methodology

This research is primarily qualitative in its holistic focus and interpretive approach. As a formative evaluation of a new domain of knowledge toward an innovative solution, the subject matter does not allow for standardized measures of comparison. As a result, this qualitative research follows a multi-method approach drawn from different areas of the social sciences including organizational behavior, education and human computer interaction design methodologies. The synthesis derived from a representative integrative literature review of the intersecting domains of knowledge provides the foundation for the research design and informs the final conceptualization. The research strategy draws upon these disciplines through a user-centered design philosophy to harness the discipline's knowledge by actively engaging key stakeholders. As qualitative research, human subjects inform the study within the context of their own environment and, in the case of this research, for their own potential benefit as a proposition for intervention for improved professional development opportunities. Through the use of a Delphi survey, the researcher facilitated a structured communication process, effective at collectively generating expert opinion and consensus, resulting in a structured conceptualization of the shared needs of the

discipline. The researcher interpreted the quantitative results of the survey to provide a categorical assessment from which a model was developed and presented to the stakeholders for validation.

The principal mode of analysis in developing a personal learning network model is akin to the HCI technology design and development cycle. Research and synthesis of representative literature inform the needs assessment and the research design. The personal learning network framework is developed through the user-centered design process (Delphi survey). As a formative evaluation, the PLN framework is informed by the needs assessment and the input from the expert panel. This design and development cycle continue throughout the implementation to ensure continual usability toward adoption of integrated design practices. (Figure 3.1).

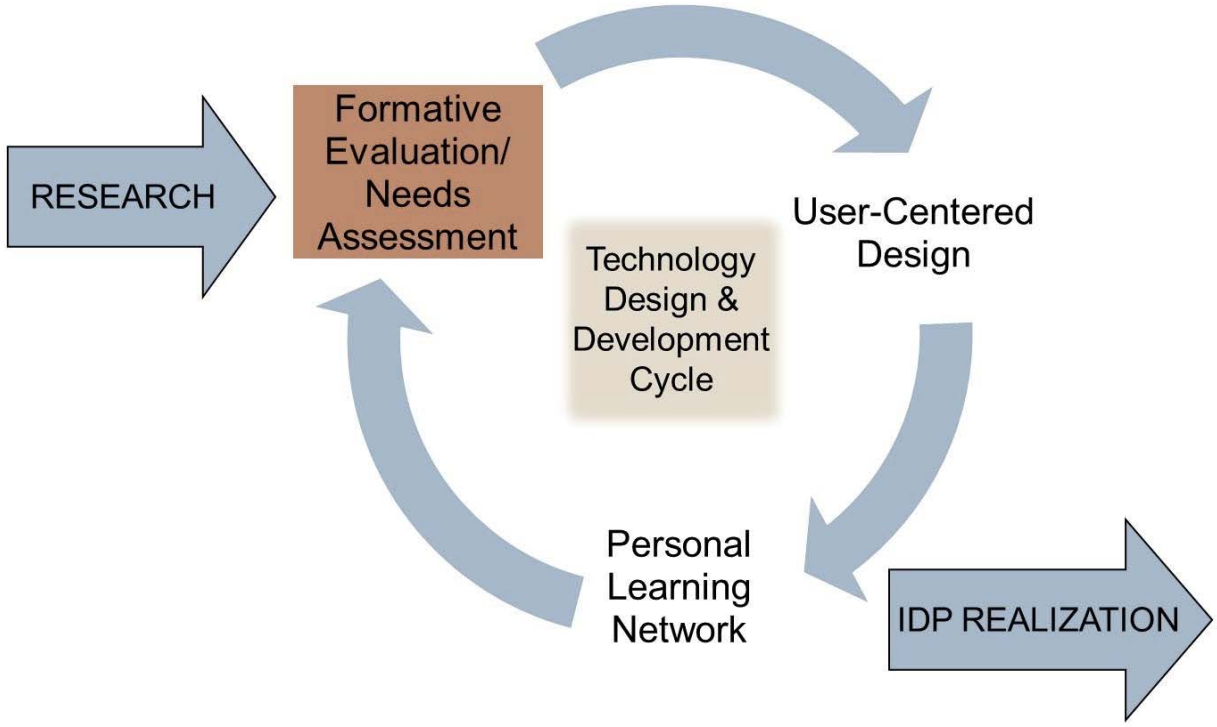


Figure 3.1

Research area within the technology design and development cycle

3.2. Literature Review

The research involves three domains of knowledge; architecture and design, professional development and personal learning networks. This research topic is relatively new and while literature exists within each primary domain of knowledge, the intersections of these domains and the focus of this research have not yet been studied. The subject matter required research on the new and emerging themes of integrated design practice and social and organizational learning toward the development of the research design and the conceptual framework. As a contributing element to a broader research methodology, an integrative literature review was employed to inform the research.

An integrative literature review is a form of research review that is utilized to integrate representative literature on emerging topics. As a relatively new form of literature review, there are few standards for comparison. However, integrative literature review research is being recognized for its value in critiquing and synthesizing new knowledge in a holistic way resulting in new conceptualizations and perspectives on topics in the social sciences. It supports a multi-method approach to the research topic and can lead to the development of new frameworks and models. The primary requirement for an integrative literature review is that the researcher provides a conceptual structure and a guiding theory or point of view on the topic. As primary research and critical analysis, an integrative literature review requires in depth discussion of the methodology used to identify, critique and synthesize the literature. As secondary research to inform the primary research study, the integrative literature review focus of this research is to synthesize the new knowledge on the topic. Depending on the goals for the research, there are four forms of synthesis that can be achieved from integrative literature reviews; Conceptual classification/ taxonomy, Metatheory, Research agenda and Conceptual Framework. (Torraco 2005). The researcher determined that the synthesis of the literature toward the development of a conceptual framework aligned with the intent of the research initiative as a formative evaluation of a new model.

The researcher's integrative literature review approach required adopting a guiding theory on the topic which was drawn from the research hypothesis: *Personal learning networks can provide architects, designers and industry professionals with a model for self-directed professional development that enables collaboration and knowledge sharing within the community of practice toward adoption of integrated design practices at a discipline wide scale.* The structure and content of the literature review were informed by the assumption that the research would lead to new knowledge and a new conceptual model.

The researcher deconstructed the topic outlined in the research hypothesis to identify the primary and secondary domains of knowledge for investigation (reference page 9, Figure 2.1). In addition to the primary domains of knowledge, the literature review requires a synthesis of literature from the intersecting knowledge domains; integrated design practice, communities of practice and social and organizational learning. The analysis included historical perspective, main concepts and applications, and research methods of the subject matter as well as the relationships between the knowledge as they relate to the guiding theory.

The investigation required searching for literature using variations on the keywords found in the guiding theory; *Personal learning networks, architecture and design discipline/ industry, self-directed learning, professional development, collaboration, knowledge sharing, community of practice integrated design practice*. As a new body of knowledge, the keyword search was extended to include words identified in the initial analysis of the literature including; *building information management, human computer interaction, information technology, social media, social networking, connectivism, organizational learning, knowledge ecology, knowledge management, e-learning and personal learning environments*. Personal learning networks, as an emerging topic, has few references but instead is broadly addressed in terms of social learning in the fields of education and technology. As a result of searching for personal learning environments, the researcher was fortunate to discover one seminal scientific research

and critical analysis of over 100 publications involving personal learning environments (Attwell, et al. 2011). This Grounded theory research provided a key activity theory framework and identified the characteristics and factors required for research and effective practice.

The research of personal learning environments provided by Attwell provided a substantial contribution to the integrative literature review allowing the researcher to critique, synthesize and apply the key aspects as they relate to the architecture and design discipline, directly informing the research design and the conceptual model.

3.3. Human Computer Interaction Methodologies

Social science involves the study of humanity using scientific methods. The human computer interaction (HCI) discipline has adapted these social science methodologies in their research because of their interest in how people behave in relation to technology. HCI draws upon multiple disciplines including mathematics, design and linguistics and has derived many of its principals from the psychological sciences. As a relatively new discipline, the field is still building theories and models to investigate issues. These theories and models can be grouped into three categories;

- Explanatory theories, which seek to explain the behavior of the world,
- Predictive theories, providing predictions of the outcomes of their designs, and
- Generative theories, providing guidelines for application of knowledge.
  (Giacoppo 2001)

The majority of HCI research tends to be generative in nature; to provide guidelines for design and development of new interface technology. HCI design models are geared toward human behavior and activity in relationship with technology. Participatory in nature, it often involves a feedback process of determining user's goals and needs, designing the interface, testing it with the users, redesigning the interface and retesting it with the users prior to implementation in order to ensure usability. Usability research is formed around formative or summative goals utilizing analytical and empirical methods.

A formative evaluation is used during development to guide the design process compared to a summative evaluation that is conducted after development or at a checkpoint in the design process. Typically, analytic methodology draws its findings from experts in the form of guidelines, theories or models and an empirical study looks at the usability of a prototype or system through observation. The goal of each of these methods of analysis is to provide guidance and feedback in the iterative development process.

In order to develop plausible reasoning for these methods of analysis and experimental designs and procedures, researchers turn to evaluation-based user-interface research and development. Evaluation research is a methodological area of social research that utilizes many of the same strategies as traditional social research but depends upon an organizational context requiring group communication and management ability. While evaluation techniques have their deficiencies, they remain a necessary tool for HCI to ground its findings. Weaknesses can include apparent over generalization and lack of control over the subject. Paired with validation by a third party, as done in product development, evaluation can provide a reliable gauge to assess an insufficient rationale or theory and to set the stage for further research and development. (Zhai 2008) Surveying is an evaluative technique used by HCI researchers to aid in the design of user interfaces. The Delphi method or principals of it are a popular surveying technique for gathering user data in developing information architecture for organizations. The method is useful in business and knowledge gathering toward innovative technological solutions.

The HCI generative theory is most closely aligned with this formative research in its goal to provide guidelines for knowledge sharing. The research design draws upon HCI user-centered design and development design philosophies utilizing to develop guidelines and models from expert opinion. The Delphi method will be used as the HCI evaluative technique to aid in the development of the personal learning network. This research is limited to the evaluation and design phases of the HCI iterative development process (Figure 3.2).

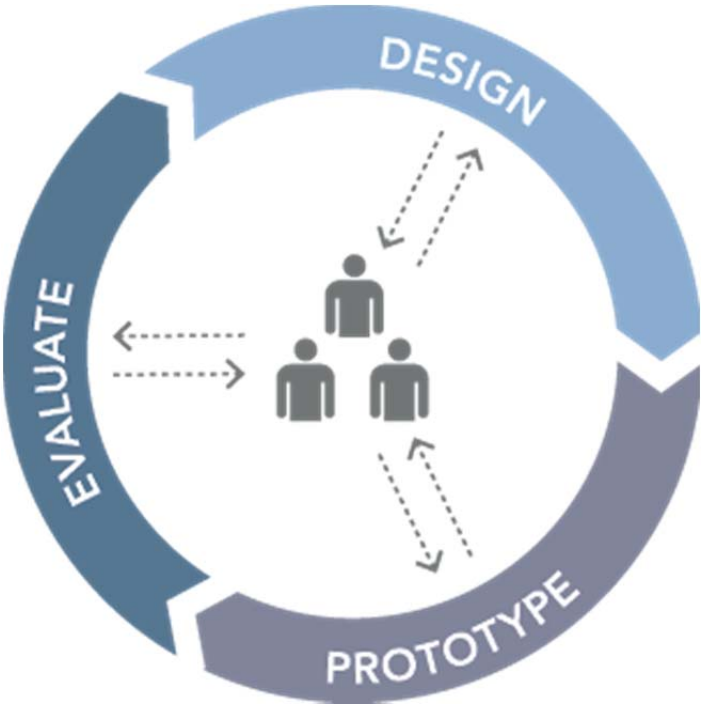


Figure 3.2

HCI development process [fair use]

(HCII, CMU 2014)

3.4. The Delphi Method

The Delphi method can be characterized as a process of structuring group communications between people with specific knowledge in order to develop forecasts in response to current issues. The process involves using an iterative feedback technique through a series of questionnaires and controlled feedback to develop consensus between experts dealing with complex problems.

Originating from the Greek Oracle at Delphi, the modern concept was taken from a defense research project, “Project Delphi”, first developed by the Rand Corporation in the 1950’s (Dalkey & Helmer 1963). Created as a means of forecasting new technologies, the Delphi method has since been used extensively in many different fields including medicine, public administration, education and technology. The rationale for the development of the Delphi method is that, in the absence of established findings for emergent domains, capturing and synthesizing the opinions of experts allows for an unbiased unified perspective. It tends to be used in evaluation where there is significant domain expertise and new organizational or technological innovations are lacking but are needed. In business forecasting, it has been applied successfully and with high accuracy compared to unstructured forecast methods (Green, et al. 2007).

Applications of the Delphi method include;

- Forecasting for a specific future issue
- Consensus building
- Avoiding Groupthink*
- Generating innovative ideas

**A mode of thinking that people engage in when they are deeply involved in a cohesive in-group, when the members' strivings for unanimity override their motivation to realistically appraise alternative courses of action (Janis 1972).*

The main steps in the Delphi method process include;

1) Formulation of the Delphi team to undertake and monitor the project.
2) Select experts who have specific knowledge and interest in the subject.
3) Develop the first questionnaire.
4) Test the questionnaire for readability.
5) Send the first questionnaire to the panelists.
4) Analysis of the first round of responses.
5) Develop second questionnaire.
6) Send second questionnaire to the panelists.

7) Analysis of the second round of the responses.

(Repeat steps 5-7 as necessary to achieve stability in the results, not to exceed 6 rounds).

8) Prepare a report to present the findings of the exercise.

(Fowles 1978)

Strengths of the Delphi method include;

- Forecasting a specific single-dimension question
- Building rapid consensus
- Inclusion of a wide range of expertise
- Ability to conduct remotely
- Innovative results

Limitations of the Delphi method include;

- Success is dependent upon the expertise of the subjects
- Predictions are uncertain when dealing with complex forecasts involving multiple factors
- Does not adjust to paradigm shifts
- Can be employed unsuccessfully due to bias or insufficient analysis by the facilitator.

Assumptions of the Delphi method:

- Experts are better equipped to provide insight into the future of their domains than theoretical approaches.
- Complex problems in which no known or right answers exist
- Participants do not have a history of adequate communication
- Experts should represent diverse backgrounds of their domains
- Exchange of ideas in person is impractical and/ or challenging

(Gordon 1968)

Context is an important consideration in deciding to use the Delphi method. It has proven useful for large organizations where experts are remotely located and it is cost prohibitive to travel. Experts are invited to contribute, sometimes receiving a stipend for their participation if the contribution itself isn't enough of a draw. They are selected because of their knowledge or opinion surrounding the particular issue. The use of a facilitator structures the flow and interactions of the participants throughout the process often solving any potential problems of group dynamics. The facilitator coordinates the process of focused questioning and collecting contributions from the panel of experts. These responses are collected and synthesized and highlight common and conflicting viewpoints. The consolidated response is then distributed to the group for further comment and each participant has the opportunity to revise their own statements based on the responses of others or the progress of the panel as a whole. Often there are only one or two more rounds of questioning and response needed to gain consensus from the group on the particular issue. Anonymity of the participants provides unbiased group communication allowing for opinions to be more freely expressed by minimizing the "bandwagon effect" often caused by apparent authority and/or conformity to the group.

The Delphi is primarily used to facilitate the formation of a group judgment and is especially used in forward planning to establish a hypothesis about how scenarios are likely to develop. It has been widely used to generate forecasts surrounding technology since it provides insight into the user's opinions and viewpoints and as such assists in identifying priorities and to design scenarios and interfaces accordingly.

The Delphi method has been most commonly applied using paper and pencil for dispersed groups of people to communicate without the constraints of time or place. However, the development and use of computer supported and web-based Delphi methods have paved the way for improved process, ease of use and potentially more dynamic results.

For example, instead of limiting the responses to the constraints of the size of a paper and to deductive or inductive thinking, a computer-based process has the potential to provide the participant with the freedom to engage in the process according to their own personal preferences. This provides the ability for anonymity through the use of pen names while also allowing the privilege of sharing their real name if appropriate. Overall, the asynchronous manner of the method lends itself well to becoming a computer-based process and also allows the process to become more dynamic. As a continuous feedback process is a much more flexible approach which may replace the traditional round structure eventually (Linstone & Turoff 1975).

In the online environment it is much easier for a facilitator to separate themselves as a moderator instead of a content leader. The function of the program allows for a more dynamic process in which the participants can update themselves and the results of votes can be seen immediately, augmenting the data collection process. In addition, the use of a web-based procedure allows for the use of graphics, color and imagery to support the survey process and encourage participation. It may even provide more rigorous data because of its more qualitative online discussion environment. Overall, the web-based Delphi method is convenient and easy to use and has the potential to be used by researchers to bring together experts to discuss and validate knowledge constructs. (Colton & Hatcher 2004)

3.4.1 Web-based Delphi-Method

The use of computer-based Delphi structures allows for effective quantitative and qualitative data collection and presentation. The ranking-type model for the Delphi method allows for both quantitative and qualitative data collection. The ranking-type model was proposed by R. C. Schmidt (Schmidt 1997) to overcome the criticism that the method does not have a valid statistical method of consensus. When using a ranking-type model, this is represented through the classification of the perceived issues or needs and the prioritization of those items with associated commentary disclosing areas of difficulty or further investigation. The approach is done in three phases and includes: brainstorming, narrowing down, and ranking (Miaskiewicz & Kozar 2006). The qualitative data can be sorted to highlight representative narrative contributions from the participants regarding each issue (Wicklein 1993). A needs matrix or conceptual framework is developed to provide graphic presentation of the ranking-type model Delphi data set.

An example of reporting both quantitative and qualitative ranking-type findings can be seen in Table 3.1. The research sought to investigate and analyze the perceptions of an on-line learning community. The students ranked and provide comments on the tools, the activities and the learning environment. The researchers were especially interested in the student's perceptions of the learning community and how co-participatory activities contributed to the community of practice.

Table 3.1 Students' ratings of co-participatory activities [fair use]

(Mentis, et al. 2001)

Students' ratings of co-participatory activities						
	1 not valuable	**2**	**3**	**4**	**5-very valuable**	**Mean rating**
	%	**%**	**%**	**%**	**%**	
Gaining an awareness of professional issues	0.00	0.00	22.22	29.63	48.15	**4.26**
Staying in touch between class meetings	0.00	11.11	3.70	22.22	59.26	**4.19**
Checking understanding of issues	0.00	0.00	25.93	29.63	44.44	**4.19**
Communicating with course coordinators	0.00	7.41	11.11	22.22	55.56	**4.15**
Creating a sense of community	0.00	7.41	7.41	33.33	48.15	**4.11**
Participating actively in forums	0.00	0.00	18.52	40.74	37.04	**4.04**
Communicating with course colleagues	0.00	7.41	3.70	18.52	59.26	**3.96**

Co-Participatory Activities ratings show the students' perceptions of the value of their on-line learning in promoting co-participatory activities. Co-participation involved acquiring a shared language for students to communicate within the community in order to promote learning. Results of this section of the survey are overall positive and show that more than half of the students rated all items as valuable or very valuable. This is significant as these items form the key elements that contribute to effective on-line communities of practice. Commonality and interdependency, as well as situatedness is reflected in the students' qualitative comments below:

· *This is a superb way of learning from each other*

· *A great window to shared information*

· *This is a great support system.*

· *Learning from others with different types of work experience is valuable*

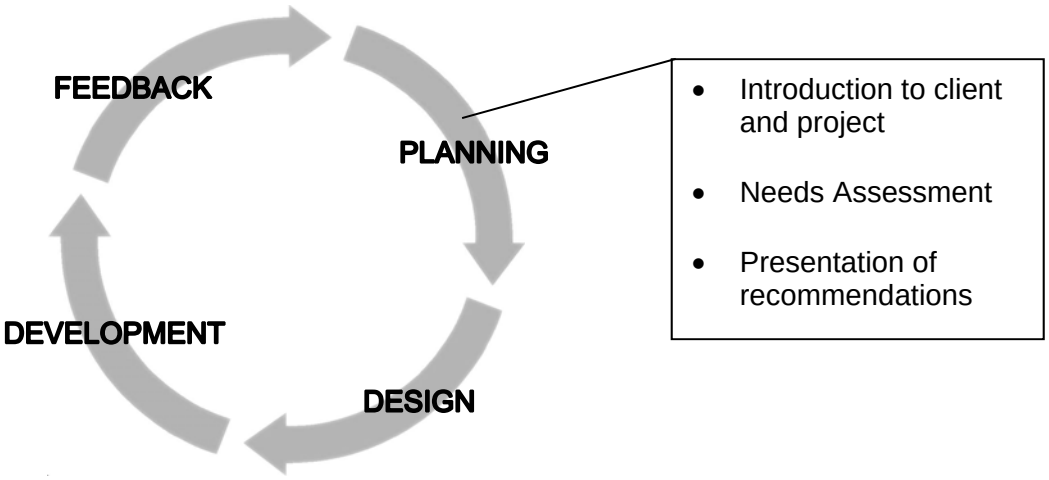
(Mentis, et al. 2001)

3.5. Professional Development Needs Assessment

The needs assessment sought to evaluate the current state of professional development in the AEC industry, what defines professional competency and the familiarity with social media strategies and tools that can be used for professional development. Metrics for professional development were drawn from the American Psychology Associations standards for learning, (McCombs 1992), education professional development principals (Moorman 1997) and industry professional development guidelines (Valence 2003), social networking technologies required for a community of practice (Wenger 2008) with reference to Atwell's core dimensions and properties required for personal learning environments (Atwell, et al. 2011). The needs assessment provides a basis for the researcher to evaluate applicability and readiness for using personal learning networks for professional development in the architecture and design industry. Needs assessments are typically conducted in the initial stage of the user-centered human computer interaction researcher and design process. The planning phase includes a needs assessment and recommendations for potential solutions prior to entering the design phase. Parallel to research and design methods used in the web development process, this research contributes to the planning phase, (Figure 3.3).

Figure 3.3

Web Development Process



3.6. Survey Categories and Factors

The PLN framework is based upon examples developed in the field of education where PLN's have been most readily adopted. While individual PLN maps are expressed in many ways, their core components are found in the types of connections required and the factors associated with those connections. Pioneer in technology integration in the field of education and PLN advocate, David Warlick identified these connections into three categories; Synchronous, Semisynchronous and Asynchronous:

- *A synchronous connection involves a traditional network that includes people and places that you connect with directly to accomplish a goal. These types of connections happen real-time and are often face to face but can be through telephone or video conferencing tools. This type of connection requires that the individual is actively engaged in and personally maintains the communication for it to be sustained.*

- *A Semisynchronous connection allows for collaboration and learning occurring anytime. It provides for a new time reference being developed that is "nearly now' and refers to online communications that involve lag time in the conversation due to each individuals personal schedules or time zones. A question may be posted to a community and one or more responses may come in over a period of time to answer the question. This type of connection requires that both the individual and the social network are needed to maintain the communication for it to be sustained.*

- *An Asynchronous connection serves to connect individuals with resources for learning. In addition to the books and files kept for reference, individuals are increasingly seeking information online to help them do their jobs. As a central goal of a PLN, the primary tool used in navigating and finding the content sources is the RSS aggregator. Social bookmarking services categorize and tag information when people add new websites to their online bookmarks making them available to the entire community. While an individual maintains their own resource connections, this type of connection is considered to be dynamically maintained in the online community as a continually evolving common body of knowledge.* (Warlick 2009)

The factors associated with the connection categories pertain to the type of learning activities that occur within those connection categories. The focus of the survey was to have the expert panel identify what factors are important for them, as individuals, in the development of a personal learning network for professional development. The researcher based the development of the factors on Attwell's core dimensions and properties developed in the scientific analysis of personal learning environments using Grounded Theory to identify emergent concepts and factors (Attwell, et al. 2011).

As such, the researcher identified twenty factors focused on the 'subject' (learning professional) and the 'tools' required to meet professional development goals 'object' (resources). The researcher referenced the six goals developed by the AIA for

Integrated Project Delivery (AIA/ AIA CC 2007), personal learning network models and guidelines (Warlick 2009) and learning and performance technologies resources (Hart 2012) to reflect the most relevant personal learning properties for professional development in the AEC industry. These twenty factors were operationalized so that they could be applied to a connection category and ranked in order of importance:

1. Creating a personal Blog or digital portfolio to document learning, activities and reflections
2. Creating social bookmarks to have access to bookmarked sites and documents from anywhere
3. Collaborating on the development of a resource or knowledge base including sharing tools, techniques and presentations.
4. Creating resources for self-reference
5. Creating resources to assist colleagues, team members and the industry at large
6. Using social networks to make and maintain professional connections.
7. Reading news, articles and Blogs
8. Reviewing and critiquing news and articles and blogs
9. Networking with local professional colleagues
10. Networking with distant professional colleagues
11. Having a visual diagram of personal learning connections as a resource
12. Self-directed learning on a need to know basis
13. Receiving on the job training
14. Using professional membership connections and knowledge base
15. Working on project teams with professional colleagues
16. Communicating real-time with professional colleagues
17. Following the work of professional colleagues
18. Receiving formal training/ certification
19. Finding and aggregating resources
20. Using collaborative project management tools such as BIM

3.7. Validation

The convergence of the needs assessment and the consensus of the expert panel determine the final results of the survey. These are presented in the form of a conceptual framework of the personal learning network. In the final round of the Delphi Survey, the expert panel confirms the results as validation of the findings. The criteria for expert panel selection are primarily based upon achieving a purposeful sampling from the different disciplines involved in integrated design practice including architecture, design and construction. Contributing factors in selection included evidence of the subject's interest in advancing professional development in the field and continued involvement in the Delphi Survey.

