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Title: Organizational Cultural Compatibility of Engineered Wood Products Manufacturers and Building Specifiers in the Pacific Northwest

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Organizations are significantly influenced by corporate cultures of the interacting organizations. Both the construction industry and engineered wood products (EWP) manufacturing industry are generally known for operating in a traditional environment maintaining conservative corporate cultures, which can create friction when they try to interact with a more liberal architectural industry or the specifiers. This study assesses the cultural disparities and communication barriers between specifiers and EWP manufacturers in the Pacific Northwest, obtaining perceptive accounts of each other. The study follows a semi-structured interview protocol to decipher the cultures of companies and professionals from the two industries. The identified cultural characteristics are supported by responses to a questionnaire administered to executive members of each organization being studied. The responses are qualitatively analyzed and consolidated to identify specific patterns of organizational behavior. The study identifies a number of factors that affect the interaction between specifiers and manufacturers, chief among which, is the presence of material distributors as the intermediate party that facilitate the material sourcing process for a project. Many factors are tied to the reason why it is challenging to change from the current

business practices. Low profit margins, lack of engineering and design competency, risk averseness and failure to create direct communication channels with architects are some of the reasons that challenge the manufacturing sector. In addition, learning disparities between the two sectors, the deficit of contemporary EWP knowledge creation and intense competition among manufacturers for EWP market share create difficulties for specifiers to use new EWP products in projects. Consolidated collective organizational behavioral knowledge of this study will benefit EWP manufacturers, specifiers and policy makers alike to close up the gap in communication and improve the cultural compatibility between these two members of the construction value chain.

Organizational Cultural Compatibility of Engineered Wood Products Manufacturers and Building Specifiers in the Pacific Northwest

by
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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Balapity Modarage Shanuka Ruvinath Fernando, Author

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1 Introduction

The construction industry in general is extremely complex due to a multitude of factors; the complexity of resources used, the number of stakeholders involved and their respective interests and the multiple phases of a project lifecycle, to name a few. A building construction project (residential, non-residential or commercial) needs the involvement of multidisciplinary teams consisting of owners, developers, architects, consultants, engineers, contractors, sub-contractors, and suppliers.

In a construction project, structural engineers are responsible for the integrity of buildings, while architects generally consider the visual and functional aspects. Even though architecture and structural engineering are the central technical professions involved in design and material selection in building construction, the influence of other stakeholders can also play a significant role in the choice of material. For instance, the developer and contractors in Sweden tend to be influential actors in the decision process when it comes to material selection for a given building project (Roos et al., 2010).

There are multiple factors influencing choice of building materials: knowledge and experience, common practice in the industry, building type, building codes, example buildings, technological solutions, economic issues and environmental properties (Roos et al. 2008), cost, performance (Bysheim and Nyrud, 2009), and the infrastructure in the design and construction industry (O'Connor et al. 2004). Many of these factors thus explain why concrete and steel are currently the dominant materials used in building construction. The lack of potential alternative materials

with performance that can equal concrete and steel, has resulted in their long-term, strong position in the construction sector.

In this situation, relatively new structural wood products can be seen as a leading competitor to concrete and steel that can potentially proliferate in the global construction sector. Although the environmental performance of wood as a building material is well documented (Gustavsson et al., 2006; Gustavsson and Sathre, 2011; Ruuska and Häkkinen, 2012, 2013, 2014; Pajchrowski et al., 2014), a perception of wood as a material that fails to meet other important critical factors is borne by building material specifiers. This is substantiated by findings that architects and engineers in Canada and the US who were previously reluctant to specify wood, were influenced by examples of good building practice or case studies to change their stance and specify more wood in building projects (Kozak and Cohen, 1997). However, research done in recent times indicates that experts in wood construction have positive views about adoption of wood building systems (Mallo, 2015).

A number of engineered wood products (EWPs) have become accepted in the marketplace. Recently cross laminated timber (CLT), a relatively new product and building system, originally developed in central Europe is now gaining attention in the US multi-family residential and non-residential building markets, particularly in the mid-rise building segment. In the US forest sector, the motivation for new wood products stems from the fact that, North American public forest inventories are increasing in age and density, along with the potential for fire and disease (Wood Design Focus, 2016). An increased penetration of CLT and other structural wood products in the US could therefore offer substantial support to forest sector management efforts. Such growth

could also help revive the declining trend in rural economies in the US that rely on the forest products industry (Podesto and Breneman, 2016).

CLT as a building material and system is in a fledgling stage. Therefore, the use of CLT in buildings is largely dependent on the extent to which US architects and engineers choose them in their projects. The level of awareness about technical and economic aspects of CLT in the architectural and engineering sectors is low in the US and thus acts as a barrier for adoption of CLT in the country (Mallo and Espinoza, 2015). This could also directly affect the development of current and new manufacturing facilities of EWPs. For instance, potential manufacturers of CLT may hesitate to invest in production lines fearing that their output will not be a preferred choice of material specifiers and developers of construction projects. Although the literature does not provide substantial evidence in the US context, developers in Australia tend to be conservative where the majority is looking to reduce risk by investing in projects that use tried and tested material. As a result, there are very few innovators in the Australian construction wood industry due to the risks involved and the problems in obtaining investment funding (Forest and Wood Products, Australia, 2012).