3.8. Analysis

As a formative evaluation, qualifiers for final analysis are developed during the course of the research. They are based upon the initial goals of the research, the synthesis of the literature review, the convergence of the survey results and the feedback from the representative stakeholders. The formative evaluation draws upon the scientific analysis of personal learning environments (Attwell, et al. 2011), the lessons learned by communities of practice (Wenger 1998) and personal learning network practitioners (Warlick 2009) and the goals identified for AIA Integrated Project Delivery (AIA/ AIA CC 2007).

A multi-level analysis approach was taken to allow the researcher to understand if personal learning networks are an applicable solution for the professional development needs of the AEC professional community. The analysis sought to connect the perceived needs of the expert panel with the goals of the industry utilizing social networking connection categories, factors and tools. These elements form the basis for the development of a PLN framework for the industry and outline the requirements for management, application and use for professional development.

3.9. Research Group

The researcher invited the Building Smart Alliance membership to participate in the research study. The Building Smart Alliance (bSa) is an organization of the National Institute of Building Sciences. The bSa represents forward thinking industry professionals who have a broad perspective of both the challenges and the opportunities of the AEC professional today. Membership includes architects, designers, engineers, contractors, owners and facility managers with a specific interest in advancing the industry through collaborative technologies such as BIM (Building Information Management).

The Building Smart Alliance was created in response to the profound changes taking place in the design and construction industry. It was established to lead in the development of tools and standards to increase efficiency and modernize the industry.

> ***VISION***
>
> *A global environment where all participants can readily and transparently share, apply and maintain information about facilities and infrastructure to enhance quality and economy of design, construction, operation and maintenance.*
>
> ***MISSION***
>
> *Improve all aspects of the facility and infrastructure lifecycle by promoting collaboration, technology, integrated practices and open standards.* (NIBS 2013)

Membership includes individuals and organizations representing the interests of the building industry including AEC professionals, property owners, facility managers, government and stakeholder groups. The bSa encourages membership involvement in its four strategic goals:

- *Create a strong industry presence and recognition for the buildingSMART alliance vision and mission and the programs to support and achieve them.*
- *Connect major participants of the building industry in a stakeholder activity model that promotes improved information exchange processes.*
- *Implement and support coordination of candidate open standards and guidance to ensure information flows throughout the lifecycle of the building to all stakeholders.*
- *Develop a consensus infrastructure to advance open industry standards for interoperability and collaboration between practitioners*

The researcher is the president of the VT bSa Student Interest Group which provides information and seminars about BIM to the VT student and professional community. The researcher was invited to participate in The BIM Working Group comprised of bSa, IFMA (Institute for Facilities Management Association) and I2SL (International Institute for Sustainable Laboratories) to research the challenges involved with the adoption of BIM as the primary tool for collaboration within the industry. This consortium's research primarily indicates that education of the professional is a significant barrier to BIM being adopted as a common platform for integrated design practice and toward ensuring the future of sustainable energy and environmental performance in the industry. This research was presented at the bSa session of the 2013 annual National Institute of Building Sciences annual conference and the researcher was invited to present the proposed use of the PLN for professional development as a means of mitigating the educational challenge in the industry. At the researcher's request, the head of the consortium and the president of the bSa, Dana 'Deke' Smith, facilitated the invitation to participate in the research study to the membership base of approximately 600 professionals.

3.10. Research Approach

The research process (Figure 3.4) was conducted during a six month period following the completion of the literature review. Once the expert panel was engaged, the researcher sought to constrain the Delphi Survey process to a four month period to maintain interest and focus within the expert panel throughout the process.

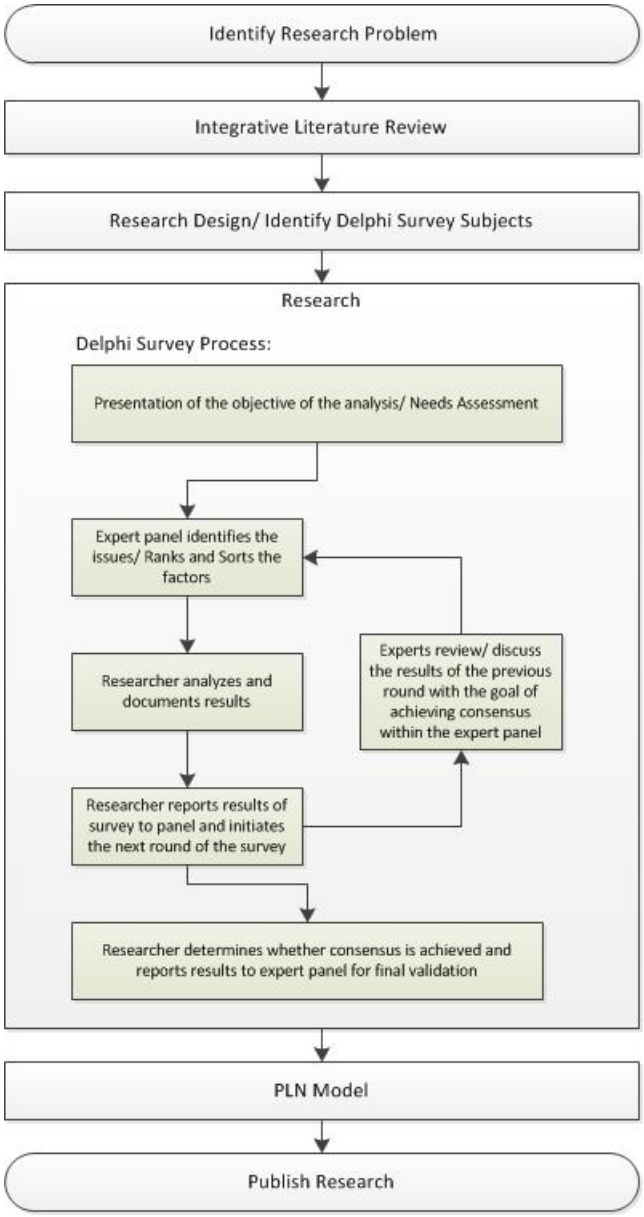


Figure 3.4

Research Process Diagram

Invitation:

The invitation letter (Appendix B) outlined the intent of the study to investigate and develop a framework for Personal Learning Networks (PLN's) for professional development in the AEC industry and to specifically to address the following questions:

- *PLN's have been researched and adopted in the field of education but can this strategy be successfully applied to the AEC industry?*
- *Are there any perceived constraints to social learning unique to our industry?*
- *The field of education has identified specific factors that contribute to a Personal Learning Network;*
- *Are there additional factors that need to be considered within our industry?*
- *How should we prioritize these factors?*
- *How should we group these factors?*

Upon accepting the invitation, the introduction to the survey provided further explanation of the intent of the research question and the role of the participant in the study:

This study seeks expert opinion regarding the innovative use of social media for professional development in the AEC (Architecture, Engineering and Construction) industry. Specifically, this survey aims to develop expert consensus toward the development of Personal Learning Networks (PLN's) as a mechanism for the continual learning deemed necessary for professionals to stay current in a rapidly changing field. Research suggests that Personal Learning Networks are an effective method for continual learning and have the ability to reach across disciplinary borders providing a catalyst for integrated practices such as BIM to take hold in the industry. Experts have the unique ability to innovate new methods of professional development; to evaluate the potential for and contribute to the development of a framework for Personal Learning Network's in the AEC industry.

Procedures:

The survey (Appendix C), Social Media for Professional Development in the Design and Construction Industry, was sent to the 23 respondents. The participants were informed that they were participating in a formative evaluation using the Delphi Method. A Delphi survey is achieved through a series of questionnaires and controlled feedback to develop consensus between experts anonymously in innovative areas such as technology where current knowledge does not exist. The scaling method is used to rank factors that need to be considered to achieve the goal. A Delphi survey is conducted in three or more rounds until consensus can be gained within a group of a dozen or so experts. Consensus is gaged using Kendall's W coefficient of concordance. This non-parametric statistical analysis is used to assess agreement among raters from 0, indicating no agreement, to 1, indicating complete agreement.

1. The first stage of the survey provides an introduction to the intent of the research initiative, a request for informed consent and demographic information followed by a needs assessment.
2. Round one of the Delphi survey serves as an introduction to the personal learning network and the identification and categorization of the factors being evaluated.
3. Round two provides for validation of the factors and ensures that the researcher has correctly interpreted the responses. The factors are grouped and ranked by relative importance by each expert with the goal of gaining consensus within the expert panel.
4. Round three is geared to finding consensus within the group. Should consensus be gained at this stage then the survey is complete.
5. Additional rounds are conducted until consensus is gained (not to exceed 6 rounds).

The questionnaire was conducted with an on-line Qualtrics-created survey tool over the course of several months, beginning in November 2012 and concluding in March 2013.

Introduction:

The researcher first sought to introduce the expert panel to the purpose of the formative study as the basis for the development of innovative strategies and connections required to improve professional development in the AEC industry.

- *Personal learning networks are being harnessed for continual learning within the fields of education and organizational development, but can this strategy be successfully applied to the AEC Industry?*
- *What is the state of professional development and what professional competencies are expected in the AEC Industry?*
- *There are specific learning factors and connections that contribute to a personal learning network; Are there additional factors that need to be considered within our industry? How should we prioritize these learning factors?*

A definition of a personal learning network was provided for reference at the beginning of each round for reference:

A Personal Learning Network is a network of professionals with whom you share knowledge and from whom you gain knowledge. It allows the professional to harness social media tools to connect, contribute, converse and request information according to their own personal learning objectives. Currently, personal Learning networks are successfully being utilized within the fields of education and organizational learning.

Participant Profile:

To confirm that the expert panel was representative of the industry, the participants were asked to answer demographic questions:

1. What is your area of expertise in the Architecture, Engineering & Construction (AEC) Industry?
    - ☐ Architecture/ Design
    - ☐ Engineering
    - ☐ Construction
    - ☐ Facilities Management/ Owner
    - ☐ Other
2. How many years of experience do you have in the industry?
3. What is the highest level of education that you have completed?
4. How many years of experience do you have in the industry?

Needs Assessment:

Expert input is required to identify and understand the specific needs and characteristics of the industry required for personal learning networks to be adopted as an effective professional development strategy. In round one, the experts were asked to answer three questions toward the needs assessment to determine if there is agreement regarding the overarching professional competencies required in the profession and in the evaluation of the current state of professional development in the industry as well as to understand each individuals familiarity with social media strategies and tools that can be used in professional development.

The panel was tasked with rating the importance of general metrics for professional competency including technical skills, knowledge, practice, communication and professionalism. As a point of reference for the research analysis, the experts evaluated the current state of professional development in the AEC industry. These metrics were determined by level of agreement and included generalized questions about whether industry professionals know what training they require to succeed in the future and whether they are provided with adequate professional development opportunities within their organization, as well as the overarching question if they agree the industry needs improved methods from professional development to keep up with the rapid pace of change in the field. The final question in the needs assessment was specific to understanding the expert panel's level of familiarity with current social media. They were asked questions such as how much they utilize social media for on the job training and professional development purposes, how much they collaborate and make professional connections and how much they utilize and contribute to the online knowledge base in the industry. These metrics provide an understanding of the current state of professional development in the field as a foundation for the analysis as well as an indication of the direction that the industry is ready to take.

Round 1- Personal Learning Network Development Factors:

The concept of a personal learning network and the connection categories and factors were introduced to the expert panel. The subjects were asked to sort the factors into the three categories by the type of connection needed and recommend additional factors if desired. Factors could be relevant in more than one category. The expert panel was asked to rank the factors by level of importance in terms of self-directed learning with the profession. The goal was to achieve a high enough level of consensus within the expert panel that the importance of the factors is assumed to apply to most industry professionals (Figure 3.5).

What factors are important for the development of a personal learning network?

In the following question, you will be sorting the factors into groups and then ranking them in terms of being necessary for professional development in the AEC industry;

1. Sort (drag and drop) the 20 personal learning factors by the type of connection needed.
2. Rank them in order of importance.

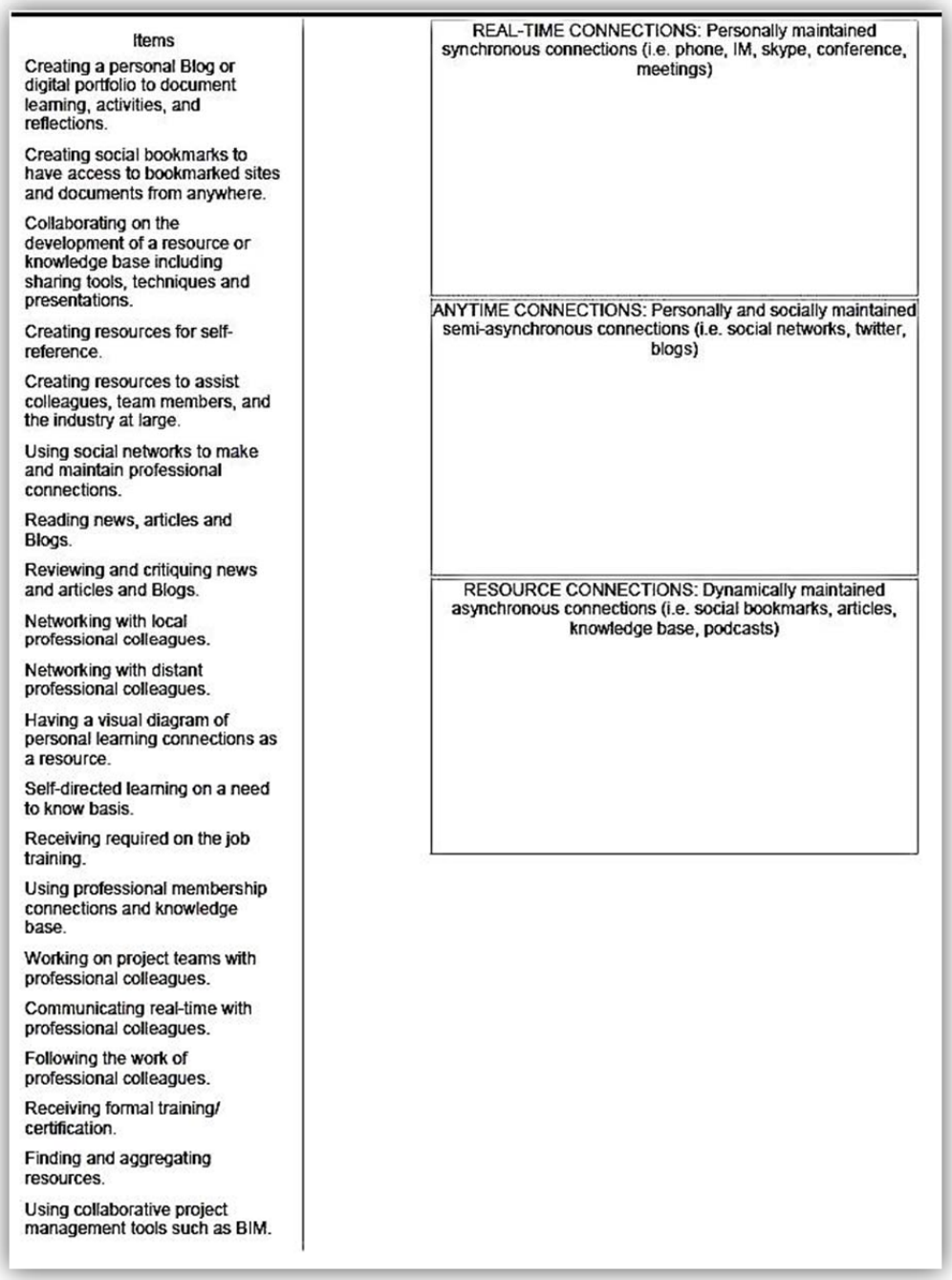


Figure 3.5

Round 1: PLN Development Factors

Following this introductory round, the expert panel was asked to add any factors that may not have been listed for potential inclusion in the next round of the survey. The expert panel was invited to continue participating in the study with the understanding that the following rounds of the survey focused solely on the continued refinement of the rating of the factors in comparison to those of the other experts on the panel. The goal of the expert panel was to develop consensus on the factors and their relative importance for development of an effective personal learning network.

Round 2- Refinement of Personal Learning Network Development Factors:

Round two focused on the refinement of the categorization and relative importance of the personal learning network factors. With 18 experts participating on the panel representing various levels of experience and areas of expertise, the panel was asked to compare their responses to those of the other experts by referencing the results of Round 1. The responses were provided as tables and charts with primary use of a decision diagram (Figure 3.6) to help the experts visualize the decision process. Akin to a Role Activity Diagram (RAD), a decision diagram outlines the actions and processes as well as informs the expert on their role as a contributor to a greater pattern of dynamic behavior (Cordes 2008). The expert panel was tasked with sorting the twenty factors into the three types of personal learning network connection categories with specific consideration of the definition for each type of connection required and the responses of the expert panel.

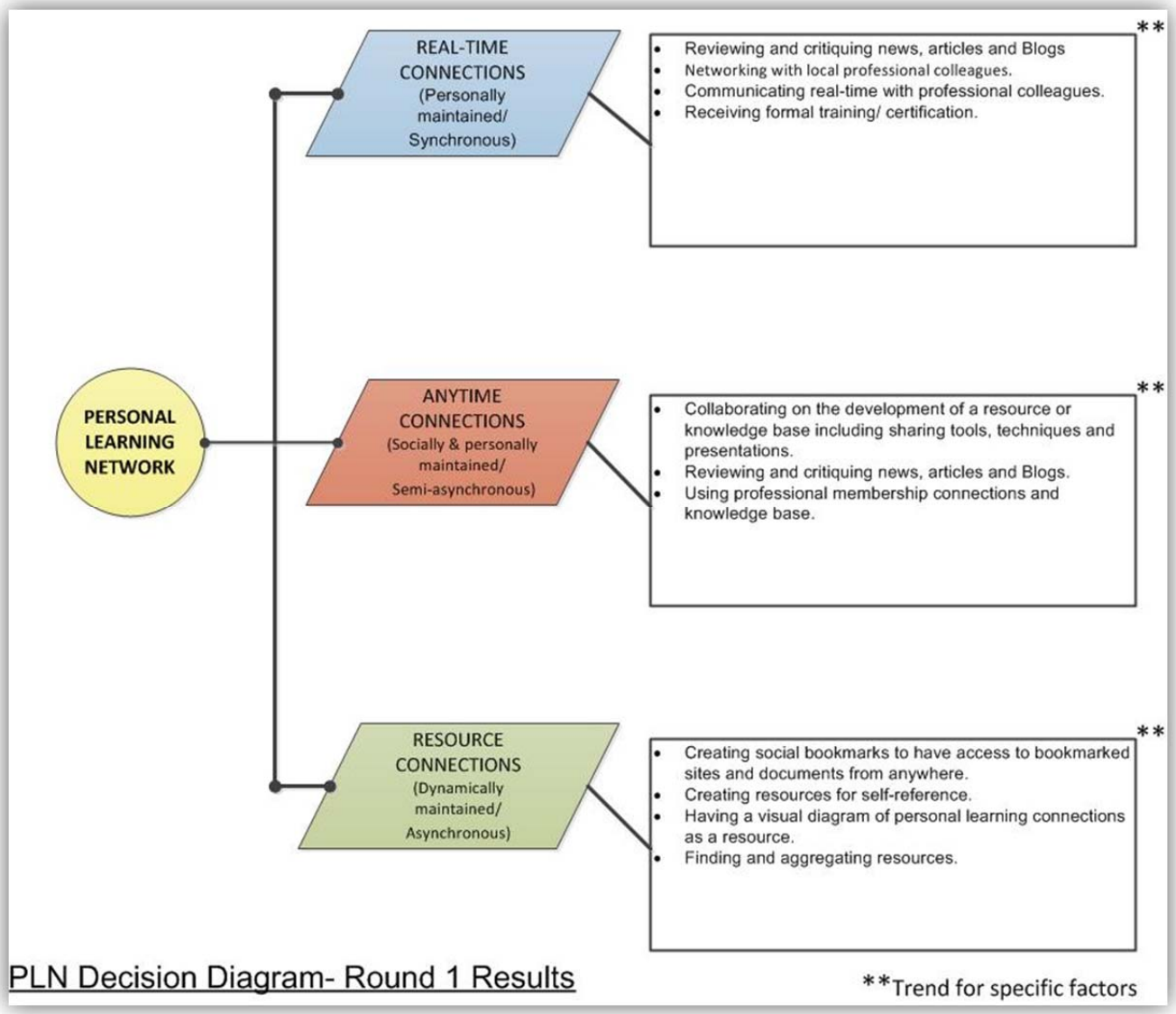


Figure 3.6

Decision diagram of results of Delphi Survey Round 1 for reference by the expert panel

Round 3- Refinement of Personal Learning Network Development Factors:

With consensus on the sorting of factors into the three connection categories in Round 2, Round 3 is focused on ranking learning factors by order of importance within each category in terms of self-directed learning within the profession. With 18 experts participating on the panel representing various levels of experience and areas of expertise, the panel was asked to compare their responses to those of the other experts by referencing the results of Round 2. The responses were provided in the same decision diagram format as Round 2 to help the experts visualize the decision process. The expert panel was tasked with ranking the twenty factors within the connection categories with the goal of achieving a high enough level of consensus within the expert panel that the importance of the factors are assumed to apply to most industry professionals.

Round 4- Confirmation of Personal Learning Network Development Factors:

In the final round of the survey, the expert panel is asked to confirm consensus on the overall ranking of the importance of factors within each connection category as validation of the findings. The participants were provided with the rank order obtained by consensus by the expert panel for each category. They were asked to confirm by concurring or disagreeing with the rank order. If the participant disagrees with the rank order, they were provided with the opportunity to indicate their preference by ranking the factors by importance.

Participant profile information is requested again in the final round to confirm that the demographics of the remaining 18 experts remain representative of the industry. In addition to the original information requested, the researcher sought to clarify the type of work that the participants perform, specifically;

What best describes the type of work that you perform?

- ☐ Owner/ Manager
- ☐ Project Manager/ Project Architect/ Project Engineer
- ☐ Design/ Specification
- ☐ Contracts/ Administration/ Scheduling
- ☐ BIM/ CAD/ IT Specialist
- ☐ Research/ Education
- ☐ Consultant/ Sales
- ☐ Other

At the conclusion of the survey, the experts are requested to provide their top recommendations for using social media for professional development in the industry.

Delphi Survey Facilitator:

In addition to the survey design and implementation, the researcher served the role of facilitator of the Delphi Survey. A facilitator coordinates the process of focused questioning and collection of contributions from the expert panel. The responses are synthesized by the facilitator through data analysis to highlight agreements and disagreements within the group. The facilitator consolidates the responses and provides graphic representations of the data to facilitate shared understanding of the results. The results of the rounds are distributed to the group and each participant has the opportunity to revise their own statements based upon the responses of other members or the group as a whole. The facilitator provides clarification and guidance as to the goal for each round and the overall goal of obtaining consensus on the survey results. The researcher did not interact with the individual experts beyond answering technical questions. All correspondence in reference to the Delphi survey was directed to the entire expert panel during the course of the survey.

CHAPTER 4

RESEARCH RESULTS

"Technology has inspired a shift from a hunting-and-gathering information economy to the domestication of the information landscape."
-David Warlick, Learning & Leading with Technology, 2009

4. Delphi Survey Results

4.1. Introduction, Needs Assessment & Round 1- PLN Development Factors

There were 23 respondents to Round 1 of the survey, Social Media for Professional Development in the Design and Construction Industry. The beginning of the survey includes an introduction to the intent of the study with a request for informed consent and demographic information about the expert. This portion of the survey includes a contextual needs assessment to evaluate the expert panels' view of the current state of professional development in the AEC industry, what defines professional competency and their familiarity with social media strategies and tools that can be used for professional development. The second portion initiates Round 1 of the Delphi survey as an introduction to the PLN framework and identification and categorization of the factors being evaluated. The expert panel was provided the opportunity to add any factors that may not have been listed for potential inclusion in the survey.

Expert Panel:

In order to achieve expert consensus, a Delphi Survey is best achieved with a dozen experts. There were 23 participants in the initial round of the online Delphi Survey that allowed for a certain amount of attrition over several rounds. The demographics of the participants (Addendum D) provided for the desired focus on the AEC industry with inclusion of additional stakeholders in an integrated design process:

Area of expertise in AEC Industry

- 30-36 % Architecture/ design
- 21-25% Construction
- 9-14% Engineering
- 13% Facilities Management/ Owner
- 7% Education/ Research
- 21-22 % Other (Environmental Engineering, BIM, GIS)

Average level of education: Master's degree

Average level of experience: 21-25 years

Needs Assessment Results:

The needs assessment sought to identify the expert panels' views on what defines professional competency in the industry (Figure 4.1) and the current state of professional development in the industry (Figure 4.2) as well as to understand their individual familiarity with social media strategies and tools that can be used for professional development (Figure 4.3).

Consider what defines professional competency. Rate these professional competencies by importance in the AEC industry.

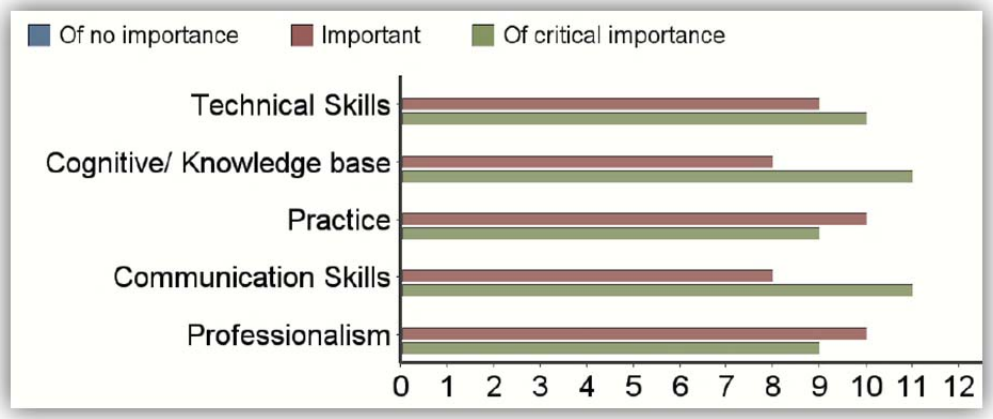


Figure 4.1

Professional competency results

Evaluate the current state of professional development in the AEC industry.

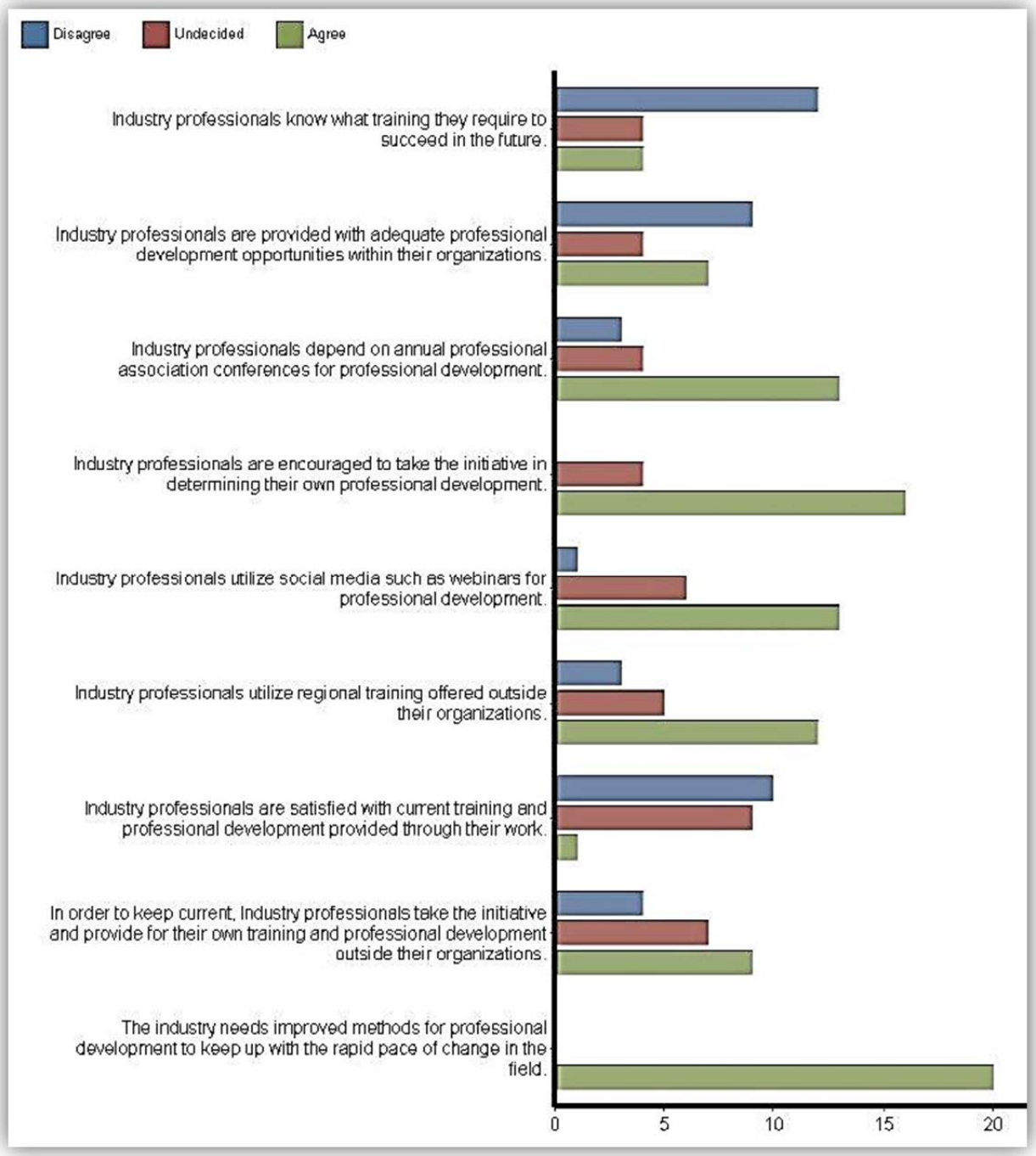


Figure 4.2

Current state of professional development in the AEC industry results

What is your familiarity with social media strategies and tools that can be used for professional development?

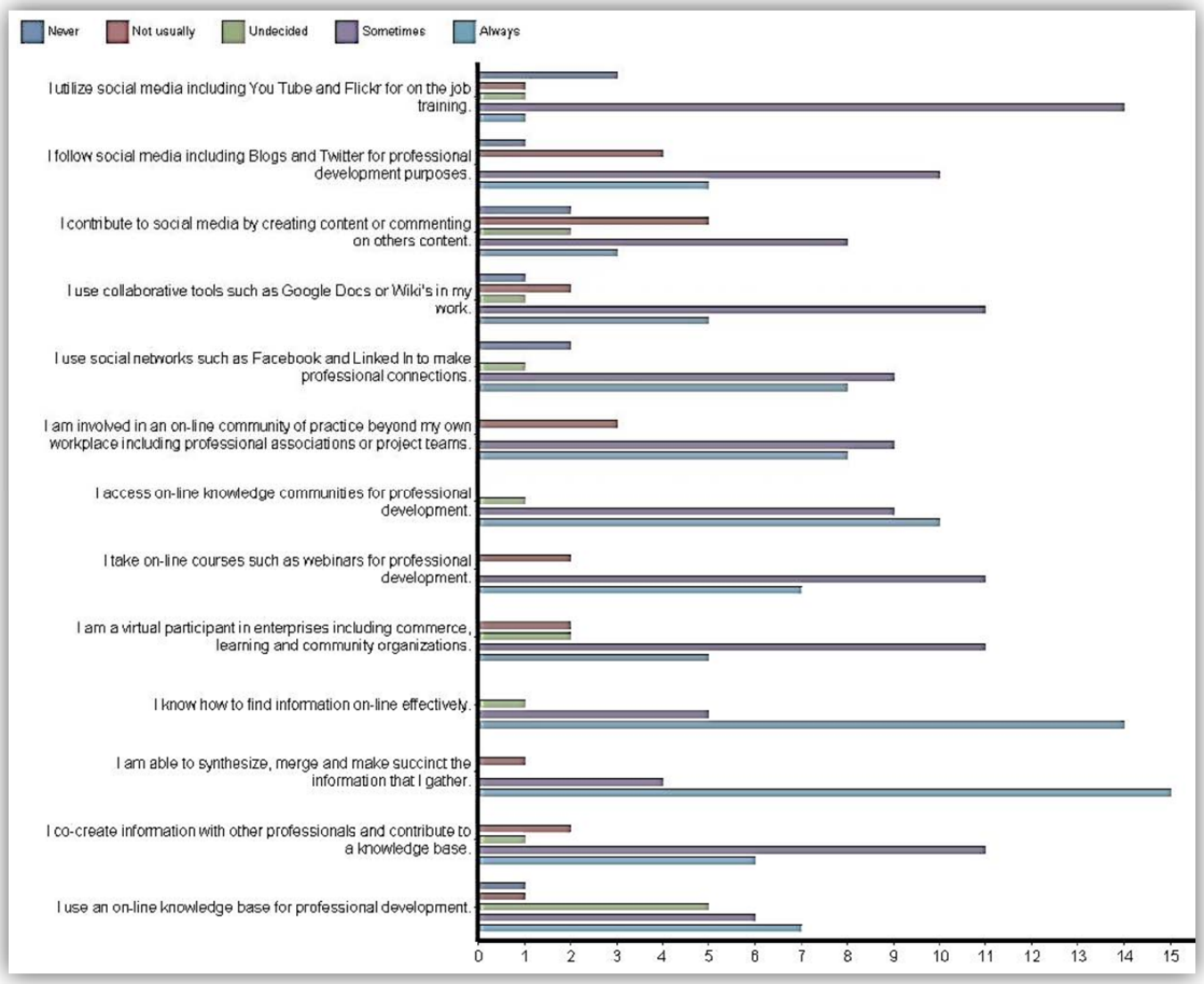


Figure 4.3

Expert panel familiarity with social media strategies and tools that can be used for professional development results

Round 1- Personal Learning Network Development Factors:

What factors are important to the development of a personal learning network? The expert panel was introduced to the definition of a personal learning network and the types of connection categories and factors involved in their development. In Round 1, the expert's primary goal was to sort the factors into the three connection categories (Figure 4.4). Additionally, they were asked to rank the factors by order of importance to initiate the thought process in terms of their necessity for professional development in the AEC industry.

What types of connections are required and what factors are important to the development of a personal learning network?

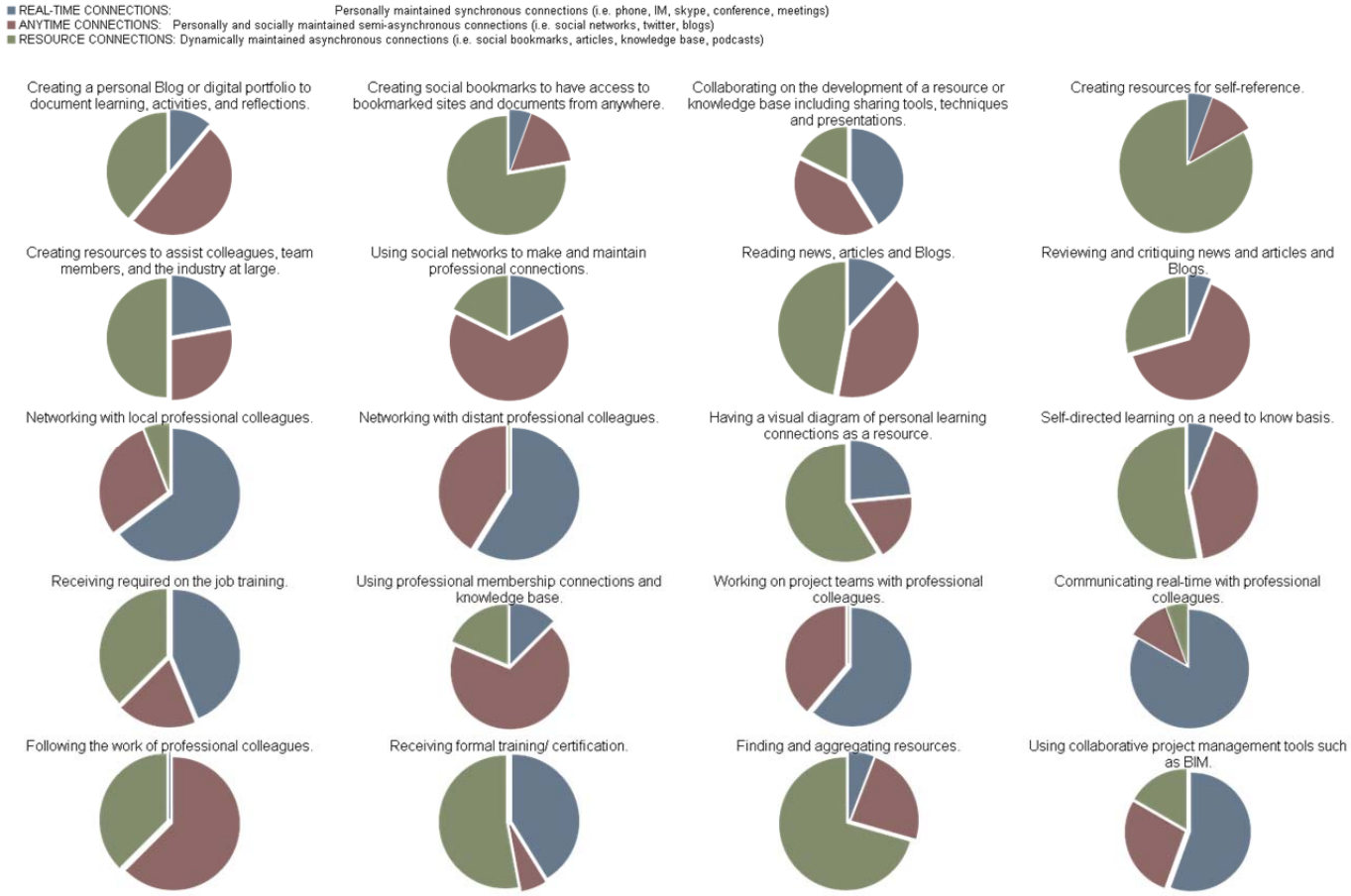


Figure 4.4

Round 1 personal learning network development connection categories & factors results

Personal Learning Network Additional Factors:

Following the survey exercise, the panel members were asked to provide any additional factors that they felt should be included in the following rounds of the survey.

Please add any factors that may not have been listed for potential inclusion in the next round of the survey:

- *Chat when learning to answer questions*
- *Perhaps something about the learning that takes place between ourselves and customers and ourselves and suppliers*
- *Greg Hale made an outstanding presentation at Autodesk University last Wednesday on Mobile Tools and Technologies for BIM Managers....How can I send that to you? The AIA Board has encouraged a radical rethinking of assumptions and a small team are developing options for the annual conference in Denver next year. Are you talking with BOD level professionals?*
- *Groups like AIA, ASHRAE, ASPE, and NCARB need to use the virtual media better for communication*
- *Hands on field work, for me, is critical in determining the best possible solutions for technical problems in dealing with compatibility and functionality of various Building envelope components. It's easy for A/E's to draw/detail typical conditions, but there always seems to be important, overlooked, details that come up in the field. Have solved these types of problems numerous times in the past, I have developed a working knowledge and invaluable insight in what to do and look for in plan review of up-coming projects.*
- *It seems that a lot of the listing dealt with the tools for collaboration and i think that the concept of "collaborative meaning making" should be addressed more in-depth. Indeed, the tools are great, but primary to the issue, as i see it, is how the collaborative process occurs in the experiences of the people doing the work.*
- *Learning and communication styles for individuals are very different. Social media are self-selecting; therefore, it is important to figure out to be inclusive of those who have not adopted social and other online media. There are about one and a half generations still in the professional pipeline, often at senior positions, who will still influence the profession for the next one or two decades. If they are not influencers then they are still sources of knowledge, experience, and wisdom. Digital myopia will not permit us to use all the available talent to the best of the industry.*
- *Product, manufacturer or system specific forum participation.*

The researcher reviewed the input and determined that the input did not constitute the addition of more factors. Instead of providing specific factors for inclusion, the expert panel provided comments and opinions that spoke to the broader scope of learning strategies. The researcher generated a word cloud (Figure 4.5) for use in analyzing the frequency of word use with primary and secondary words as the most important for consideration in synthesizing the comments into themes. Additionally, the researcher decided to provide the opportunity for the expert panel to offer comments and recommendations at the close of the survey as a way to meet the perceived need for them to share their opinions as well as to further contribute to the analysis.

Figure 4.5

PLN additional development factors word cloud

- Primary- Learning & Media
- Secondary- Communication, Work, Collaborative, Social, AIA, Field, Problems, Important

4.2. Round 2- Building the Personal Learning Network

In Round 2 of the Delphi survey, the expert panel is identified as having 18 members representing various levels of experience and expertise. The round is focused on categorization of the factors that contribute to the development of a PLN. The results of Round 1 are analyzed using Kendall's W coefficient of concordance, with .7 indicating strong agreement. The panel is provided with a graphic representation of the results to help to compare responses with other experts. Additionally, the PLN Decision Diagram is introduced to assist the expert panel in a shared understanding of the results of Round 1 and provide a visual model of a PLN (Figure 4.6).

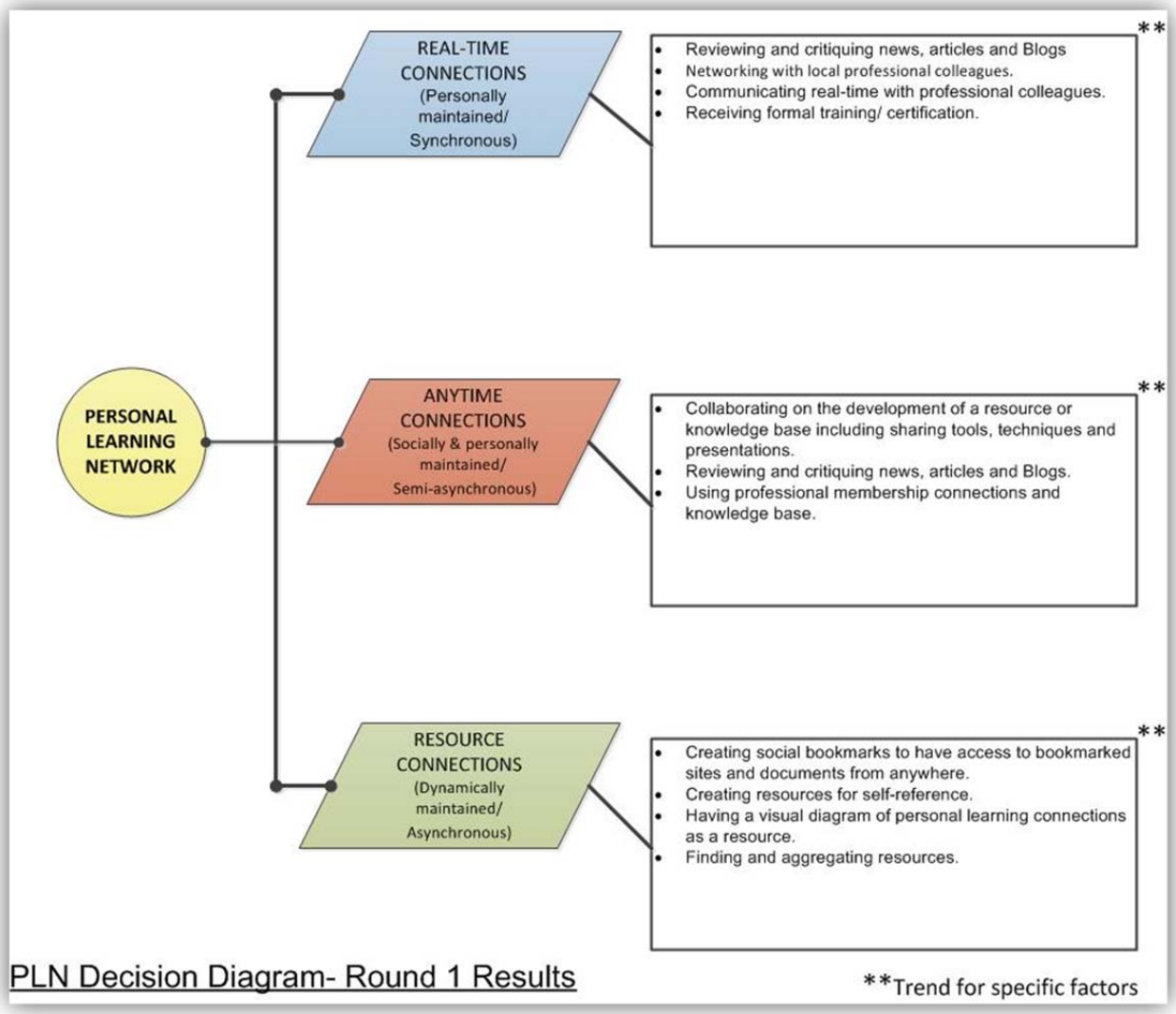


Figure 4.6

PLN Decision Diagram- Round 1 Results

4.3. Round 3- Refinement of Personal Learning Network factors

In Round 2 the expert panel has successfully aligned each of the learning factors within one or more connection category. The results of Round 2 are provided in format of the PLN Decision Diagram for consistency and to allow the panel to see a visual representation of the progress of their efforts (Figure 4.7). In Round 3, the panel is asked to focus on ranking the factors by order of importance in terms of self-directed learning within their profession. The goal of the survey remains to achieve a high enough level of consensus within the expert panel that the importance of the factors is assumed to apply to most industry professionals.

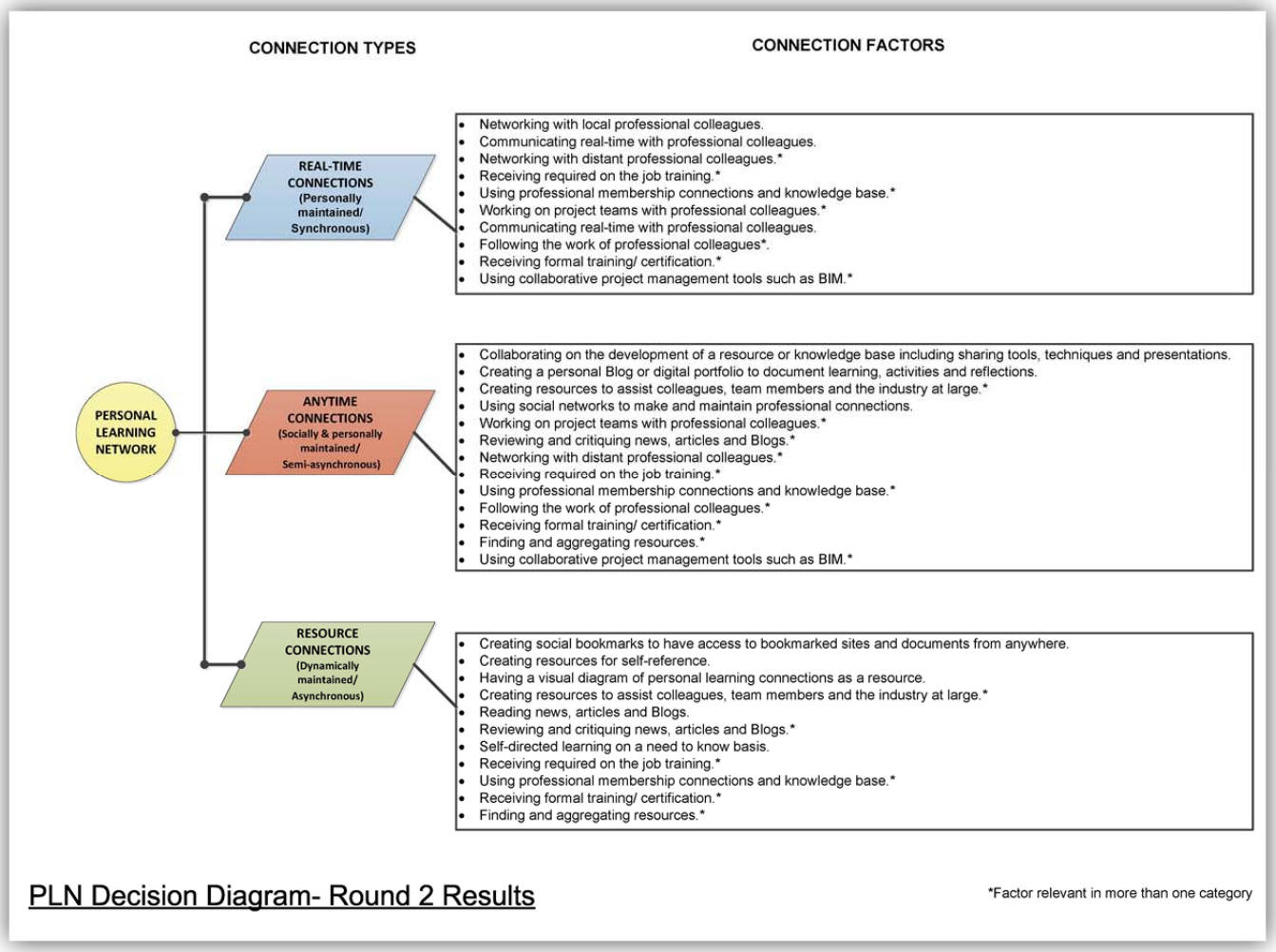


Figure 4.7

PLN Decision Diagram- Round 2 Results

4.4. Round 4- Confirmation of consensus results

The goal of a Delphi survey is to obtain consensus among a group of experts on a subject requiring an innovative solution to a complex problem. The final round of the survey served as validation that consensus had been achieved.

In the final round, the expert panel was asked to confirm agreement on the rank order provided in Round 3 or, if in disagreement, to provide alternative ranking. There are three categories of personal learning connections and associated factors that the expert panel was asked to provide the rank order for; Real-Time Connections (personally maintained synchronous connections), Any-Time Connections and Resource Connections category (dynamically maintained asynchronous connections). There were factors that consistently applied to more than one category and were identified as such. The results were analyzed by level of agreement within the expert panel using Kendall's W for ordinal data:

$$W = \frac{12S}{m^2(n^3 - n)}$$

There was significant agreement in Real-Time Connections despite some disagreement on the ranking order of some of the factors. Face to face connections are the most familiar and understood of the communication methods which perhaps contributed to the ability of the expert panel to come to consensus in this category more readily than the other two categories.

For real-time connections:

Kendall's W for ordinal data
W = 0.2902778 p(X2[8]) = 0.0005002764

This result means that the probability of the obtained chi-squared value for larger N=12 is 0.0005002764, which means X^2obs=0.7104847< 2.179731=$X^2_{8,\ 0.025}$. Thus reject the H0: W=0 at alpha=0.05 level, and therefore it can be concluded that there is significant agreement among the 14 respondent with respect to how they ranked the questions.

Since W = 0.2902778 is not quite close to 1, it can be concluded that there may remain some disagreement on the ranking order of the factors in the real-time connections category.

There was also enough evidence to support significant agreement for Resource Connections despite the disagreement on the ranking order of several of the factors. People are familiar with and require resources for learning. The challenge is that there is a lack of core knowledge bases in the industry and professionals have adapted by cobbling together a variety of resource connections:

For resource connections:

Kendall's W for ordinal data
W = 0.3885101 p(X2[10]) = 1.106475e-06

This result means that the probability of the obtained chi-squared value for larger N=12 is 1.106475e-06, which means X^2obs=0.6372143< 2.179731=$X^2_{8,\ 0.025}$, reject the H0: W=0, and therefore it can be concluded that there is enough evidence to support that there is significant agreement among the 14 respondent with respect to how they ranked the questions.

Since W = 0.3885101 is not quite close to 1, it can be concluded that there may remain some disagreement on the ranking order of the factors in the resource connections category.

The Any-Time Connections category proved to be the most challenging for the expert panel to agree upon in terms of the overall ranking of the importance of the factors. In the final list (Figure 4.8), there were several factors (2&3, 5&6, 7&8, 9&10) that were ranked fairly equally (>.50) to each other. According to Kendall's W, this does not indicate significant agreement because (4) of the (10) experts did not concur, having ranked these several factors in reverse order of importance; (i.e. 3&2, 6&5, 8&7, 10&9):

For any-time connections:

Kendall's W for ordinal data
W = 0.1488095 p(X2[12]) = 0.04444607

This result means that the probability of the obtained chi-squared value for larger N=12 is 0.04444607, which means $X^2_{8,\ 0.975}$=17.53455>X^2obs=5.07133< 2.179731=$X^2_{8,\ 0.025}$, fail to reject the H0: W=0, and therefore it can be concluded that there is not enough evidence to support that there is significant agreement among the 12 respondent with respect to how they ranked the questions.

It can be concluded that the 14 respondents agree with the categorization but disagree on the ranking order of the factors for the any-time connections category.

However, the researcher determined that the expert panel could be determined to have achieved *sufficient* agreement. Consideration was given to the fact that 71.43% of the expert agreed with the rank order, that the factors of issue were nearly equal to one another in ranking and, in terms of its utility as a guideline, that the results can still serve to inform the learner. The challenge in ranking of factors may be attributed to the variations in expertise or perhaps the individuals own experiences with web 2.0. The researcher determined that this connection category requires further investigation upon implementation to better understand the parameters involved. As the most dynamic of the categories, the individual professional will likely need to spend the most time managing this area of their personal learning network.

4.5. Final Personal Learning Network

The researcher applied the results of the consensus on the relative importance of each factor within each connection category and applied them to the final personal learning network framework (Figure 4.8).

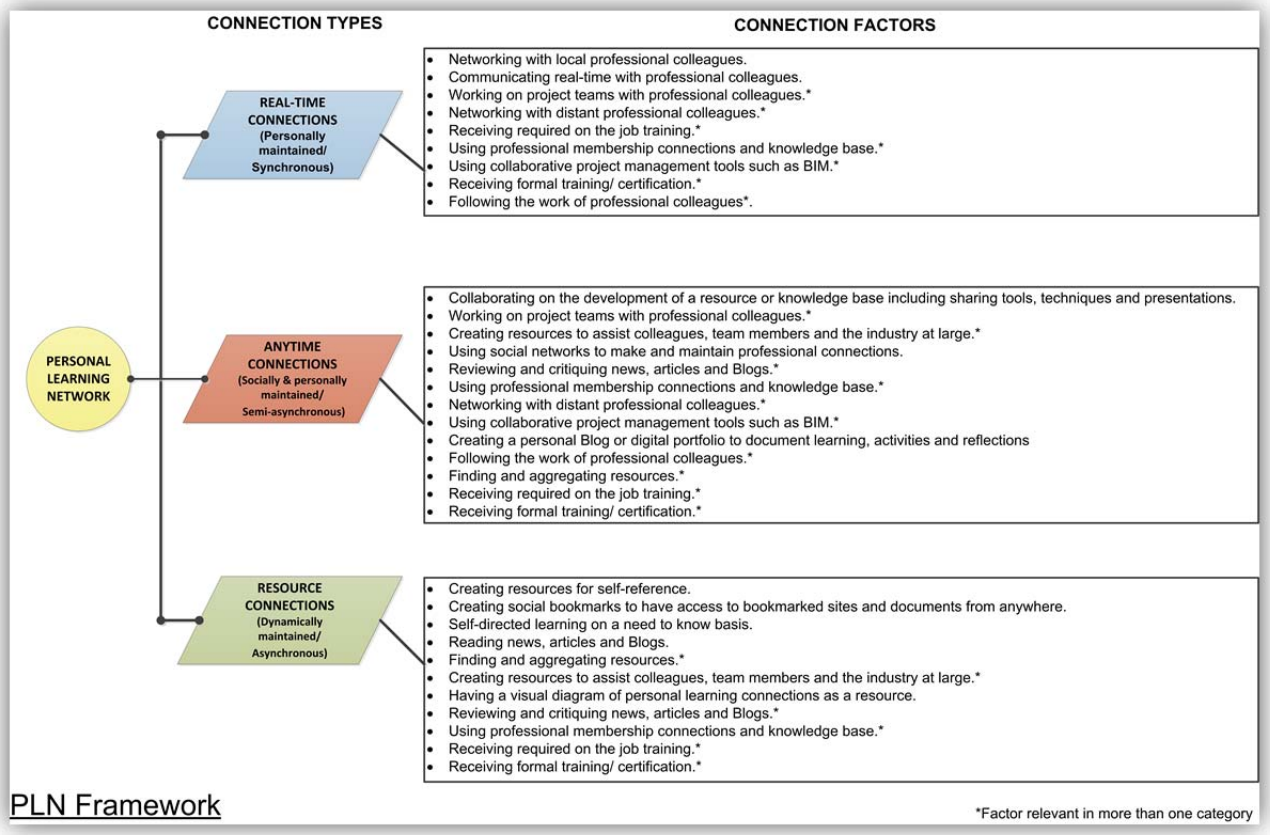


Figure 4.8

Final Personal Learning Network Framework

Expert Panel recommendations:

The comments provided by the expert panel in Round 1 offered insight about the concerns and opinions of the expert panel. As a result, following the conclusion of the survey, the researcher provided the panel with the opportunity to provide recommendations for consideration in the development of personal learning networks for the industry:

- *Social media is an effective aggregator of many different sources of information e.g.: blogs, white papers, discussions. With the ability to link the above to a single venue, it provides a more direct interface to the myriads of information.*
  - *Construction, Sales consultant, 36-40 years of experience, Assoc. degree/ Technical education*
- *Focus on Quality not Quantity of social input sources to avoid a lot of "noise" which can obscure more relevant information.*
  - *Construction, BIM/CAD/ IT Specialist, 21-25 years of experience, Assoc. degree/ Technical Education*
- *At this point in time it feels like the multitude of media and the scarcity of time is highly counter-productive. Resources are scattered across so many different feeds and threads, with a lot of tripe and even garbage interspersed, that learning appears to be obstructed rather than facilitated.*
  - *Architecture/ Design, Research & Education, 21-25 years of experience, Professional Degree*
- *Members of the A/E/C industry should avoid becoming too insular but be willing to leverage social media to cultivate a professional network within and outside of our industry.*
  - *Engineering, Owner/ Manager, 11-20 years of experience, Master's degree*

- *It seems to me that the dialog between the design, construction, and facilities maintenance phases of the industry are key… learning the challenges faced by each specific phase should lead to greater understanding by all.*
  - *Construction, Director of BIM Training for Construction Tradesperson Instructors, 26-30 years of experience, Master's degree*
- *The overarching issues (are) to continuously learn and educate oneself while in the job setting. Thus, lines of demarcation between communication types and the reason for that communication blurs. Personal learning, the networks for that purpose, and the job itself become indistinguishable.*
  - *Geospatial, IT Transformation, 31-35 years of experience, Master's degree*

The six comments were representative of the expert panel in terms of experience. The researcher examined the recommendations by producing a word cloud (Figure 4.9) for use in analyzing the frequency of word use with primary and secondary words as the most important for consideration.

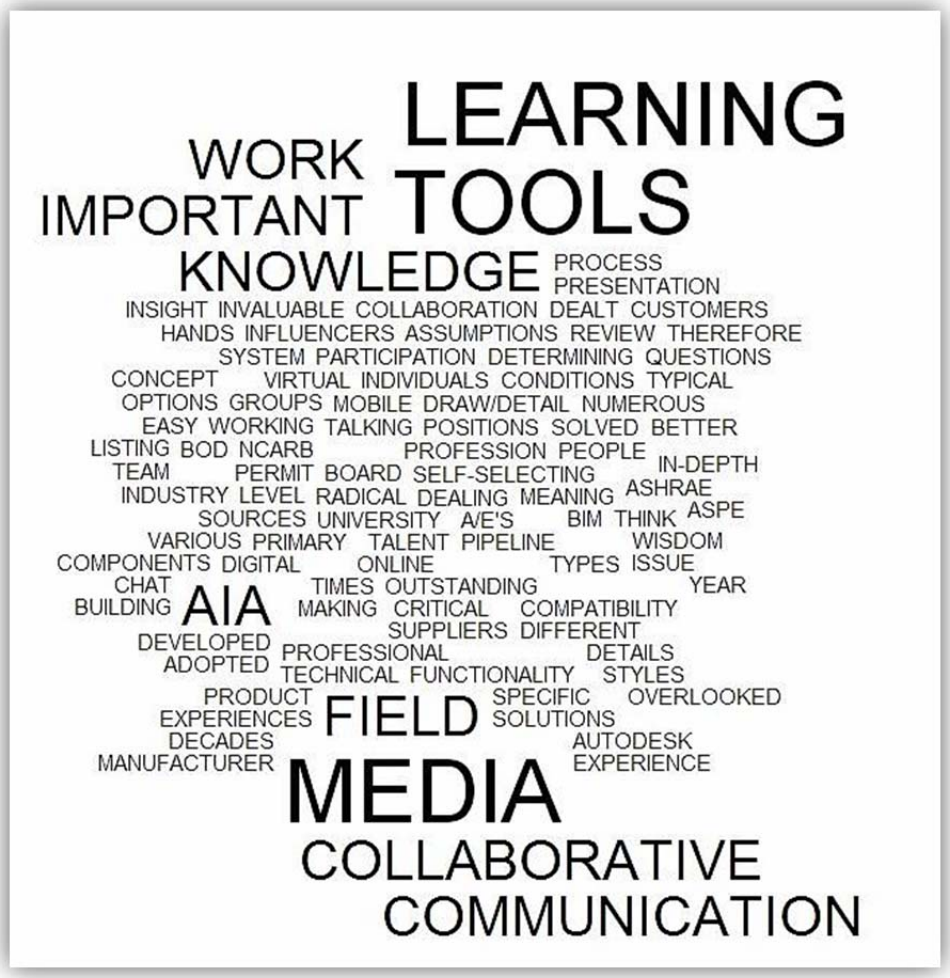


Figure 4.9

PLN expert panel recommendations word cloud

- Primary- Learning, Tools, Media
- Secondary- Work, Important, Knowledge, AIA, Field, Collaborative, Communication

Of the six comments, three revolve around information management and three pertain to social learning. With reference to these common threads, the word map and the goal of the expert panel to provide recommendations for the development of personal learning networks for professional development in the industry, the researcher synthesized the comments into two primary challenges and recommendations for consideration in the analysis:

1) Social learning

Challenges: Lack of connections, dialog and professional networking within the industry

Recommendations: Cultivate social networking and knowledge sharing at the project level and within the industry to facilitate social learning within the context of the job.

2) Information management

Challenges: Information overloads and time scarcity

Recommendations: Provide the professional with a single venue capable of filtering quality information to better facilitate learning and knowledge sharing in a timely manner.

The results of the Delphi survey provided expert consensus on a PLN framework that provides common ground for industry professionals to use as a starting point in determining the important connection categories and factors needed for their personal learning network. The expert panel provided specific indication of the challenges they face in terms of social learning as well as recommendations for consideration in implementing personal learning networks for professional development in the industry.

CHAPTER 5

INTERPRETATION & DISCUSSION

I'm trying to make the world a more open place.
-Mark Zuckerberg, Founder & CEO of Facebook

5.1. Summary of Research Results

As formative research, integral in the development of innovative solutions, the Delphi survey expert panel provided professional expertise in identifying and understanding the specific needs and characteristics of the industry required for personal learning networks to be adopted as an effective professional development strategy.

The needs assessment indicates that the foundation is in place for a community of practice, that there is a commitment to learning at both the organizational and industry professional level and that the learning goals of the AIA knowledge community are in line with the goals of the industry professional. Based upon the perceived needs of the industry professional paired with the need to overcome the barriers that exist within the community of practice, the researcher developed three requirements for creating and implementing personal learning networks for professional development in the industry:

1) ***Cultivate social networking and knowledge sharing at the project level and within the industry to facilitate social learning within the context of the job.***

2) ***Provide the professional with a single venue capable of filtering quality information to better facilitate learning and knowledge sharing in a timely manner.***

3) ***Empower the professional to harness their own professional development through clear articulation of industry and individual learning goals and specific learning outcomes and backed by organizational commitment and support.***

The researcher developed a recommended model for a personal learning network for the architecture and design industry is comprised of three elements; an overarching Professional Development Activity Diagram for the AEC industry, a PLN Framework identifying the factors and connections required for social learning and recommendations for current tools to facilitate management and learning.

The researcher outlined a strategy for implementation including the steps for the creation and management of a personal learning network as well as the requirements for ongoing development and sustainability to support the learners' social learning process. The implementation strategy includes the factors and influences for consideration by the learner from concept to future implications for the self-directed social learning endeavor.

5.2. Data Analysis

5.2.1. Delphi Survey Results

Delphi Expert Panel:

The invitation to participate in the Delphi Survey was sent out to the National Institute of Building Sciences building Smart alliance (bSa) listserv and was facilitated by the president of the organization on the researcher's behalf. The invitation was a call to the membership as forward thinking individuals who have comprehensive perspective of both the challenges and the opportunities of the AEC profession today. By participating in this organization, these professionals already have some understanding that professional development is a significant barrier to the bSa vision and mission. The researcher proposed that instead of depending solely on organizations for the professional education required to remain effective moving forward, that individuals can take control of their own professional development as both a stop gap measure and to remain competitive in the future.

The membership was invited to participate in this formative research project to assist in defining the basis for development of effective strategies and communication channels to improve professional development in the industry. As formative research, integral in the development of innovative solutions, participants would provide their professional expertise in identifying and understanding the specific needs and characteristics of the industry required for Personal Learning Networks to be adopted as an effective professional development strategy.

There were 23 participants in the initial round of the online Delphi Survey with the participants representing the AEC industry with inclusion of additional stakeholders in an integrated design process. The participants were representative of the industry with (7) architecture and design professionals, (6) Construction industry professionals, (5) 'Other' industry stakeholders, (3) facility manager/ owner representatives and (2) engineering industry professionals. Of these experts, (7) had 11-20 years of experience, (6) had 26-30, (4) had 6-10, (3) had 21-25, with the remaining three on either end of the spectrum. The highest level of education completed was (7) with a Master degree, (6) with a Bachelor degree, (3) with a Doctoral Degree, (3) with a Professional degree and (1) with a High School degree. All participants were invited to participate on the expert panel and continue with the additional rounds of the survey.

The final round of the survey served to validate the consensus obtained in Round 3. The remaining 14 respondents continued to be representative of the AEC industry. The additional value of 'Education' was added to better determine who the 'Other' stakeholders represented. The architecture and design industry had (5) representatives with (3) in construction, (3) 'Other' industry stakeholders, (2) engineering and (1) in education. Facilities Management/ Owners were not represented at this stage of the survey. The value 'Associates degree/ Technical Education level was added for additional clarity. 50% of the respondents held Master degrees, followed by 15% Doctoral and 15% Associates Degree/ Technical Education with the remainder holding High School, Bachelor and Professional degrees. The level of experience of the expert

panel is a bell curve with the majority at 21-25 years of experience. These professionals described their work as (2) Owner/ Managers, (2) Project Manager/ Project Architect/ Project Engineer, (2) BIM/ CAD specialist, (3) research/ education, (1) Consultant, (3) 'Other' professionals.

Conclusions:

A Delphi Survey ideally has about 12 experts to provide for enough variation in expertise and opinion while retaining a small enough panel to allow for consensus to be obtained in a reasonable timeframe. While the survey began with 23 respondents, natural attrition allowed for the 14 most interested experts to remain for the final round and validation that consensus was reasonably achieved within the expert panel. The Delphi Survey requires a level of expertise that was met with the majority of experts holding 21-25 years of experience. Likewise, representation from the AEC industry was varied with a majority of architects and designers but inclusive of the stakeholders in the integrated design process; construction, engineering, owners and educators. The researcher has determined that the Delphi expert panel provided the level of expertise required to contribute to the specific knowledge required and to develop forecasts in response to a complex issue as required (Appendix D).

5.2.2. Needs Assessment

The needs assessment was done as part of the first round of the Delphi Survey to determine what the importance of professional competency metrics, the expert panels impression of the current state of professional development in the industry as well as to gauge the their abilities as they pertain to social media.

The expert panel found all of the overarching metrics defining professional competency in the field important, with Cognitive/ Knowledge base, Communication Skills and Technical Skills leading in the area of critical importance.

The experts were asked for their level of agreement as to the state of professional development in the AEC industry:

- 50% are dissatisfied with training offered through their work, (with 45% undecided and 5% satisfied).
- 80% are encouraged to take the initiative in determining their own professional development.
- 60% don't know what training they require to succeed in the future, (with 20% undecided and 20% understanding what is required).
- 60-65% depend on professional organizations providing conferences, regional training and webinars for training.
- 100% agree that we need improved methods for professional development to keep up with the rapid pace of change in the field.

The experts were asked for their level of familiarity with social media strategies and tools used for professional development:

- 85-95% are involved with on-line communities of practice.
- 75-80% utilize tools including YouTube, Flickr, Blogs & Twitter, Google Docs and Wiki's.
- 80-95% know how to find information, access knowledge communities, take webinars and make professional connections.
- 90% co-create information with other professionals and contribute to a knowledge base.
- 55% contribute to social media by creating content.

The needs assessment showed that, according to the expert panel, the AEC industry professional needs improved methods for professional development to keep up with the rapid pace of change in the field. The most important metrics defining professional competency are their skills and knowledge base and their communication and technical skills.

In terms of the current state of professional development, professionals are;

- Encouraged to determine own professional development goals.
- Unsure about what they need to learn to succeed in the future.
- Unsure if they are satisfied or are dissatisfied with workplace training and,
- Look to professional organizations to provide training.

In terms of familiarity with social media strategies and tools for professional development, representatives of the industry on the expert panel understand how to;

- Connect with communities of practice
- Utilize on-line tools such as Google, Blogs and Twitter
- Access information and learning on a need-to-know basis
- Contribute to knowledge sharing

The researcher sought to compare the results of the needs assessment with the six goals developed by the AIA for Integrated Project Delivery (AIA/ AIA CC 2007) for integrated design practices to evolve in the architecture and design industry.

> *1. **Collaborate** with industry leaders to facilitate the dialogue, share knowledge, and accelerate the rate of change for all those seeking to improve the industry's current practices by utilizing integrated approaches to the design, construction and operation processes;*
> *2. **Communicate** the benefits of collaborative approaches to public and private sector clients, and promote changes to the design and construction procurement process to allow early information sharing;*
> *3. **Promote** the benefits of developing a virtual model of a project using available technologies, built with interaction and input from an integrated and collaborative team of project stakeholders – owners, designers, consultants, constructors, subcontractors and suppliers;*
> *4. **Develop** and promote the integration of collaboration techniques and technology into education curricula for architects and architectural students to enhance their design and team collaborative skills;*
> *5. **Engage** the legal profession and the insurance industry in preparing contracts that support the integration of collaborative models and technology into the design and build industry and offering insurance coverage's responsive to IDP; and,*
> *6. **Promote** documentation of the measurable contributions resulting from implemented integrated project delivery approaches to stakeholders and promote the value and achievements of increased use of integrated project delivery methods.*

To inform the research analysis, the researcher examined the goals by highlighting the operative words and producing a word cloud (Figure 5.1) to analyze the frequency of word use with primary and secondary words as the most important for consideration.

Figure 5.1

AIA Integrated Project Delivery Goals word cloud

- Primary- Promote, Collaborative, Design, Integrated, Project
- Secondary- Industry, Approaches, Benefits, Insurance, Team, Stakeholders, Delivery, Integration, Technology, Construction.

The researcher cross referenced the learning goals of the industry with the specific challenges and recommendations for learning identified by the Delphi expert panel. The AIA learning goals were assessed by the relative importance of words determined in the word cloud with specific attention to the operative of each goal; Collaborate, Communicate, Promote, Develop and Engage. The researcher's synthesis of the challenges for social learning identified by the Delphi expert panel indicated a lack of connections, dialog and professional networking within the industry. Their recommendations are to cultivate social networking and knowledge sharing at the project level and within the industry to facilitate social learning within the context of the job. The researcher determined that, from the commonality in word usage, there is some common ground in terms of the subject matter that needs to be learned. However, because the expert panel expressed that their social learning is hindered due to a lack of social networking and knowledge sharing within the community of practice it is evident that the AIA learning goals cannot be readily met as desired.

A personal learning network for professional development requires a successful community of practice. The Community of Practice Key Design Elements (Van Winkelen 2003) outline the necessary elements required for a community of practice to successfully network and develop a knowledge base. To exemplify the relationship between the factors required for social learning within the context of a community of practice, the researcher has paired these elements with the perceived existing state of practice within the architecture and design industry (Table 5.1).

Table 5.1

Community of Practice Key Design Elements

Adapted to evaluate Community of Practice Key Design Elements in terms of the Architecture + Design Existing State of Practice [fair use] (Van Winkelen 2003)

Community of Practice Key Design Elements	**Architecture + Design Existing state of practice**
An appropriate subject area, which generates shared interest	Integrated Design Practices and Integrated Project Delivery provide a common subject area and shared interest between stakeholders.
Fulfillment of certain roles, which provides for expertise or facilitation as required	AIA and extended knowledge community leadership have provided the expertise in determining high level learning goals for the industry. The expert panel indicates that the facilitation of expressing those learning goals to the industry professional is lacking because they indicate that they are not sure what they need to learn to succeed in the future.
A culture of trust and openness, which encourages personal exchanges to help build relationships	The expert panel indicates that there is a lack of connections, dialog and professional networking within the industry and recommends that social networking and knowledge sharing within the industry and at the project level could facilitate social learning within the context of the job.
A clear purpose, which results in tools to work more effectively	The industry professional uses social media tools to work more effectively. Specific learning goals toward learning outcomes may not be clearly defined for the industry professional.
Appropriate organizational support, which includes technology, coaching and on-line resources	AIA (Soloso) provides support in terms of on-line resources at a professional organization level. Workplace technological support and coaching are dependent on the circumstances of the industry professional.
Organizational acquiescence, which demonstrates commitment at the corporate level through active participation of the leadership.	AIA knowledge community and leadership has provided clear goals however the importance of the subject matter and clear learning objectives for the industry professional may not have been adequately promoted.

Conclusion:

The foundation is in place for a community of practice in terms of a shared body of knowledge and commitment to learning at both the organizational and industry professional level. The industry professional is knowledgeable of the social media tools required to work more effectively. However, challenges are apparent in terms of the lack of knowledge exchange in the industry and unclear learning goals at the industry professional level. Based upon the two recommendations that the researcher derived from the comments provided by the expert panel paired with the need to overcome the barriers that exist within the community of practice, the researcher developed three goals for creating and implementing personal learning networks for professional development in the industry.

The needs assessment indicates that the learning goals of the AIA knowledge community are in line with the goals of the industry professional in terms of the overall need to; ***Cultivate social networking and knowledge sharing at the project level and within the industry to facilitate social learning within the context of the job.***

The expert panel also identified information management as a key recommendation for the industry professional; ***Provide the professional with a single venue capable of filtering quality information to better facilitate learning and knowledge sharing in a timely manner.***

The researcher has determined that in addition to the recommendations provided by the expert panel an additional recommendation must be generated to overcome the barriers that exist within the community of practice: ***Empower the professional to harness their own professional development through clear articulation of industry and individual learning goals and specific learning outcomes and backed by organizational commitment and support.***

These three goals cover the macro view of the industry as well as the needs of the professional to provide the researcher with the requirements for creating and implementing personal learning networks for professional development in the industry.

5.2.3 Personal Learning Network Parameters

The three goals that the researcher derived from the needs assessment directly inform the parameters and requirement for development of the PLN model:

1. **Goal:** Cultivate social networking and knowledge sharing at the project level and within the industry to facilitate social learning within the context of the job.
   Model Criteria: Provide a graphic visualization to assist the professional in identifying the types of connections and factors that may be required in developing, organizing and facilitating their individual professional development plan.
2. **Goal:** Provide the professional with a single venue capable of filtering quality information to better facilitate learning and knowledge sharing in a timely manner.
   Model Criteria: Provide recommendations for management of the PLN harnessing current tools for information management, social networking and knowledge building.
3. **Goal:** Empower the professional to harness their own professional development through clear articulation of industry and individual learning goals and specific learning outcomes and backed by organizational commitment and support.
   Model Criteria: Provide a broad overview of the domains of influence and their interconnectedness in the development of a personal learning network for professional development.

In order to meet the requirements outlined in the needs assessment, the researcher determined that the recommended model for a personal learning network for the architecture and design industry should be comprised of three elements, one to meet each of the three goals and model criteria outlined; an overarching Professional Development Activity Diagram for the AEC industry, a PLN Framework identifying the factors and connections required for social learning and PLN Application recommendations for current tools to facilitate management and learning.

PLN Activity Diagram provides a broad overview of the domains of influence and their interconnectedness in the development of a personal learning network for professional development. The activity diagram remains constant as long as an individual is engaged in self-directed learning. It serves as a model for the professional to ensure that all domains of influence are being considered when determining goals toward learning outcomes.

PLN Framework provides a graphic visualization to assist the professional in identifying the types of connections and factors that may be required in developing, organizing and facilitating their individual professional development plan. The types of connections remain consistent with the factors and their relative importance serving as a starting point for the professional to adapt as required.

PLN Application considers the management of the PLN harnessing current tools for information management, social networking and knowledge building. This is the most dynamic of the three elements and will change dependent upon the individual's preferences, learning objectives and the latest and greatest web 2.0 tools and resources available.

PLN Activity Diagram:

As a learner-centered activity, the Delphi survey questions were oriented to the individual expert and the factors that were relevant to them in the development of a personal learning network. This was done with the understanding that they were a member of an expert panel and needed to consider the other panelists input, ultimately coming to consensus on the connections and factors that would be most relevant to the industry as a whole. Simiarly, the process of implementing a personal learning network begins with the learning professional and the tools required to reach their learning objects within the greater context of the architecture and design industry community of practice.

The researcher developed a Professional Development Activity Diagram for the AEC Industry (Figure 5.2), based upon the Activity Theory diagram (Engestrom 1987) and Attwell's Grounded Theory research of the body of knowledge surrounding personal learning environments and their core dimensions and factors detailed in the literature review and used in the design of the Delphi survey (Attwell, et al. 2011). The researcher customized the activity diagram in line with Attwell's scientific analysis of the primary characteristics of personal learning environments through an activity theory lens as a tool for analysis.

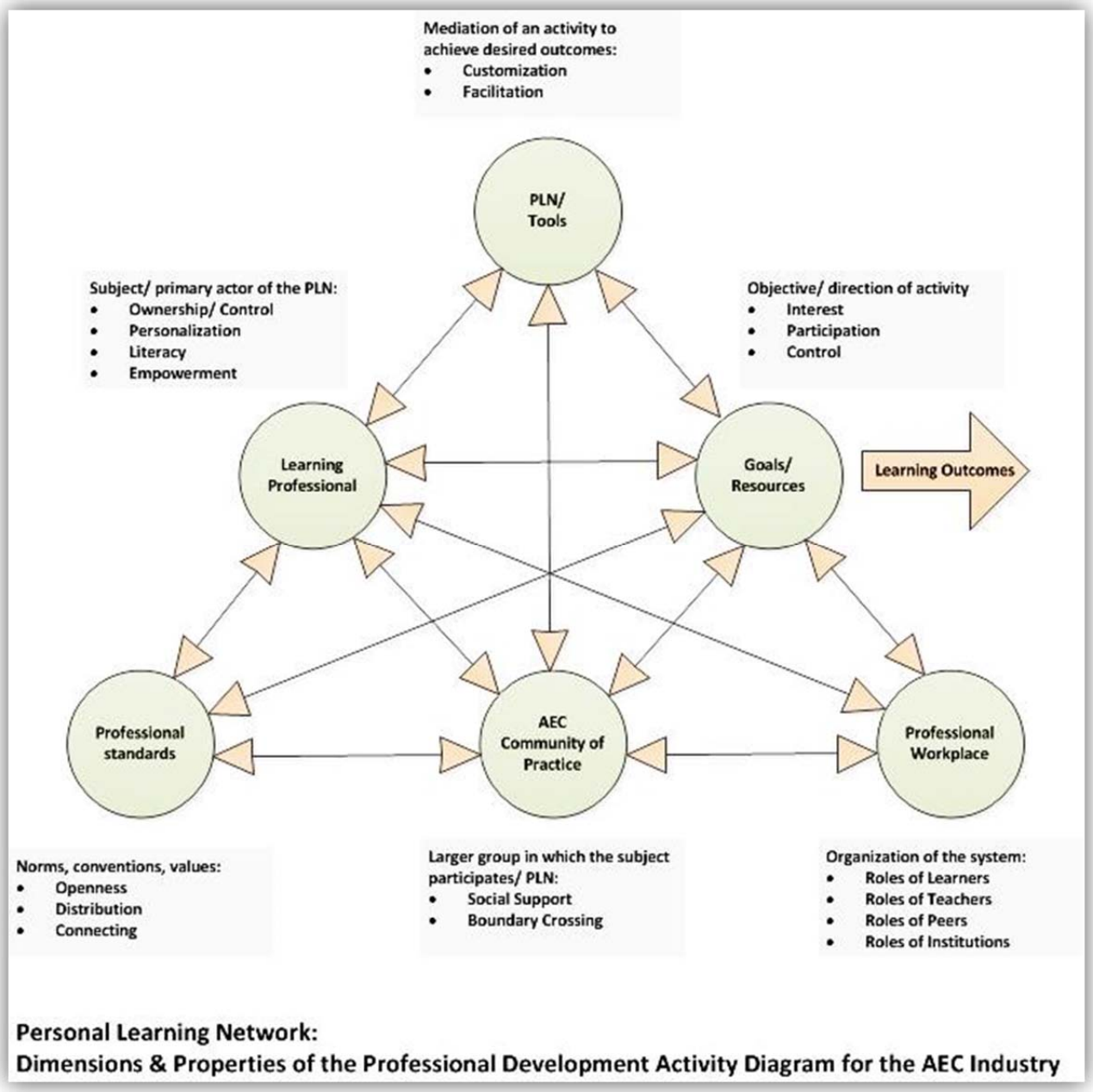


Figure 5.2

PLN Activity Diagram

The essential elements; domains, dimensions and properties, of the Professional Development Activity Diagram for the AEC Industry.

Research on the distinguishing features of PLN's suggests that they can be viewed as complex activity systems and therefore can be analyzed using the Activity Theory framework. The scientific analysis research of personal learning environments (Attwell, et al. 2011) includes the external factors of societal norms, community and organizational influence. Developed by Attwell as a tool for analysis, the activity triangle model represents the primary elements of an activity system. The top most triangle is indicative of where the subject (learner) utilizes tools (PLN) to interact with objects (Resources) to reach desired goals (learning outcomes).

The extended triangle incorporates the necessary influences of rules of engagement (Professional Standards), the AEC community of practice and the individual's professional workplace. Each domain is relevant and important for consideration in developing a personal learning network as are the connections between them. An understanding of these domains and their interconnectedness can provide the professional with a deeper understanding of the various influences and roles involved in social learning and professional development.

The core elements of an activity diagram for a personal learning environment lies in the top triangle; Subject, Objective and Tools. The factors that are relevant to the domain of the subject or learning professional are ownership, personalization, literacy, and empowerment as they relate to the other domains of the activity diagram essential for a personal learning network. The objective of a personal learning network is to engage in learning activity toward learning outcomes, the domain of professional development goals and resources, which requires interest, participation and control in relation to the other domains of the activity diagram. The learning professional utilizes an individually customized PLN framework and associated tools and applications to faciliate and manage the connections between the other core domains of the activity diagram toward their learning goals.

The extended triangle represents the influences of social learning and communities of practice required for a personal learning network for professional development. The AEC community of practice provides industry goals, project delivery tools, social networking support, and ‘Boundary Crossing’ in terms of collaboration and knoweldge transfer. Professional standards are determined at the industry level as well as within the organization and include the requirements for licensure and professionalism as well as openness to new methods and tools, distribution of resources and content, and connecting different disciplines and domains. The professional workplace includes the influences of the individual roles of the learning professional and their organization, discipline, project team and mentors to assist the learner in understanding the actors in their personal learning network and the fact that the learning professional may serve the role as teacher and learner.

Actualzing an effective personal learning network can achieved by first understanding the essential elements and core dimensions and properties of the Professional Development Activity Diagram for the AEC Industry providing an overview of the individual domains and their interconnectedness and dependency on one another:

1) The Learning Professional: Ownership/ Personalization, Literacy (Metacognition, Self-directed learning, digital literacy), and Empowerment (Identity, motivation, goal setting)
2) Professional Development Goals/ Resources: Interest, Participation, and Control (of Goals, Tools, Standards, Community and Workplace)
3) Personal Learning Network/ Tools: Customization and Facilitation (of Goals, Tools, Standards, Community and Workplace)
4) The AEC Community of Practice: Social Support and Boundary Crossing (of Goals, Tools, Standards, Community and Workplace)
5) Professional Standards: Openness, Distribution and Connecting (of Goals, Tools, Standards, Community and Workplace)
6) The Professional Workplace: Learners, Teachers, Peers and Institutional Roles (influencing Goals, Tools, Standards, Community and Workplace)

Once the domains and core elements and properties of the PLN activity diagram are understood, architects and designers will have a deeper undertanding of how their personal leanring network will be situated within the greater context of the profession as they work to develop their personal learning network.

PLN Framework:

The PLN framework allows the learning professional to understand the required connections and factors for a personal learning network for professional development in the AEC industry as developed by the Delphi expert panel. The researcher determined that a visual representation facilitates understanding of the types of connections and factors that may be required in creating a personal learning network that meets their individual professional development plan. The types of connection categories were drawn from the guidelines for developing personal learning networks (Warlick, 2011) as well as the research in technologies for communities of practice (Wenger, 1999). The three types of learning connections that an individual engages in require definitions to exemplify their use and how they are maintained;

1) A Real-Time, synchronous, connection includes people and places that you connect with directly to accomplish a goal. The interactions can be face-to-face or via telephone or video conferencing tools. This type of connection requires maintenance by the learner for it to be sustained.

2) An Anytime, semisynchronous, connection allows for collaboration and learning occurring ‘nearly now’. These social networking connections involve lag time in the interaction including email and project collaboration tools such as BIM (Building Information Management). This type of connection requires maintenance by both the learner and the social network for it to be sustained.

3) A Resource, asynchronous, connection provides learners with the resources they need for professional development. The primary goal of a personal learning network is to gain knowledge and learners are increasingly seeking content online to do their jobs. Resources connections must be dynamically maintained by the online community to remain relevant within the evolving common body of knowledge.

The factors were developed based upon Attwell's applied Grounded Theory of the comprehensive literature review to identify the consistent factors for consideration in the development of personal learning environments (Attwell, et al. 2011). The factors were chosen and adapted by the researcher to focus on professional development in the architecture and design industry and to be from the point of view of the professional. Twenty factors were developed for the PLN framework to focus on professional development in the architecture and design industry from the point of view of the professional. These factors serve as a starting point for the learner with the understanding that they that they reflect the current state of practice and were developed to apply to most AEC industry professionals:

1. Collaborating on the development of a resource or knowledge base including sharing tools, techniques and presentations.
2. Networking with local professional colleagues
3. Creating resources for self-reference
4. Working on project teams with professional colleagues
5. Communicating real-time with professional colleagues
6. Reviewing and critiquing new and articles and blogs
7. Self-directed learning on a need to know basis
8. Using social networks to make and maintain professional connections.
9. Reading news, articles and Blogs
10. Networking with distant professional colleagues
11. Using professional membership connections and knowledge base
12. Finding and aggregating resources.

13. Using collaborative project management tools such as BIM
14. Having a visual diagram of personal learning connections as a resource
15. Creating a personal Blog or digital portfolio to document learning, activities and reflections
16. Creating social bookmarks to have access to bookmarked sites and documents from anywhere
17. Creating resources to assist colleagues, team members and the industry at large
18. Following the work of professional colleagues
19. Receiving required on the job training
20. Receiving formal training/ certification

The Delphi expert panel successfully sorted the factors into the three categories of personal learning connections; Real-Time Connections (personally maintained synchronous connections), Any-Time Connections and Resource Connections category (dynamically maintained asynchronous connections). Several factors consistently applied to more than one category. The researcher found that there was significant agreement in Real-Time Connections. This is likely because face to face connections are the most familiar and understood of the communication methods. There was also significant agreement in Resource Connections. While individuals may use resources differently they all require resources for learning. The challenge is that there is a lack of core knowledge bases in the industry and professionals have adapted by cobbling together a variety of resource connections. As the most dynamic of the categories, Any-Time Connections proved to be the most challenging for the expert panel to agree upon however sufficient agreement was obtained for the purposes of this study. The ranking of factors may be affected by the individual's area of expertise as well as their experiences with social media. These connections are directly influenced by the rapidly changing nature of the web. As such, the learner will need to actively engage in managing this area of their personal learning network to maintain its effectiveness.

The development of the personal learning network framework by the Delphi expert panel was presented following each round of the survey as a graphic representation akin to an activity diagram to assist them in understanding the objective of the survey and how their input compared to the others on the expert panel. The researcher determined that this visualization may assist the professional in identifying the types of connections and factors that may be required in developing, organizing and facilitating their individual professional development plan. The types of connections remain consistent with the factors and their relative importance serving as a starting point for the professional to adapt as required. (Figure 5.3)

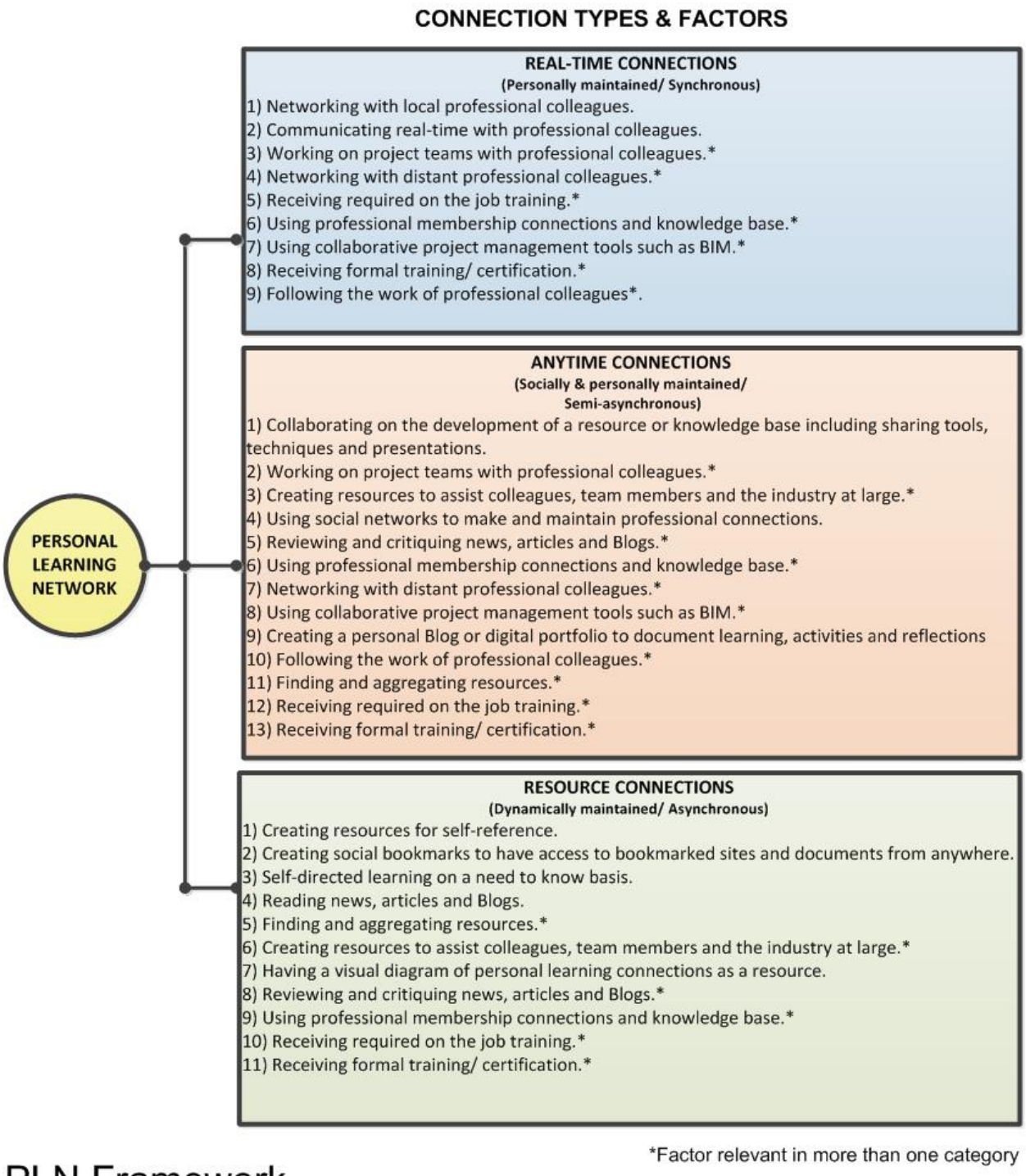


Figure 5.3

PLN Framework

PLN Application:

Which tools professionals choose to use, and why they choose to use them, are as individual as they are. Tools will change dependent upon the individual's preferences, learning objectives and tools and resources available. The application of a personal learning network for professional development requires harnessing current tools for information management, social networking and knowledge building as well as the overall management of the personal learning network.

The web and the platforms and tools available are evolving rapidly. As a moving target, this requires that the learning professional avoid a fixed mind set and remain open to the possibility that a certain platform or tool of choice may no longer be the best solution and be willing to migrate accordingly. By adopting an overall strategy of continuous learning the professional can remain open to and evaluate the next best recommendation for a platform or tool.

The Center for Learning & Performance Technologies surveys over 500 education and workplace learning professionals from 48 countries and provides a list of the best learning tools available (Table 5.3).

Table 5.3

Excerpt from the Top 100 Tools for Learning 2013: Best Of awards [fair use]

(The table highlights the key tools and their relative position on the list in brackets)

(Hart 2013)

Best presentation tool	**Best e-learning authoring tool**
Gold: PowerPoint (5) Silver: Prezi (15) Bronze: Keynote (53)	Gold: Articulate (24) Silver: Adobe Captivate (37) Bronze: iSpring solutions (46)
Best screencapture or screencasting tool	**Best live e-learning/webinar tool**
Gold: Jing (27) Silver: Camtasia (28) Bronze: Snagit (31)	Gold: Google Hangouts (10) Silver: Adobe Connect (30) Bronze: Webex (44)
Best learning management system or learning platform	**Best file sharing tool**
Gold: Moodle (11) Silver: Coursera (38) Bronze: eFront (67)	Gold: YouTube (3) Silver: Slideshare (16) Bronze: Flickr (52)
Best social network	**Best private social networking platform**
Gold: Twitter (1) Silver: Facebook (9) Bronze: Google+ (10)	Gold: Yammer (20) Silver: Edmodo (29) Bronze: Ning (96)
Best collaboration tool	**Best curation tool**
Gold: Google Docs (2) Silver: Skype (13) Bronze: Diigo (21)	Gold: Pinterest (22) Silver: Scoopit (23) Bronze: Flipboard (36)
Best blogging tool	**Best productivity tool**
Gold: WordPress (8) Silver: Blogger (18) Bronze: Tumblr (65)	Gold: Evernote (6) Silver: Pocket (49) Bronze: OneNote (69)
Best file storage / synchronization service	**Best newcomer (not appearing in another category)**
Gold: Google Drive (2) Silver: Dropbox (7) Bronze: Skydrive (43)	Gold: Feedly – replacing Google Reader as the RSS reader of choice (19) Silver: Today'sMeet – private backchannel tool (85) Bronze: WhatsApp – private messaging tool (86)

The researcher focused specifically on the results for social networking and social learning tools. Currently, Twitter remains at the top of the list as a social network for the 5th year in a row. The best learning management systems and learning platforms, such as Moodle and Coursera, are used specifically for on-line courses. There are private social networking platforms used for business (Yammer) and in the field of education (Edmodo) as well as to cultivate a community (Ning). Google Drive/ Docs have become the favorite synchronization service, knowledge base and open collaboration tool, has with Google + ranking in the top three best social network and Google hangouts as the top live e-learning and webinar tool.

Google appears to have it all in one platform, which is desirable from an information management perspective however it has not received the engagement expected in Google + Communities since it was launched in 2012 (I2thinktank.com 2014). The field of education remains one of the only communities of practice to employ personal learning networks for professional development and there is a significant number that have chosen Google + for social learning (freetech4teachers.com 2014). Google + facilitates connections (Gmail contacts) and communities (public and private circles). The advantage over Twitter is that Google + format allows for a better understanding of the context of a discussion and ability to follow conversations.

In order to navigate the realm of choices, the learner should identify what their specific needs are within their community of practice and choose platforms and tools in terms of their functionality. As a social learning endeavor, this requires adoption of the platforms and tools that are most readily used within the existing professional community of practice. For example, sites like LinkedIn and the AIA Knowledge Communities are recognized platforms for professional connections and for Blogging. An industry professional working on a project team may utilize an open BIM platform to collaborate with the project team. Google plus could provide a common platform for a learners email, contacts, calendaring and file sharing requirements. The industry professional should investigate the platforms and tools that their community of practice currently

utilizes to ensure that they choose social media platforms that facilitate professional connections.

According to Jane Hart, Centre for Learning & Performance Technologies, there are over 2,000 tools for professional development (Hart 2014). These can be categorized by social and collaborative spaces which include social networks and platforms to create spaces for groups or communities of practice as well as tools to meet specific needs for creating and sharing information. The primary areas that social media learning professionals identify as important for learning are blogging, RSS readers, social bookmarking, knowledge sharing and social networking tools. As important factors for social learning, the learner should investigate and apply these learning tools to their personal learning network from each of these categories with the understanding that the specific platform examples provided are only valid at the time of publication and are subject to change with the dynamic nature of the web;

Blogs that are specific to the learner's area of expertise can provide micro-learning opportunities as well as a means to contribute knowledge and make connections with other professionals within the context of the work day. These can be found through LinkedIn, professional organizations, and through individual experts in the field. While some blogs are closed for comment, there are many that can engage the professional in discussion about a certain topic of interest. Twitter is considered a micro-blogging/ micro-sharing tools that can provide tips and guidelines or to harvest useful links. Tweetdeck provides a means to organize and group them and manage the information. The learner can skim these regularly to keep abreast of knowledge in the field and to contribute where they may have information to share.

RSS readers are a key component of a learner's social media took kit because they are the primary information filtering tool for managing of the sheer quantity of information that is produced on social media. A RSS feed enables a user to receive updates from favorite websites and to aggregate information from multiple sites. The learner can identify which types of information they would like to receive and have the information

presented in an organized manner. This requires setting up an RSS reader platform, such as Google Reader, and identifying the websites of interest.

Social Bookmarking is the practice of saving websites of interest and tagging them so that you can visit them in the future. Social bookmarking sites such as Delicious allow users to register and search and collect resources of interest as well as to designate them as public or private. By providing access to others bookmarks, the community of users over time develop keywords to define resources. With consideration for the fact that these resources are being developed by amateurs, its value is in its function as a collaborative filter for resources. In terms of the implications for teaching and learning, the tagging of resources with keywords created by the community of practice provides a shared framework for finding and storing information (Educause 2005). This requires identifying a social bookmarking site such as Delicious or Google Reader and searching for resources of interest to find like-minded individuals and common tags for resources.

Knowledge Sharing tools are currently being harnessed by the online community for photo sharing (Flickr), screencast sharing (Jing), and presentation (Slideshare) and video sharing (YouTube). These tools can be harnessed for on the job training through the multitude of how to videos and access to professional presentations. Open BIM has the potential to provide industry specific support for knowledge sharing within the scope of a project and sharing of artifacts as a resource. Identifying knowledge sharing tools will depend on the need and the nature of the information. The learner will need to be connected to both the open web knowledge sharing community as well as within the bounds of the community of practice. This requires vetting resources within the online community or within the community of practice to determine whether they are relevant and valid. Additionally, this requires an understanding of what resources are considered open and which ones are protected, especially within an organization or project team.

Social Networking sites such as Facebook and LinkedIn have become the primary venues for social networking often mixing both personal and professional contacts. These open networks provide a broad overview of a learner's connections and can point

them to new contacts and information. In addition, communities of practice often require more private collaborative connections which can be achieved through customizable sites like Google communities or Ning. These social networks are often formed around a particular project of course and need to be initiated and facilitated by a community of practice or project leader. Ideally a learner will develop broad social networking connections while fostering those required as part of a project team, organization or course because ultimately those connections intermix within a community of practice.

The current recommendations for platforms and tools address information management; social networking and knowledge building and Google provides a common venue for connecting and collaborating. However, the overall management of the personal learning network and the expert panel's recommendation for a single venue is not included in the top 100 tools for learning. The management of information has become a primary focus for the technology industry. Management of information from the home start screen was one such solution resulting in several platforms, including Pageflakes and iGoogle, which are no longer viable (Gilbertson 2012). Netvibes has survived as a dashboard for managing the web from a home screen. It can serve simply as a personalized RSS reader or, though membership, can support brand monitoring and social analytics including team solutions (Netvibes.com 2014).

A visual diagram of personal learning connections was considered to be a factor relevant to the Delphi expert panel in the Resource Connection category. The activity diagram serves as a macro view to understand how one's personal learning network is situated within the greater context of the profession and the PLN framework serves to provide a view of the individual components of a personal learning network. A common venue that serves to manage web resources and provide visualization of the social network is required.

The researcher discovered Pearltrees as a platform that serves as a visual and collaborative tool that allows its community members to organize and connect and easily located all of the content of interest to them. As a visual means to dynamically

manage information within one platform, Pearltrees appears to be a viable current solution for the common venue sought by the expert panel.

Developed and launched in 2009 as ‘The web’s third frontier”, the CEO and Founder Patrice Lamothe proposed that the next logical internet phase was the democratization of the organization of the web (Lamothe 2014). Pearltrees allows the user to be a spectator, a creator and an organizer. It provides the ability to dynamically manage web resources and provides a content curation service and file management capability as well as facilitating connections and collaborate with others with the same interests through synchronization tools with Twitter and Facebook. It is also a mobile application allowing for access to the links from anywhere and anytime.

The researcher developed a Pearltree to confirm its applicability (Figure 5.4). Pearltrees provided the ability to organize web resources categorically with pearls representing the various web resources and connections in the researchers learning network. The researcher was able to change the visual layout of the Pearltree, adding and subtracting limbs, pearls and the connections between them into a logical diagram. Adding pearls of shared interest immediately provided the researcher with related pearls to discover. The more pearls discovered and picked, the more closely the recommendations for related topics will be. The speed that you use Pearltrees on iOS will affect your exploration of topics allow; moving slowly will provide more detail on a topic however it will jump from interest to interest the faster it is used. The value of the knowledge resource is indicated by the thickness of the blue ring around the pearl representative of the amount of contributors that have selected it. Teams can be formed to help develop personal and resource connections allowing for private Pearltrees and messaging. Professional adaptation of Pearltrees allows for customization, privacy control, archiving 100 GB of data, editing and presentation of content. Its intent as a new tool for organization of the web provides a platform that can be utilized by the individual and potentially harnessed by the community of practice for social networking and knowledge sharing.

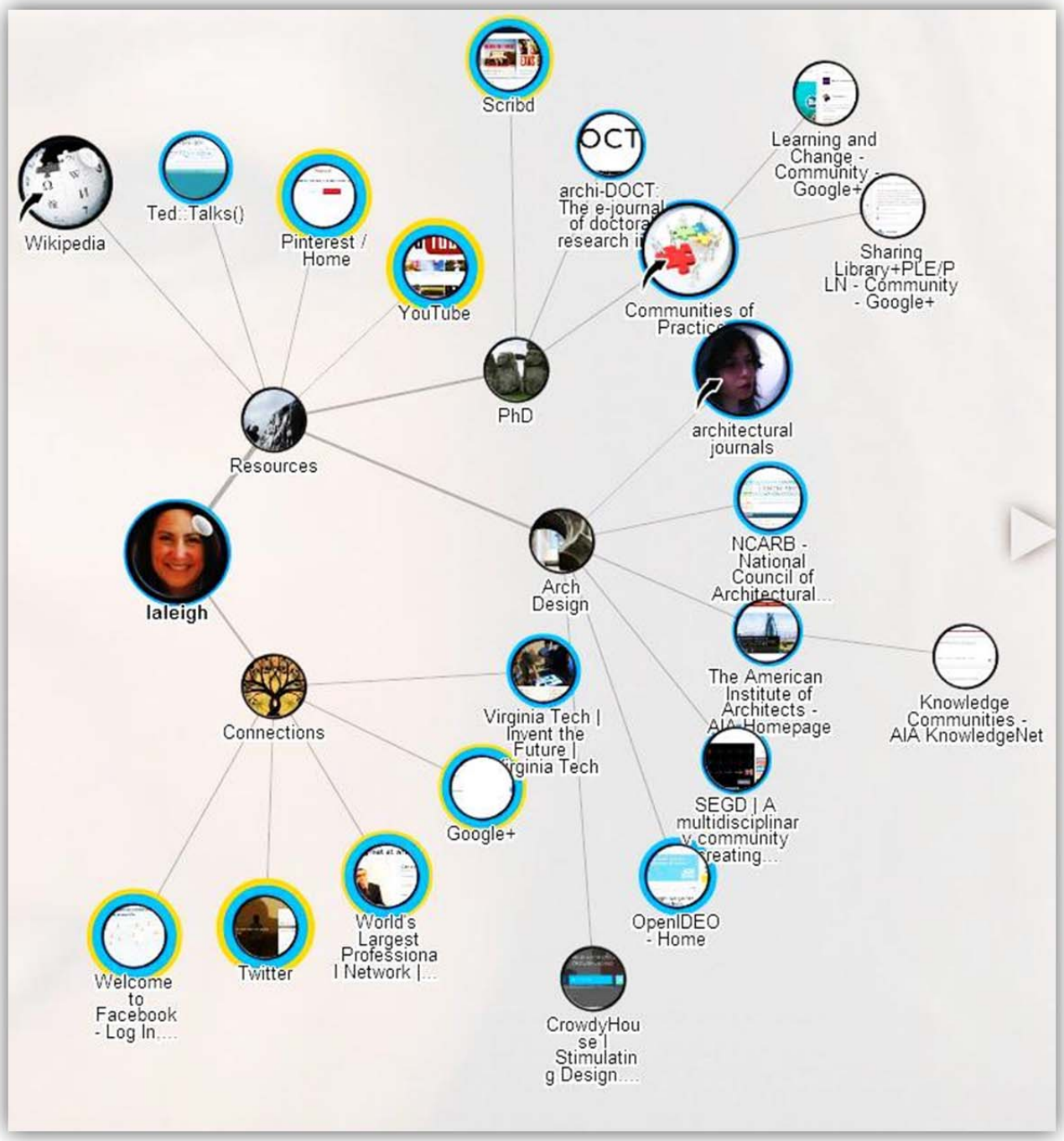


Figure 5.4

Researcher's Pearltrees PLN representation.

Conclusion:

The results of the Delphi survey indicate that the AEC professional has a commitment to self-learning as well as an interest in advancing the knowledge of the industry as a whole. The expert panelists are familiar with social learning tools and interested in engaging in personal learning networks for professional development. The final PLN framework and recommendations paired with the results of the needs assessment provided the researcher with three goals and the parameters required for developing three PLN models to facilitate implementation.

The goal is not simply to learn a new strategy, but instead to create conditions for perpetual learning an environment in which innovation and experimentation are viewed not as tasks to be accomplished or projects to be completed but as ways of conducting day-to-day business—forever. Furthermore, participation in this process is not reserved for those designated as leaders; rather, it is a responsibility of every member of the organization. (DuFour 2006)

5.3. IMPLEMENTATION

The implementation of personal learning networks for professional development in the architecture and design industry requires an understanding of the goals for professional development in the field and how they relate to individual practice, an understanding of social networking and the concept of communities of practice and an understanding of social media platforms and tools. Additionally, as a self-directed learning endeavor, the professional must have the proclivity to engage in the development of their personal learning network and contribute to the exchange of knowledge in pursuit of learning goals toward learning outcomes.

The objectives for implementation are to provide the architect and design professional with an interactive toolkit that provides broad and specific learning goals as determined by the AEC industry for integrated design practices and a guideline to developing a personal learning network. This toolkit is anticipated to be developed by the researcher in collaboration with AIA and industry leaders as the next phase of this work. The guideline requires a contextual view of PLN's for professional development in the industry, recommendations for the framework, implementation, development and sustainability of a PLN. These elements consider the macro view of the industry as well as the needs of the professional to provide the requirements for creating and implementing personal learning networks for professional development in the industry and is in line with the user-centered design development cycle for continued improvement.

The researcher provided implementation strategies for each goal and corresponding PLN model:

1) *Cultivate social networking and knowledge sharing at the project level and within the industry to facilitate social learning within the context of the job.*
   PLN Model: PLN Activity Diagram
   PLN Implementation Strategy: Ideation

2) *Provide the professional with a single venue capable of filtering quality information to better facilitate learning and knowledge sharing in a timely manner.*
   PLN Model: PLN Framework
   PLN Implementation Strategy: Management

3) *Empower the professional to harness their own professional development through clear articulation of industry and individual learning goals and specific learning outcomes and backed by organizational commitment and support.*
   PLN Model: PLN Activity Diagram
   PLN Implementation Strategy: Development & Sustainability

PLN Implementation Strategy:

The implementation of a personal learning network for professional development requires that the industry professional identify current tools for information management, social networking and knowledge building as well as the overall management of the personal learning network. Which tools professionals choose will change depending upon the individual's social networking preferences, learning goals and the current platforms and tools available. Consistent management and continual development of the personal learning network by the learner is required for it to be sustained. While it may take effort upfront to create a personal learning network, the management and development of it can be accomplished through the process of social learning.

The researcher outlined a strategy for implementation including the steps for the creation and management of a personal learning network as well as the requirements for ongoing development and sustainability to support the learners' social learning process:

Ideation:

- Conduct a self-assessment of existing PLN within the context of the AEC Activity Diagram.
- Identify existing methods, tools and platforms
- Map existing connections and resources
- Identify existing learning goals and outcomes
- Identity the external domains of influence
- Conceptualize new PLN
- Identify required methods, tools and platforms
- Identify new learning goals and outcomes
- Map new connections and resources

Management:

- Create base framework for individual PLN
- Harness existing or adopt new organizational method
- Utilize a single venue to manage PLN
- Organize the PLN according to connections, resources and topics
- Add connections and resources for new knowledge/ connections
- Cut off redundant/ ineffective or old connections and resources
- Activate/ Hide tangent connections and resources
- Participate/ contribute/ share

Development:

- Reflect on the external influences to the PLN
  within the context of the AEC Activity Diagram
- Plan new learning goals and outcomes
- Develop areas lacking organization connections, resources and tools
- Test existing organization, connections, resources and tools

Sustainability:

- Actively add to knowledge base
- Actively mine resources for new knowledge
- Actively seek out new connections/ tools
- Actively participate and contribute to social learning

Ideation:

The first step is for the leaner to take an inventory of their current state of professional development within the context of the activity diagram. The activity diagram provides for a broad perspective of the learner role as a self-directed learner and the connections, factors and tools required to achieve learning objectives and the influences of the domains of their discipline, their job and the AEC community of practice. This will allow the learner to begin to identify how their professional development and learning goals relate to the goals of the AEC industry. Identifying learning objectives will provide direction for implementing the personal learning network allowing the learner to begin to conceptualize the future state of their PLN. Each learning objective requires tools, connections and resources be identified toward learning outcomes. Engaging in this process encourages participation in the social learning process including the contributions that can be made by the learner to the community of practice. This meets the first goal outlined by the researcher;

Cultivate social networking and knowledge sharing at the project level and within the industry to facilitate social learning within the context of the job.

This can be applied to the AEC industry at the project level in particular. The Delphi expert panel expressed the fact that AEC industry professionals have knowledge within their area of practice that would be beneficial to share with other areas of practice during each phase of the project. Since the disciplines currently are somewhat insular, the industry professional needs to make an effort to share knowledge and artifacts within the bounds of a project as well as to cultivate the greater community of practice.

Management:

The management of the PLN is essential for the learner to have an awareness and understanding of their own thought process and to maintain control of their social learning model. Organizing the PLN according to connections by the factors involved in social learning can be achieved by creating a base PLN from the PLN Framework developed by the expert panel. Harnessing an existing or adopting a new organizational method is important to organize and manage connections and web resources. A visual diagram of the PLN can support the learner in analyzing their cognitive process and how best to manage their information. Aligning resources and topics within a single venue can support organization of connections and resource information management. Depending on the learning objective there will always be new knowledge connections and resources to add. Management is also required to remove connections and resources or to hide inactive ones once a learning objective has been achieved or a project has been completed. Management is a continual effort yet once a PLN is developed, especially with a single venue it can be achieved through the social learning process. This will achieve the second goal outlined by the researcher;

Provide the professional with a single venue capable of filtering quality information to better facilitate learning and knowledge sharing in a timely manner.

The influence of the discipline, the individual learning professional's organization or the current integrated project delivery platform (Building Information Modeling- BIM) may require integration into the management of the personal learning network. According to a study by McGraw-Hill Construction (Aliya 2012), the trend in the AEC industry shows a steady increase in the adoption of BIM in the industry with more and more clients demanding it for their projects. Building Information Modeling (BIM) project software has evolved to provide for open information environment for knowledge-based collaborative processes throughout the lifecycle of a project and it may serve as the primary venue for the industry professional for a majority of their project work and meet necessary social learning objectives. However, it does not currently have the capability for the

broader connections and factors outside the project scope. The industry professional may be required to manage two parallel venues, such as BIM for project work and Pearltrees for information management and social learning, within the context of the AEC community of practice.

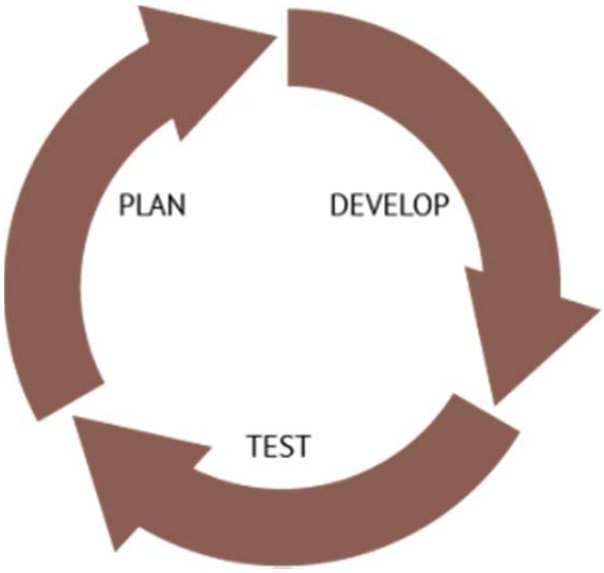
Development:

Once the industry professional has created a personal learning network and established an understanding of how to manage their social learning model they can begin to develop it. At this point, the industry professional will be better able to identify the contributing external influences and can refer back to the Professional Development Activity Diagram for the AEC Industry in identifying new learning objectives and what is required to achieve them.

Developing the PLN requires identifying the specific technologies or tools and their relevancy and usefulness to the individual and the professional community of practice. While recommendations help facilitate and guide the implementation of a personal learning network, technological advances and individual's preferences require continuous development of their personal learning network. This is reflective of the iterative development process in web interface design (Figure 5.6). The iterative development process allows a professional to sustain a continuous cycle of planning, developing and evaluating their personal learning network in terms of learning goals, connections and tools toward learning outcomes.

Figure 5.5

Iterative Development Process



The framework for analysis (Table 5.4) provides an example of how the tools and their usefulness can be evaluated. This data is an excerpt from a larger table drawn from *Technologies for Communities* as an example of asynchronous knowledge sharing with a focus on the use of discussion boards and the relevancy of its features. Conceptual frameworks can be utilized in the development of a PLN as a mechanism to gauge the effectiveness of any tool by an organization or an individual. Success with a tool can be shared through the knowledge sharing activated by the PLN, effectively allowing for the community to learn the latest and greatest tools available to keep their PLN's agile and dynamic.

Table 5.4 Excerpt of tool-feature table: Analysis of tools specific to asynchronous interactions with a focus on the use of discussion boards and their features [used with permission] (Wenger, et al. 2005)

Asynchronous Interactions		
• Email • Email Lists • Discussion Boards • Questions & Answers • Polling • Wikis • Blogs	These types of tools enable communities to interact across geography, hours of the day and time zones	Especially useful for distributed communities across locations and time zones, but used more generally by all types of communities to keep in touch, interact, and do things without meeting.
Discussion Boards	**Tool Description**	**Tool Usefulness**
Issues addressed by the feature set include: 1. message posting 2. message display and viewing options 3. enabling participation 4. administrative functions	Enables written discussions in asynchronous mode. Members participate whenever they can from wherever they are. They can post successive messages, with date stamp and author name, onto an environment where they can view the entire discussion. Today most discussion boards are web-based because the Web has become such an accessible interface for many people. Sometimes also called online forums or discussion databases.	This is a classic tool, used by many communities to sustain conversations without meeting physically. Especially useful when time zones are a problem, but expect turn-taking to be slower the more time zones are covered. May require some getting used to, but we have seen communities accomplish a lot in this medium in terms of asking for help, discussing issues in depth, socializing, and reflecting. Compared with e-mail lists, discussion boards do usually require participants to learn an additional interface. But they are better for discussing many topics in parallel. And they also enable adding and viewing postings in the context of an entire thread, which gives more of a "community feel" to the conversation. The price is that it is not as easy to follow one person's evolving thinking as it is in blogs.
Features	Feature Description	When Relevant
1.5 Upload attachments with messages	One or more document or multimedia files can be uploaded with a posting	Increasingly indispensable as people want to include documents, pictures, and other files in their conversations. Especially important for communities that want to use this medium for in-depth conversations.
1.6 Preview own postings	See a posting as it will appear in the discussion before committing to posting it.	Very useful when people are not confident with written text, with the community's main language, or with the process of posting.

The system and infrastructure provided in the workplace can often drive the methods used for social learning. For example, in terms of anytime connections, companies may use Microsoft Outlook for personal information management (contacts, email, calendaring, file sharing) while others support Google (Gmail, Google +, Google drive). Either method can be applied to a PLN. Likewise; there are various tools that serve the same purpose, such as RSS feeds for aggregating web resources including Feedly and Google Reader. Methods, tools and applications are in a constant state of development and the professional must actively seek them out to achieve the desired future state for their personal learning network.

Sustainability:

The dynamic nature of the web requires an agile approach to sustaining personal learning networks. The learner must actively participate and contribute to the social learning process through seeking out new connections and tools, mining resources for new knowledge as well as adding to the knowledge base. This includes having an understanding of AEC industry goals as well as evolving nature of the web.

The nature of the web itself is changing and its development is being explained in terms of ‘real time’ and incorporating a diverse grouping of functionalities and uses. According to Pearltrees developer and web visionary, Patrice Lamothe, its development is influenced by web technologies, tools and usage however the decentralized nature and infinite diversity of the web makes its future state nearly impossible to envision. He points to the founding principles of the web as the only ideas that will allow us to model its activities and synthesized them into three objectives:

1) *Allow anyone to access any type of document*
2) *Allow everyone to organize the entire collection of documents.*
3) *Allow everyone to disseminate their own documents*

The technologies, products and uses originated in the first and second phases will not disappear. On the contrary, the next phase will combine the three principles that are the basis of the web's history and originality: each user will be a spectator, a creator and an organizer. The Web will thus become for everyone what it once was for only a happy few: a medium that is complete, democratic and democratized. (Lamothe 2010)

The AEC industry goals for collaboration toward integrated design practices are in line with the development of the web. The key collaboration issues are coordination of workflow, sharing of artifacts and limitations due to discipline usage and data integration. There has been a lengthy evolution of coordination efforts from the 'traditional' interdisciplinary 2D approach to a 'platform' model-based (BIM) collaboration approach requiring data compatability between disciplines. The 'open' BIM approach allows each discipline to utilize their own software, to have data ownership and workflow transparency. The goal of an open BIM network is open collaboration for better coordinated projects. A primary goal of the buildingSMART alliance, the open BIM network promotes a universal approach to the collaborative design, realization and operation of buildings based upon open standards and workflows (NIBS 2013).

According to the Pike Research report (InfraUSA 2012), the key challenges facing the AEC industry when implementing BIM toward the realization of integrated design practices are resistance to change, investment in training and redefining roles. These challenges reflect those identified by the Delphi survey expert panel in their recommendations for developing personal learning networks for professional development in the industry and the goals outline by the AIA knowledge community for integrated desing practice. While the AEC industry is evolving rather slowly, the fact that they have set clear goals and learning outcomes provides each discipline, organization and industry professionals with a common directive. This serves the third goal outlined by the researcher;

Empower the professional to harness their own professional development through clear articulation of industry and individual learning goals and specific learning outcomes and backed by organizational commitment and support.

Each discipline, organization and industry professional need to take the initiative to reach the objectives outlined by the AEC industry. The researcher believes that this can most readily be achieved through self-drected learning and utilization of personal learning networks for professional development. The Professional Development Activity Diagram for the AEC Industry developed by the researcher is an important tool in terms metacognition. Having an overview of the domains of influence on the learner's social learning model provides the awareness and understanding necessary to develop learning objectives. Sustainable self-directed learning requires motivation and direction toward learning outcomes. The AEC industry has provided the pressure and direction needed and the web is providing the vehicle for collaboration and knowledge sharing. Sustaining a personal learning network requires that the industry professional keep a finger on the pulse of their social learning network.

5.4. CONCLUSION

Through literature review and the Delphi Study, the researcher has determined that personal learning networks have the potential to meet the architecture and design industry's need for a knowledge-sharing venue that facilitates professional development and that can reach the multifaceted participants of the integrated design movement. It requires that the individual actualize and manage their own professional development by building upon existing connections and tools. It is an agile framework that adapts to the rapid changes in technology, the industry and the individual learner.

Foremost, the venue encourages broad participation by engaging the practitioners through relevant and beneficial topics to their areas of interest by providing information and learning opportunities and creating opportunities for engagement. The function of the venue allows for a community of practice to freely emerge, supporting remote global teams and partnerships. As an interactive open and inclusive social network it allows for participants to share methods of practice and collaborate on projects, to build trust and to share lessons learned, or even to find new job opportunities. As a repository of knowledge, stories of practice and artifacts are readily accessible and understandable by all stakeholders. A formative evaluation of personal learning networks for professional development in the AEC industry paves the way for stakeholders to lead the evolution of a technology-supported community of practice as a catalyst for discipline-wide realization of integrated design practices.

This work will provide the architecture and design industry with an agile model for professional development which industry leaders have had a hand in crafting. As a formative evaluation, this research accomplishes the planning stage in the web development process; engagement with the user, the needs assessment and presentation of recommendations. The goals of the AIA knowledge community for integrated design practices are in line with the recommendations made by the Delphi expert panel.

The researcher identified three requirements and provided implementation strategies for each in the development of personal learning networks for professional development in the industry:

Ideation:

As a learner-centric model, the process of implementing a personal learning network begins with the learning professional and what is required to reach their learning objects within the greater context of the architecture and design icommunity of practice.

The Activity Diagram is an important tool in terms metacognition. Having an overview of the learner's social learning model provides the awareness and understanding necessary to develop learning objectives.

- Identifying learning objectives will provide direction for implementing the personal learning network allowing the learner to begin to conceptualize the future state of their PLN.
- Each learning objective requires tools, connections and resources be identified toward learning outcomes encouraging participation in the social learning process.
- Since the disciplines currently are somewhat insular, the industry professional needs to make an effort to share knowledge and artifacts within the bounds of a project as well as to cultivate the greater community of practice.

This meets the first goal to *Cultivate social networking and knowledge sharing at the project level and within the industry to facilitate social learning within the context of the job.*

Management:

Once the learning objectives are understood the learner can refer to the activity diagram and begin to identify what is required to meet their own learning goals as they relate to the goals of the AEC industry.

The PLN Framework provides common ground for industry professionals to use as a starting point in determining the important connection categories and factors needed for their personal learning networks.

- The management of the PLN is essential for the learner to have an awareness and understanding of their own thought process and to maintain control of their social learning model.
- Organizing the PLN according to connections, resources and topics within a single venue provides the learner with a dynamic and effective platform for information management.
- Management is a continual effort yet once a PLN is initiated it can be developed through the social learning process.

This will achieve the second goal to *Provide the professional with a single venue capable of filtering quality information to better facilitate learning and knowledge sharing in a timely manner.*

Development & Sustainability:

Once the industry professional has created a personal learning network and established an understanding of how to manage their social learning model they can begin to develop and maintain it.

PLN Application considers the management of the PLN harnessing current tools for information management, social networking and knowledge building.

- The application of a personal learning network for professional development requires harnessing current tools for information management, social networking and knowledge building as well as the overall management of the personal learning network to sustain it.
- This is the most dynamic of the three elements and will change dependent upon the individual's preferences, learning objectives and the latest and greatest web 2.0 tools and resources available requiring an agile and adaptive approach.
- While the AEC industry is evolving rather slowly, the fact that they have set clear goals and learning outcomes provides each discipline, organization and industry professionals with a common directive.
- The learner must actively participate and contribute to the social learning process through seeking out new connections and tools, mining resources for new knowledge as well as adding to the knowledge base.

This serves the third goal to *Empower the professional to harness their own professional development through clear articulation of industry and individual learning goals and specific learning outcomes and backed by organizational commitment and support.*

The findings pave the way for the architecture and design community to engage in developing personal learning networks for professional development and through adoption could result in the development of social networking tools specific to the industry. The projected outcome is a discipline-wide adoption of integrated design practices and the development of a knowledge base for the industry.

5.4.1. Limitations

Emergent Topic & Developing Research Methodologies:

The overarching limitation to this formative evaluation could be argued to be that it is an emergent topic with an innovative solution based upon new literature and developing methodologies. The researcher actively sought research methods that were aligned with the intent of the study, the goal for integrated and collaborative practices. This was accomplished by actively engaging the community of practice in the development of an innovative solution; the Delphi survey method is used for innovative business forecasting and the formative evaluation and user-centered design method is used by the HCI field to advance user interfaces toward an effective solution.

As a new area of research, the understanding and scientific analysis of personal learning networks is limited. While the PLN model is based in a Grounded Theory critical analysis of literature of personal learning environments from over 100 publications, and analyzed through an Activity Theory lens (Attwell, et al. 2011), comparative studies could provide a greater context for interpretation. Similarly, while the field of HCI grounds much of their activity-based computing work on Activity Theory (Carroll, 2011), it is a relatively new area of inquiry requiring further reductionist contributions to advance the field. As an activity centric human based system, an ideal does not exist which requires a customized solution (Kaptelinin & Nardi 2012). As such, this work follows the constructs of Activity Theory as it relates to personal learning networks with the intent of contributing a customized applied perspective to the HCI

body of knowledge. Further research of the use of Activity Theory as a model for self-directed computer-supported learning and the influences of external factors would be beneficial to confirm the findings.

The Delphi survey method is an innovative survey tool used to engage experts in finding an innovative solution where none currently exists. Typically, it is used within an organization as opposed to an interdisciplinary group. While the expert panel met the requirements in terms of shared expertise and goals, it would benefit other communities of practice, within and outside the field of architecture and design to engage in Delphi survey's to confirm the effectiveness of the method toward interdisciplinary innovations. In terms of this study, it would be beneficial to conduct the survey again with another expert panel for comparison. The difficulty in obtaining consensus in the Any-Time Connection category may be due to the composition of the expert panel in terms of the area of expertise or the type of work the panelist perform. As the most dynamic connection type, this could also be attributed to developing nature of social media.

Social Media:

An important limitation for consideration is the constantly evolving realm of the web. The results of this research are a snapshot in time with the understanding that it is a rapidly evolving area. A key element of the study is social networking. Web 2.0 and the advent of social networking are in its formative years in terms of technology and its use. There are vast array of applications and media platforms that continue to evolve or be abandoned based upon their success. There is a wide spectrum of adoption and use of technologies and social media by individuals depending on age, necessity and interest. The web itself is developing into a heterogeneous amalgamation of functionalities and uses that is being dubbed Web 3.0. This requires that any model or application remain agile and that the learner continually adapt to the new web landscape.

The Workplace:

In order for a personal learning network to be an effective tool for professional development, the researcher has determined that a learner is influenced by external domains including their own workplace. The individual's workplace presents potential limitations depending on the level of support in terms of technology and professional development. While most organizations are supportive of self-directed learning and professional development, there may not be initial understanding or support for platforms and tools needed for developing PLN's. For example, a practice may not support a specific information platform such as Google to consolidate contacts, calendaring, email and file sharing. Similarly, a practice determined to protect their knowledge may not be supportive of sharing artifacts or of collaborative BIM platforms. However, the current trend is a reduction in corporate training and a move to e-learning (Dagada 2004), opening up the possibility for more job support for self-directed technology-supported learning opportunities. With the new e-learning professional development paradigm, the clear direction from the AIA community of practice and the grassroots efforts of the professional, these boundaries have the potential to erode over time.

The learning professional:

Being a Professional Learner is becoming more and more prevalent as individuals are now expected to be responsible for their own professional development and career path. The researcher determined that given the challenges and dynamic nature of the external factors involved in using technologies for collaborative learning the industry, the industry professional would be best served by taking responsibility for their own professional development. These learners may have challenges with self-directed learning in terms of understanding what is required or even individual issues such as basic motivation or lack of leadership support. There are barriers for success of a PLN

that lie with the individual professional and the challenges they may face with self-directed learning, including:

- Choosing not to learn or make the connections required
- Choosing the wrong connections or resources
- Not effectively prioritizing learning needs
- Not using correct methods to optimize learning
- Not effectively managing learning
- Not effectively learning material

(Robotham 1995)

PLN's are developed and managed by an individual to meet their needs. These barriers to individual learning challenges apply to all forms of learning and, with the exception of an individual who chooses not to learn, can be balanced by activating and effectively managing ones PLN. Barriers to an individual's ability to develop and managing their PLN may be attributed to a lack of inclination toward sources that challenge the individuals world view or a lack of apparent means or tools to connect as desired. The foundation of the PLN model is connections. These connections and the methods used to make them do not necessarily require extensive use of social networking tools however it would limit the extent of the potential connections and resources available. The PLN for professional with limited technology use would begin with the same framework and identify areas where they could apply technology and tools to maximize their learning potential. Potential barriers or limitations to the PLN itself, such as changing management methods or online application tools are mitigated by the agile quality of a PLN and the ability for an individual to readapt their learning network to suit.

The future of learning:

Personal learning networks and their effectiveness for professional development for adults could benefit from comparative analysis with emerging research surrounding self-organizing learning environments and engaged online learning. Educational technology researcher, Dr. Minjuan Wang, has developed Cybergogy as an educational approach that combines pedagogy and andragogy to better enable self-directed and collaborative online learning (Wang 2006). This model systematically combines the critical learning environment domains of cognitive, emotive and social elements into the learning system to actively engage the learners in the learning process toward improved learning outcomes. SOLE (Self-Organized Learning Environments) research (Sugata 2013) indicates that, in addition to the fact that learning is an emergent phenomena that occurs when given access to the internet and collaboration with peers, the state of knowledge itself has radically changed. No longer is it necessary for a learner to amass knowledge but instead they need to know how to find knowledge.

The effectiveness of the proposed PLN Model:

As a formative evaluation contributing to the planning phase of implementation, the effectiveness of the proposed PLN model for professional development is not evaluated. Validation of this research was limited to the development of the proposed PLN framework and the required connections and factors involved in social learning within the industry. Further research is required to determine the effectiveness of the PLN model. Specifically, the researcher seeks to engage industry professionals representative of the AEC industry to determine the effectiveness of the proposed strategy. By introducing select participants to personal learning networks and engaging them in implementation of the PLN model, the researcher can identify affordances in the perceived and actual design of the method. Through a HCI user-centered design approach, industry representatives can test the implementation of the PLN model to determine potential barriers and success. Through this iterative process, the PLN model

can evolve, be refined and validated for broad implementation. This effort would produce artifacts and a road map, including representative visual diagrams of PLN's and lesson's learned, that industry professionals can use as a basis for developing their own PLN's.

5.4.2. Continuance

As a formative evaluation, this research serves the planning phase of the development process. The continuation of this research effort is necessary to realize implementation of personal learning networks for professional development in the industry. This requires engagement with industry leadership in terms of providing the necessary support and guidance as well as further engagement with industry professionals to ensure the usability of the proposed PLN model.

Engaging AEC leadership and the industry professional:

As a user-centered designed self-directed learning initiative, the overarching goal is to provide guidance the AEC industry professional. The researcher will seek funding to engage in an interactive design process with select professionals to assess the effectiveness of the proposed PLN model over period of 6 months. Through this effort, the researcher will build a library of lessons learned and artifacts including PLN models developed by the different disciplines within the AEC industry. The researcher will develop curriculum and instructional tools including artifacts and recommendations from the community of practice for use by industry professionals in developing personal learning networks.

Based upon the results of this study, the researcher has determined there are boundaries to implementation that exist beyond the control of the industry professional that need to be addressed at the leadership level. While an industry professional can immediately engage in self-directed learning activities utilizing personal learning

networks, there are boundaries that exist that will make the overarching goal for adoption of integrated design practices difficult to achieve. These external influences are mostly beyond the individuals control and are due to the boundaries between groups. In the case of the AEC industry these groups could include a project team, a discipline, a practice or an organization. It is a time of collaborative potential and this issue is one that is being actively addressed in business world. With evidence indicating that companies that engage in boundary spanning collaboration achieve bottom-line success, the researcher has determined that the lessons learned surrounding the Nexus Effect can be applied to the future research effort (Ernst, et al. 2011). By engaging the AIA organization and those in leadership roles in the AEC industry, the boundaries between groups that prevent collaborative successes can be dismantled.

Boundary spanning leadership and the resulting ideal state of the Nexus Effect is a strategy developed by the Center for Creative Leadership (CCL) (Ernst, et al. 2011). This groundbreaking work was derived from a decade of case studies and research that indicate its effectiveness as a means for facilitating collaborative learning and virtual teams between groups. As interconnected as our world has become, human relationships are defined by boundaries. These boundaries exist as individuals and as groups across demographics, regions and organizations as a psychological safety mechanism. Boundaries will continue exist to maintain protection and defined purpose despite the challenge to work more collaboratively.

The ability to span boundaries towards a common goal requires an understanding of the effects of boundaries and how leaders can work to create synergies between groups towards a nexus of collaboration. In brief, this can be achieved by leadership in six practices; *Buffering, Connecting, Mobilizing, Weaving and Transforming*. Leadership is required to employ these practices in order to provide direction, alignment and commitment toward a shared understanding of goals, coordination of resources and a commitment toward collective success. The first step involves engaging the individual in understanding the parameters of boundaries and that they have the opportunity to connect, lead, influence and change the nature of their boundaries. The managing of

boundaries is addressed in terms of *Buffering* and the necessity for safety within groups through the protection and flow of some but not all resources across boundaries facilitating knowledge sharing. The strategy requires an appreciation of the human need to be an individual with the drive to belong to a greater group through *Connecting*. By forging common ground between groups, people can suspend boundaries and build trust toward *Mobilizing* an intergroup community. This allows for the discovery of new frontiers and the *Weaving,* or interlacing of boundaries toward group interdependence, and *Transforming*, enabling the cross cutting of boundaries and reinvention toward innovation or the Nexus Effect (Ernst, et al. 2011). This business perspective on boundary spanning provides a proven example of how leadership in the industry can support self-directed learning and pave the way for integrated practices to take hold.

The boundaries that exist within the industry can also be harnessed as a potential means of driving new ideas through the concept of the Adjacent Possible Theory. Originally conceived by Stuart Kauffman to argue how innovation often is generated by new associations and combinations of existing ideas, Steven Johnson developed the concept to explain where good ideas come from;

"The adjacent possible is a kind of shadow future, hovering on the edges of the present state of things, a map of all the ways in which the present can reinvent itself. The strange and beautiful truth about the adjacent possible is that its boundaries grow as you explore them. Each new combination opens up the possibility of other new combinations." (Johnson 2009)

With an understanding of boundaries and what is truly necessary for protection as well as their value as potential frontiers, industry leaders and professionals can begin to push their limits toward building new ideas and innovative solutions for the AEC industry as a whole.

The future of professional development in the AEC industry:

We are in the midst of a learning paradigm shift due to the exponential changes in technology and knowledge that are taking place. The future of learning is envisioned to be extraordinarily different then it has been for the past several generations. Thought leaders indicate that we need to reframe our understanding of learning and human development, what essential skills are required and to provide new frameworks for schools and organizations. John Moravec is one such leader who is exposing the challenges and benefits of the 21st century worker and providing a vision for how we must adapt to succeed in what he calls the Knowmad Society.

The Knowmad Society (is) the future of learning, work, and how we relate with each other in a world driven by accelerating change, value networks, and the rise of Knowmads (or) knowledge workers: Creative, imaginative, and innovative people who can work with almost anybody, anytime and anywhere. (Moravec 2013).

The future is uncertain however the Knowmad Society approach provides some insight for professional learners in terms of understanding the challenges opportunities that may arise. By 2020, they project that almost half of the Western workforce will be *knomadic.* This represents a massive shift for a professional who has traditionally been situated in static top-down organizational relationships with job responsibilities being dictated by others. The new knowledge worker will be able to harness the advanced information and communication technology to work beyond existing organizational and geographic boundaries by leveraging social media connections. The new knowledge worker will be valued for their ability to navigate and acquire knowledge and will be responsible for designing their own work and their own futures.

This research supports the vision outlined by John Moravec by putting the responsibility for professional development in the hands of the industry professional. However, while the learning goals for the industry have clearly been articulated, there may be a lack of understanding and support for the self-directed learner from industry leadership. The

researcher has determined that in order for the learner to succeed in the future additional infrastructure is required.

Ideally, PLN information, technological support and guidance would be provided at both the professional organization level and at the workplace. This includes providing the industry professional with information about developing and managing PLN's as well as recommendations for professional and resource connections to ensure quality. Having a mentor or guide that can provide individual support and feedback within the office or virtually through an organization is key to the success of any new learning endeavor especially one that requires that it continually evolve to meet the needs of the learning professional during this time of technological advancement. Given that the AIA has set the goals and the stage for integrated design practices and has developed interactive knowledge communities, it would be appropriate for the organization to provide this support to the industry leadership and the individual professional. The researcher recommends that infrastructure be put in place to achieve the AIA goals through dedicated PLN education and a learning support network as well as through a single collaborative knowledge management platform.

The knowledge management aspect is perhaps the most complex of the challenges that the industry will face in the future in terms of filtering quality and proprietary information especially with the move to open source and data management. Businesses utilize data management companies such as SAS, one of the world's largest software companies, to manage and store data and help with decision-making (SAS 2014). Big data management systems, such as Hadoop, have provided a means for the collection and storage of that information. Big data is the term used to describe the exponential growth and access to data. The filtering and managing of data is critical for it to be valuable for the industry professional. Cloud software can provide filtering and management creating a trusted knowledge base for the profession that is non-proprietary and accessible to everyone. Putting data management infrastructure in place to support the industry is a necessity for knowledge sharing and the future of leaning and integrated practices in the industry.

Currently, it is up to the individual to both find and to determine whether their connections and resources are of quality and it will likely continue to be necessary in the future. This need has been recognized and there are developments in the area of artificial intelligence including adaptive informational filtering research. The application of this work is soon to provide user-based knowledge filtering geared to the user's profile and activity. It will retrieve relevant information and evolve over time by extending the search to include parallel terms and ideas as well as adapt to the users changing interests (AI 2014). The application of customized and intelligent information filtering is a requirement for the individual professional to successfully manage their PLN in the future.

Assessment of professional development is necessary for use by the individual as well as leadership to determine success. By identifying goals and leaning outcomes coupled with an ai learning feedback mechanism that provides information about PLN activities, the learner can identify those personal and resource connections that are of value, the amount of time spent on activities and next steps for professional development. As a mobile application, interactive learning feedback would provide the learner with tips and tools to take advantage of learning opportunities during the course of the work day.

The dissemination of this new self-directed professional development model must be initiated at the professional organization level as a means to both achieve the goals of the industry as well as to ensure that the industry professional can succeed in the future. This education can best be achieved by developing a networked strategy for educating the industry professional at the national, regional and local levels through conferences, webinars and meetings. The leaders in the field can be trained in boundary spanning leadership and the Nexus Effect, a strategy developed by the Center for Creative Leadership (CCL) (Ernst, et al. 2011), in support of the effort.

Then, the leaders develop their own PLN's and then through membership engagement at the regional and local level, can provide workshops and guidance to the industry professional. Providing a support network, both online and in person, is necessary to ensure that the industry professional has someone that they can contact for individual support in developing and managing their PLN, navigating tools and software and providing guidance in the changing professional landscape.

Ideally, the industries professional development infrastructure will be situated in a common platform. The researcher envisions that a single platform could be developed to provide from one or an amalgamation of several existing successful knowledge sharing platforms. The learner requires a non-proprietary knowledge base that supports continued professional development. An open source cloud-based software knowledge management system is required to allow for a shared location that provides big data management, privacy levels, smart filtering and learning assessment tools.

The learner requires a means to establish and visualize their connections and resources. The Pearltrees application serves as a framework for how the vast web resources can be organized and shared in a diagrammatic and logical manner. Utilizing their team approach, the various knowledge communities and project teams could share, collaborate and store their resources within the boundaries required. Those in leadership positions could facilitate and provide guidance to the teams as required. Additionally, the learner requires the ability to make and manage professional connections, to have a dialog with them and the ability to collaborate on project artifacts. Google has a platform of interactive products that provide the means for social learning supporting collaboration through synchronization services, knowledge sharing and communities of practice.

This platform would provide a single venue for the professional to engage in learning specific to the industry goals while also participating in individual communities of practice related to their current job. A cloud-based knowledge management system with ai applied filtering would provide the learner with access to the knowledge base of the

profession specific to their needs while maintaining necessary proprietary industry limitations. Access to the various knowledge communities would provide meaningful connections and learning opportunities in a trusted environment allowing for the bridging of boundaries and potential innovation.

Additionally, there needs to be ongoing support at the professional organization level through dedicated professional development personnel that can be reached by phone or online chat tools by the learner. Those in leadership positions in the workplace will need to provide support to their employees in terms of providing appropriate technology and the time and ability to engage in PLN's and knowledge sharing toward the overarching goals of the industry. By example of the leadership and a networked approach to the dissemination of knowledge, the industry can more readily and quickly adapt to a new professional development model as required for jobs of the future.

AIA Professional Development Charter:

Given that the AIA has set the goals for integrated design practices, it would be most effective it the organization developed a professional development charter to achieve them. They currently support professional development initiatives including interactive knowledge communities and could extend this effort to include PLN's. The dissemination of this new self-directed professional development model is best initiated at the professional organization level as a means to both achieve the goals of the industry as well as to ensure that the industry professional can succeed in the future. Industry leaders have provided a directive for integrated design practices however these overarching goals need the support of the leadership at the workplace so that they can be applied as specific learning objectives in the context of the particular job. As such, the researcher believes that infrastructure needs to be put in place to achieve these goals through training at the leadership level in boundary spanning leadership skills and PLN Development backed by a learning support network and knowledge base at the organizational level.

Boundary Spanning Leadership:

- Based upon the results of this study, I have identified that there are significant boundaries to effectively achieve the desired state of integrated design practices; some are necessary to maintain security and purpose, however many are not.
- Boundary spanning leadership is a strategy developed by the Center for Creative Leadership (CCL) as a means for facilitating collaborative learning and virtual teams between groups with evidence that companies that engage in boundary spanning collaboration achieve bottom-line success.
- By engaging the AIA organization and those in leadership roles in the AEC industry, unnecessary boundaries between groups that prevent collaborative successes can be challenged.
- This business perspective on boundary spanning provides a proven example of how leadership in the industry can support self-directed learning and pave the way for integrated practices to take hold.

PLN Development:

- By example of the leadership developing their own PLN's and a networked approach to the dissemination of knowledge, the industry can more readily and quickly adapt to a new professional development model as required for jobs of the future.
- Those in leadership positions in the workplace will need to provide support to their employees in terms of providing appropriate technology and the time and ability to engage in PLN's and knowledge sharing toward the overarching goals of the industry.
- This includes providing the industry professional with information about developing and managing PLN's as well as recommendations for professional and resource connections to ensure quality.

- This can best be achieved by developing a networked strategy for educating the industry professional at the national, regional and local levels through conferences, webinars and meetings.
- Having a mentor or guide that can provide individual support and feedback within the office or virtually through an organization is key to the success of any new learning endeavor especially one that requires that it continually evolve to meet the needs of the learning professional during this time of technological advancement.

Knowledge Base:

- The knowledge management aspect is perhaps the most complex of the challenges that the industry will face in the future in terms of filtering quality and proprietary information especially with the move to open source and data management.
- Businesses utilize data management companies such as SAS, one of the world's largest software companies, to manage and store data and help with decision-making including Big data management systems, such as Hadoop, which have provided a means for the collection and storage of that information.
- Cloud software can provide filtering and management creating a trusted knowledge base for the profession that is non-proprietary and accessible to everyone.
- Putting data management infrastructure in place to support the industry is a necessity for knowledge sharing and the future of leaning and integrated practices in the industry.
- Currently, it is up to the individual to both find and to determine whether their connections and resources are of quality and it will likely continue to be necessary in the future.
- This need has been recognized and there are developments in the area of artificial intelligence including adaptive informational filtering research.

- The application of this work is soon to provide user-based knowledge filtering geared to the user's profile and activity.
- It will retrieve relevant information and evolve over time by extending the search to include parallel terms and ideas as well as adapt to the users changing interests (AI 2014).
- The application of customized and intelligent information filtering is a requirement for the individual professional to successfully manage their PLN in the future.

Learning Assessment:

- Assessment of professional development is necessary for use by the individual as well as leadership to determine success.
- By identifying goals and leaning outcomes coupled with an ai learning feedback mechanism that provides information about PLN activities, the learner can identify those personal and resource connections that are of value, the amount of time spent on activities and next steps for professional development.
- As a mobile application, interactive learning feedback could provide the learner with tips and tools to take advantage of learning opportunities during the course of the work day.

Open source/ Cloud-based Platform:

- An open source cloud-based software knowledge management system is required to allow for a shared location that provides big data management, privacy levels, smart filtering and learning assessment tools.
- This platform would provide a single venue for the professional to engage in learning specific to the industry goals while also participating in individual communities of practice related to their current job.

- A cloud-based knowledge management system with ai applied filtering would provide the learner with access to the knowledge base of the profession specific to their needs while maintaining necessary proprietary industry limitations.
- Access to the various knowledge communities would provide meaningful connections and learning opportunities in a trusted environment allowing for the bridging of boundaries and potential innovation.
- Utilizing these systems team approach, the various knowledge communities and project teams could share, collaborate and store their resources within the boundaries required and those in leadership positions could facilitate and provide guidance to the teams.
- Ideally, the industries professional development infrastructure will be situated in a common platform developed from one or an amalgamation of several existing successful knowledge sharing systems capable of being able to;

    1) harness big data management and smart filtering of the industry knowledge base,

    2) provide learning and assessment feedback tools, and

    3) facilitate a PLN support network for help building and maintain connections toward learning objectives within the community of practice.

Paired with the goals, training and support network provided by industry leaders, this would provide the future ideal state for PLN's for professional development in the industry ultimately leading to the adoption of integrated design practices.

5.4.3. Benefits

The results of this research effort are anticipated to provide a significant foundation for development of personal learning networks for professional development. As a knowledge driven industry, professional organizations have been actively working toward improving professional development and knowledge dissemination. The American Institute of Architects has adopted Integrated Practice as a top emerging issue for the discipline resulting in multiple conferences, publications and professional development seminars. The National Institute of Building Sciences is actively researching the use of Building Information Modeling as an integrated design tool and working to increase the dissemination of knowledge in the industry. These leaders of the integrated design movement are invested in improving the industry and have provided clear learning objectives.

Architecture and design professionals understand that collaboration and knowledge sharing are a required skill set at the project level, within the industry and for the future and are seeking professional development opportunities. The industry professional currently utilizes social media tools for connections and learning. The industry is ripe to harness personal learning networks as a professional development model and potential catalyst for change toward adoption of integrated design practices. In turn, a technology-supported community of professional practice could result in defining and developing best practices and a knowledge base for the profession by drawing upon the knowledge capital of the practice as a whole. The more professionals that use PLN's for professional development will exponentially increase knowledge transfer. This effort could serve as the catalyst required for integrated design practice to take hold in the industry through timely and effective dissemination of knowledge to the discipline.

This body of work also has the potential to contribute to social science, education and human computer interaction research surrounding the use of the Delphi method, social networking for knowledge transfer and personal learning networks for professional development. The subject extends the range of existing research in professional

development from the enterprise level to a discipline-wide level, paving the way for further study of knowledge systems and behavior. As an emergent topic that intersects with the research interests in the field of Human Computer Interaction and Educational Technologies, this study could provide an applied perspective to the body of knowledge.

5.5. Summary

This research suggests that architects, designers and all the stakeholders in the design process can actively engage in the transformation to an integrated design practice through knowledge sharing and in doing so build a knowledge base for the profession. This can be achieved by drawing on the principles of community practice, an essential element of our knowledge economy, and realized through utilization of today's successful electronic social networking tools. As an open activity system, it has the potential to encourage collaboration, learning and innovation between all disciplines invested in the process including traditional stakeholders such as the construction industry, as well as designers of new technologies. This leverages a greater understanding between integrated design practitioners, harnessing their potential and expanding the value provided on projects and for the profession as a whole. By creating an interactive and collaborative network of practice, drawing on the power of social networking tools and collaborative information discovery, integrated design practice could effectively be realized jointly, as a profession. Provided with the guidance and support of industry organizations and leaders, PLN's provide an agile model that that can be applied discipline-wide allowing professionals to use personalized social networking strategies to meet their individual learning goals.

Eventually everything connects – people, ideas, objects. The quality of the connections is the key to quality per se.
-Charles Eames

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APPENDICES

A. IRB approval

B. Letter of Introduction to Participate

C. Delphi Survey Questions

D. Demographics

E. Integrated Design Practice Case Studies

- **The SeeVT Case Study**
- **The Planning Phoebe's Field Case Study**

APPENDIX A: IRB APPROVAL

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, VA 24060
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE: November 28, 2012

TO: James R Jones, Leigh A Lally

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: Social Media for Professional Development in the Design and Construction Industry

IRB NUMBER: **12-843**

Effective November 28, 2012, the Virginia Tech Institution Review Board (IRB) Protocol Reviewer, Brandi Evans, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Exempt, under 45 CFR 46.110 category(ies) 2**
Protocol Approval Date:	**November 28, 2012**
Protocol Expiration Date:	**N/A**
Continuing Review Due Date*:	**N/A**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

APPENDIX B: LETTER OF INTRODUCTION TO PARTICIPATE

Dear bSa Members,

How can bSa members contribute to *Moving the Industry Forward*?

The upcoming **Building Innovation 2013/ building SMART alliance conference, *Integrating BIM: Moving the Industry Forward*,** is an excellent opportunity to expand your knowledge of all things BIM and will provide the big picture of implementing BIM into our daily practice.

Now we need your insight to innovate ways to keep the industry moving forward.

We are seeking experts to participate in developing a professional development strategy for industry professionals as a catalyst for change.

Please consider being on the expert panel of bSa members collaborating on this study.

To participate: https://virginiatech.qualtrics.com/SE/?SID=SV_3Pk8IA2gs7w1PWl

Why bSa members?

The bSa membership holds forward thinking individuals who have a comprehensive perspective of both the challenges and the opportunities of the AEC professional today. Your contribution is valued. The study will be conducted over the next month with the results of the research contributing to the educational sessions at the Building Innovation 2013/ building SMART alliance conference, *Integrating BIM: Moving the Industry Forward.*

Who is doing the study?

This research is being conducted by Leigh Lally at Virginia Tech. She is a doctoral candidate in the College of Architecture + Urban Studies, the President of the bSa VT Interest Group and partner in The BIM Working Group comprised of bSa, IFMA and I2SL. The consortium's research indicates that education of the professional is a significant barrier to BIM being elevated as a common platform for ensuring the future of sustainable energy and environmental performance in the industry.

Instead of depending solely on organizations for the professional education required to remain effective moving forward, Leigh Lally suggests that we can take control of our own professional development as both a stop gap measure and to remain competitive in the future.

As a formative research project, the study will define the basis for the development of effective strategies and communication channels to improve professional development in the industry. Formative research is integral for the development of innovative solutions. Your expertise will assist the researcher in identifying and understanding the specific needs and characteristics of the industry required for Personal Learning Networks (PLN's) to be adopted as an effective professional development strategy.

Thank you in advance for your time and professional expertise.

Please contact Leigh Lally with any questions you might have.

Leigh Lally
Doctoral Candidate, Architecture + Design Research
College of Architecture + Urban Studies
Virginia Tech
Blacksburg, Virginia
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APPENDIX C: DELPHI SURVEY QUESTIONS

Social Media for Professional Development in the Design & Construction Industry

Round 1: Introduction and consent to participate

Informed Consent Form

Introduction

This formative study provides the basis for the development of innovative strategies and connections required to improve professional development in the AEC Industry. Expert input is needed to identify and understand the specific needs and characteristics of the industry required for Personal Learning Networks* (PLN's) to be adopted as an effective professional development strategy:

- Personal Learning Networks (PLN's) are being harnessed for continual learning within the fields of education and organizational development, but can this strategy be successfully applied to the AEC Industry?
- What is the state of professional development and what professional competencies are expected in the AEC Industry?
- There are specific learning factors and connections that contribute to a Personal Learning Network; Are there additional factors that need to be considered within our industry? How should we prioritize these learning factors?

** A Personal Learning Network is a network of professionals with whom you share knowledge and from whom you gain knowledge. It allows the professional to harness social media tools to connect, contribute, converse and request information according to their own personal learning objectives. Currently, Personal Learning Networks are successfully being utilized within the fields of education and organizational learning.*

Procedures

You will be participating in a formative evaluation using the Delphi method. A Delphi survey is achieved through a series of questionnaires and controlled feedback to develop consensus between experts anonymously in innovative areas such as technology where current knowledge does not exist. The scaling method is used to rank factors which need to be considered to achieve the goal. The survey is conducted in three or more rounds until consensus can be gained within a group of a dozen or so experts;

1. The first round includes an introduction to the study with a request for informed consent and demographic information about the expert. The survey portion provides for a contextual needs assessment followed by identification and categorization of the factors being evaluated. (Approx. 10 minutes)

2. Round two provides for validation of the factors and ensures that the researcher has correctly interpreted the responses. The factors are grouped and ranked by relative importance by each expert with the goal of gaining consensus within the expert panel. (Approx. 5 minutes)

3. The third round seeks to gain consensus within the group. Should consensus be gained at this stage then the survey is complete. (Approx. 5 minutes)

Additional rounds are conducted until consensus is gained (not to exceed 6 rounds). Consensus is gaged using Kendall's W coefficient of concordance. The value of W ranges from 0 to 1 with 0 indicating no consensus and 1 indicating a perfect consensus. A W value of .07 or greater indicates strong agreement.

This questionnaire will be conducted with an on-line Qualtrics-created survey over the course of several weeks.

Risks/Discomforts

Risks are minimal for involvement in this study. However, while anonymous, you may feel emotionally uneasy if it is difficult to come to a consensus with the other experts.

Benefits

There are no direct benefits for participants. However, it is hoped that through your participation, the research will lead to the development of innovative professional development methods in the industry.

Confidentiality

All data obtained from participants will be kept confidential and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). All questionnaires will be concealed, and no one other than then primary investigator and assistant researches listed below will have access to them. The data collected will be stored in the HIPPA-compliant, Qualtrics-secure database until it has been deleted by the primary investigator.

Compensation

There is no financial compensation for participation in this study however your contribution will serve the industry as a whole.

Participation

Participation in this research study is completely voluntary. You have the right to withdraw at anytime or refuse to participate entirely without jeopardy to your position. If you desire to withdraw, please close your Internet browser and notify the principal investigator at this email: laleigh@vt.edu

Questions about the Research

If you have questions regarding this study, you may contact the researcher Leigh Lally, Doctoral Candidate and Co-Principal Investigator, at laleigh@vt.edu, 540-231-4679.

Questions about your Rights as Research Participants

If you have questions you do not feel comfortable asking the researcher, you may contact her academic advisor and Principal Investigator in the School of Architecture, Professor Jim Jones at jajone10@vt.edu, (540) 231-7647. Or contact the director of the Virginia Tech Institutional Review Board, Dr. David Moore @ moored@vt.edu, (540) 231-4991.

.

I have read, understood, and printed a copy of the above consent form and desire of my own free will to participate in this study.

- ○ Yes
- ○ No

Round 1: Participant Profile

What is your area of expertise in the Architecture, Engineering & Construction (AEC) Industry?

- Architecture/ Design
- Engineering
- Construction
- Facilities Management/ Owner
- Other

How many years of experience do you have in the industry?

- 0-5
- 6-10
- 11-20
- 21-25
- 26-30
- 31-35
- 36-40
- 40+

What is the highest level of education that you have completed?

- High School
- Associates degree/ Technical Education
- Bachelor's degree
- Master's degree
- Doctoral degree
- Professional degree

How many years of experience do you have in the industry?

- 0-5
- 6-10
- 11-20
- 21-25
- 26-30
- 31-35
- 36-40
- 40+

What is the highest level of education that you have completed?

- High School
- Associates degree/ Technical Education
- Bachelor's degree
- Master's degree
- Doctoral degree
- Professional degree

How many years of experience do you have in the industry?

- 0-5
- 6-10
- 11-20
- 21-25
- 26-30
- 31-35
- 36-40
- 40+

What is the highest level of education that you have completed?

- High School
- Associates degree/ Technical Education
- Bachelor's degree
- Master's degree
- Doctoral degree
- Professional degree

How many years of experience do you have in the industry?

- 0-5
- 6-10
- 11-20
- 21-25
- 26-30

- 31-35
- 36-40
- 40+

What is the highest level of education that you have completed?

- High School
- Associates degree/ Technical Education
- Bachelor's degree
- Master's degree
- Doctoral degree
- Professional degree

Round 1: Needs Assessment

Evaluate the current state of professional development in the AEC industry.

	Disagree	Undecided	Agree
Industry professionals know what training they require to succeed in the future.			
Industry professionals are provided with adequate professional development opportunities within their organizations.			
Industry professionals depend on annual professional association conferences for professional development.			
Industry professionals are encouraged to take the initiative in determining their own professional development.			
Industry professionals utilize social media such as webinars for professional development.			
Industry professionals utilize regional training offered outside their organizations.			
Industry professionals are satisfied with current training and professional development provided through their work.			
In order to keep current, Industry professionals take the initiative and provide for their own training and professional development outside their organizations.			
The industry needs improved methods for professional development to keep up with the rapid pace of change in the field.			

Consider what defines professional competency.

Rate these professional competencies by importance in the AEC industry.

	Of no importance	Important	Of critical importance
Technical Skills	○	○	○
Cognitive/ Knowledge base	○	○	○
Practice	○	○	○
Communication Skills	○	○	○
Professionalism	○	○	○

What is your familiarity with social media strategies and tools that can be used for professional development?

	Never	Not usually	Undecided	Sometimes	Always
I utilize social media including You Tube and Flickr for on the job training.	○	○	○	○	○
I follow social media including Blogs and Twitter for professional development purposes.	○	○	○	○	○
I contribute to social media by creating content or commenting on others content.	○	○	○	○	○
I use collaborative tools such as Google Docs or Wiki's in my work.	○	○	○	○	○
I use social networks such as Facebook and Linked In to make professional connections.	○	○	○	○	○
I am involved in an on-line community of practice beyond my own workplace including professional associations or project teams.	○	○	○	○	○
I access on-line knowledge communities for professional development.	○	○	○	○	○
I take on-line courses such as webinars for professional development.	○	○	○	○	○
I am a virtual participant in enterprises including commerce, learning and community organizations.	○	○	○	○	○
I know how to find information on-line effectively.	○	○	○	○	○
I am able to synthesize, merge and make succinct the information that I gather.	○	○	○	○	○
I co-create information with other professionals and contribute to a knowledge base.	○	○	○	○	○
I use an on-line knowledge base for professional development.	○	○	○	○	○

Round 1: PLN (Personal Learning Network) Development Factors

What factors are important for the development of a Personal Learning Network (PLN)*?

In the following question you will be sorting the factors into groups and then ranking them in terms of being necessary for professional development in the AEC industry:

1. Sort (drag and drop) the 20 personal learning factors by the type of connection needed.
2. Rank them in order of importance.

**A Personal Learning Network (PLN) is a network of professionals with whom you share knowledge and from whom you gain knowledge. It extends the makeshift learning process into an intentional framework that includes the social capital and connections resulting in sustained professional development. A PLN allows the professional to harness social media tools to connect, contribute, converse and request information according to their own personal learning objectives. Educational research has outlined essential learning factors and connections deemed necessary for the success of a Personal Learning Network.*

Items	REAL-TIME CONNECTIONS: Personally maintained synchronous connections (i.e. phone, IM, skype, conference, meetings)	ANYTIME CONNECTIONS: Personally and socially maintained semi-asynchronous connections (i.e. social networks, twitter, blogs)	RESOURCE CONNECTIONS: Dynamically maintained asynchronous connections (i.e. social bookmarks, articles, knowledge base, podcasts)
Creating a personal Blog or digital portfolio to document learning, activities, and reflections.			
Creating social bookmarks to have access to bookmarked sites and documents from anywhere.			
Collaborating on the development of a resource or knowledge base including sharing tools, techniques and presentations.			
Creating resources for self-reference.			
Creating resources to assist colleagues, team members, and the industry at large.			
Using social networks to make and maintain professional connections.			
Reading news, articles and Blogs.			
Reviewing and critiquing news and articles and Blogs.			
Networking with local professional colleagues.			
Networking with distant professional colleagues.			
Having a visual diagram of personal learning connections as a resource.			
Self-directed learning on a need to know basis.			
Receiving required on the job training.			
Using professional membership connections and knowledge base.			
Working on project teams with professional colleagues.			
Communicating real-time with professional colleagues.			
Following the work of professional colleagues.			
Receiving formal training/ certification.			
Finding and aggregating resources.			
Using collaborative project management tools such as BIM.			

Please add any factors that may not have been listed for potential inclusion in the next round of the survey.

What is your email address?

Your email address is required to continue participating in the study and will only be used by the researcher for the sole purpose of conducting this survey and sharing the results with you. Your input will remain anonymous.

You will soon receive a brief follow-up survey that is focused solely on continued refinement of the above factors. You will be comparing your responses with those of the other experts on the panel. The goal is to develop consensus on the factors and their relative importance for development of an effective Personal Learning Network.

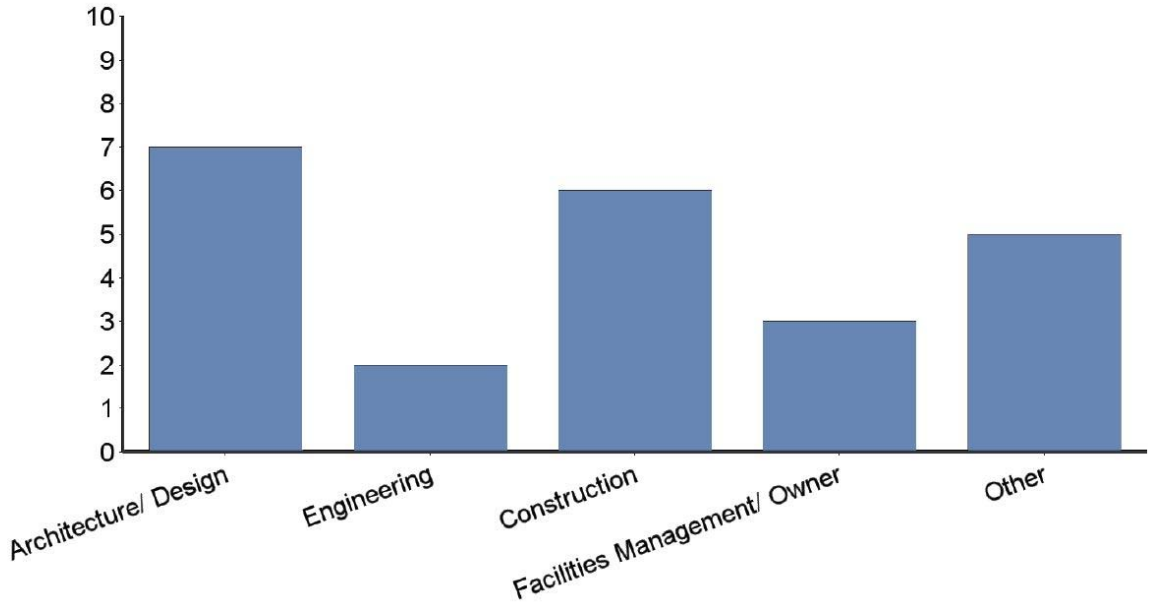
Thank you for your continued time and effort!

Email:

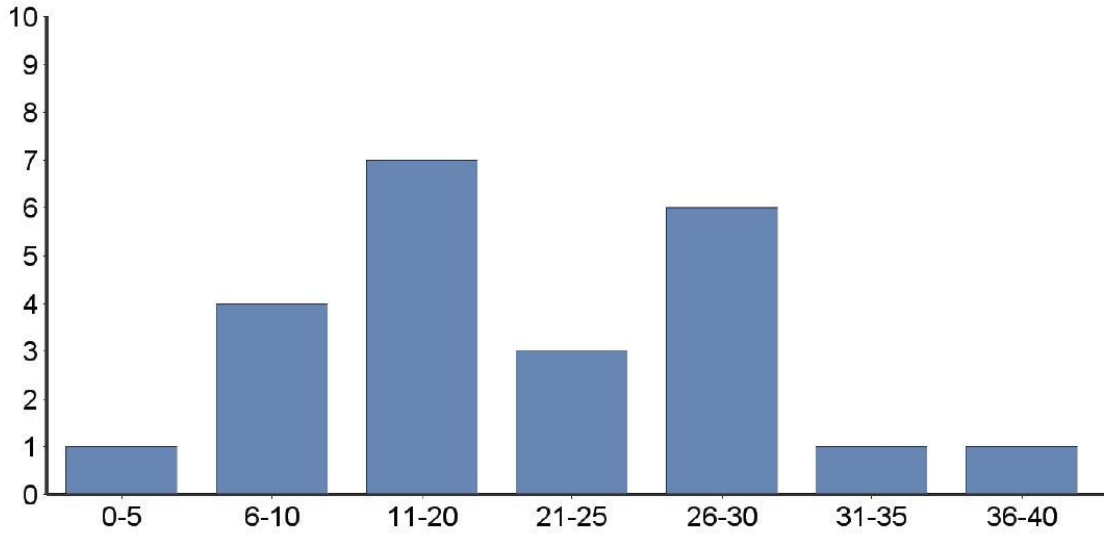
Leigh Lally Doctoral Candidate Architecture + Design Research College of Architecture + Urban Studies Virginia Tech

APPENDIX D: DEMOGRAPHICS

What is your area of expertise in the Architecture, Engineering & Construction (AEC) Industry?



How many years of experience do you have in the industry?



APPENDIX E: INTEGRATED DESIGN PRACTICE CASE STUDIES

The Planning Phoebe's Field™ Case Study:

The researcher had the opportunity to take a unique project oriented course with Mitzi Vernon, an Associate Professor of Industrial Design in the College of Architecture and Urban Studies. In addition to more than 15 years of teaching experience, she holds a Master of Architecture from Virginia Tech and a Master of Science in Engineering from Stanford University. As the principal investigator and originator of the project, Phoebe's Field™, she was awarded two grants from the National Science Foundation, with a third pending, to design a traveling science museum exhibition for middle school aged children about the physics of fields.

By offering the project as a special study course through the Architecture department and the Computer Science department, Mitzi Vernon assembled an interdisciplinary student team to do the preliminary planning phase of the work. Involving commercial and public partners in design, use and evaluation, the advisors and consultants on the project included experts in education technology, science exhibition design, and mechanical and electrical engineering. The team included Virginia Tech faculty from industrial design, architecture, instructional technology and computer science. The project team defined the parameters for the exhibit design and developed concepts as part of a submission for a second phase grant to the NSF to construct an exhibition that would visit six museums across the U.S. over a four year period. This interdisciplinary project team, composed of students, faculty and professionals, created a project plan which highlights multidisciplinary collaboration in the design process.

This workshop-oriented course has been a model for multidisciplinary collaboration encompassing science education, environmental psychology and technology, as well as architectural and industrial design. A year-long endeavor, the researcher worked as one of a 12-member interdisciplinary student team on the development of the exhibition concepts for submission to the NSF while using the experience as a member of an interdisciplinary design team as a case study for my research. The researcher facilitated two surveys, one during the course of the project and one as a project review at the completion of the planning phase, followed by a post-project debriefing. This data has resulted in two publications:

- ‘Planning Phoebe’s Field™, a case study: multidisciplinary collaboration and integrated design practices in the development of a children’s science exhibition’ was published through the American Institute of Architects Case Studies Initiative in March 2007. (Lally, et al. 2007)
- “Planning Phoebe’s Field: an analysis of the characteristics of an effective collaborative student design project” was accepted for presentation in a paper session at the 2007 AERA (American Educational Research Association) conference. (Cennamo, et al. 2007)

The Phoebe's Field™ project story and the project team’s reflections on multidisciplinary collaboration in the design process provide many lessons for both academia and practitioners. The study showed that collaboration was most effective when a team is given a clear set of goals and that inclusion early on in the process was critical for team cohesiveness. Indicative of the challenges of interdisciplinary collaboration, team members were confronted by differing ontology’s, in terms of discourse and modes of operation. Overall, the findings of the case study showed that, given strong leadership, a multidisciplinary team can produce innovative designs through integrated design practices.

The SeeVT Case Study:

In collaborating with the computer science department on the Phoebe’s Field™ project, the researcher met Dr. Scott McCrickard with the Center for Human Computer Interaction. His research involves the use of mobile technologies to enable navigation through ‘location-aware’ notification systems. The researcher began working with Dr. McCrickard and his team of graduate students to develop mobile technology systems, such as PDA’s or smart-phones, for use on the Virginia Tech campus as part of their SeeVT research project.

In 2007, student teams worked with university clients to develop prototypes under the supervision of the graduate students and Dr. McCrickard. The projects included; The Newman Project, a university library wayfinding and information retrieval system; VTAssist, a handheld wayfinding and notification system to assist to students with disabilities; and SeeVTart, an opportunistic art tour system to showcase the universities extensive art collection housed at the Inn, conference and alumni center. The researcher led the design and planning effort on the SeeVTart project and consulted with the team in their development of research initiatives related to integration with the built environment.

As a participant-observer on the project, the researcher facilitated a case study which provided the underpinnings for the submission of papers involving technology and the built environment. This research has resulted in two papers:

- "Setting the stage for community-based tech-ubiquity" was submitted in a call for papers from IEEE Pervasive Computing involving research of ubiquitous computing in an urban environment in January, 2007. It was not accepted, however, peer review provided insight to the differing perspectives of the design and ICT disciplines regarding this subject.
- "Setting the stage for community-based tech-ubiquity in the built environment", submitted for publication in the Design Intelligence technology issue, was accepted and published online in April 2007. (Lally, et al. 2007)

The Center for Human Computer Interaction strives to design with a user-centered multi-stakeholder approach. The research often intersects with that of the college of architecture and urban studies in the design and integration of technology into the built environment.

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