The dynamics in the US construction sector are rapidly changing and so are the attitudes, perceptions, and knowledge level of specifiers and developers with regard to use of wood in construction. Since specifiers with adequate experience and confidence in EWPs are the most likely people to use wood in building projects, the degree of collaboration between specifiers and EWPs suppliers/manufacturers can be a crucial factor in diffusion of knowledge about the products

to the architectural and engineering communities. Because they are relatively new to the market, the use of EWPs such as CLT needs significant cooperation among manufacturers, designers, and builders.

Study Objectives

As more efforts are made by a multitude of stakeholders to introduce new EWPs such as CLT to the US construction industry, it would be imperative for specifiers and EWP manufacturers to be aware of it and be geared for change. In an environment where more collaboration is needed, the organizational and professional, cultural disparities between manufacturers and specifiers may be a significant barrier. Although, a number of related studies have been conducted in Europe, especially in the United Kingdom and Scandinavian countries, a substantial void exists in recent literature assessing the cultural disparities and communication barriers between US specifiers and manufacturers giving a perceptive account of each other.

Therefore, the objectives of this study are to:

- Identify and assess the cultural and communication gaps between EWP manufacturers and specifiers in the US
- Identify the changes required in the US wood construction value chain to enhance collaboration among the members of the value chain, focusing on the perceptional view of EWP manufacturers and specifiers

A study of this sort may also reveal information about additional requirements (changes in industry structure, approach to market, etc.) other than the regulatory requirements, for the use of structural wood products in US buildings.

2 General Background

Wood is a natural material that has been used as a primary building material by humankind throughout history. Solid wood sawn from logs with minor processing is the main form that wood is utilized in building construction. However, the variability in natural composition of wood causes solid wood to be heterogeneous between species, between trees of the same species and even among the pieces from the same tree, in terms of structural properties (FPL, 2010). In order to overcome inhomogeneity of wood and to better utilize in construction, EWPs were developed. With EWPs, the applicability of wood in construction dramatically increased primarily due to increased control over properties of wood material.

The range of EWPs predominantly consist of plywood, oriented strand board, laminated veneer lumber, parallel strand lumber, laminated strand lumber, i-joists and glued-laminated timber (glulam). Of these, glulam to some extent represents a separate class of EWPs called mass timber products (MTP) wherein large solid wood members are produced by laying up lumber that is glued or nailed together. CLT and Nail Laminated Timber (NLT) are more recently introduced products to this category in the North America. Mass timber products offer the possibility of producing structural timbers that are much larger than the trees from which the component lumber was sawn (FPL, 2010). The range of construction applications for MTPs include floor and roof beams and, shear and vertical load bearing walls.

Glulam

Glulam is an EWP consisting of two or more layers of lumber that are glued together with the grain of all layers, which are referred to as laminations, parallel to the length. North American standards permit a maximum lamination thickness of 50 mm, and the thickness of lumber members are typically 25- or 50-mm. Dimensions of glulam members are usually limited by the capabilities of the manufacturing plant and the transportation system (FPL, 2010).

Laminated veneer lumber

Laminated veneer lumber (LVL) is a composite of wood veneers layered and bonded with adhesive that can be made into billets of varying thicknesses and widths. It was developed in response to a need for increased strength and stiffness, good dimensional stability, and low variability in highly engineered structural components (Forest Products Laboratory, 1987). The grain of all veneers are parallel-aligned and hence display strong edge-loading properties. Applications of LVL include headers, beams and flanges for I-joists.

Cross laminated timber

CLT is a massive structural composite panel made from 3 to 9 layers of dimension lumber that are glued together, alternating the direction of their fibers for each layer. The configuration of lumber improves the overall rigidity, stability, and mechanical properties of the panels. CLT elements have an odd number of layers to achieve balanced construction (Mallo and Espinoza, 2015). CLT

can be used as prefabricated walls, floors and roofing elements in a variety of buildings including residential, commercial and public structures.

Nail laminated timber

NLT is a mass timber panel system which can be used for a similar variety of applications which CLT is used for. NLT is produced from dimension lumber stacked on edge and fastened together with nails or dowels. Plywood sheathing is often added to one top side to provide a structural diaphragm. Although it is not widely used in North America, NLT is a popular housing construction material in Germany (Krämer, V., 2001).

2.1 Specifier and manufacturer interactions

Previous research on construction material specification shows that designers are rather conservative by having a suite of products that once used are then used on projects that follow (Mackinder, 1980). Specifically, items with demonstrated reliability are continually used by designers while products associated with failure are dropped. Consideration of items outside the familiar portfolio of products occur when the specifier's familiar products do not offer a solution to a problem. However, the likelihood of them specifying new materials is largely dependent on the extent to which their performance is substantiated by extensive research and whether the materials have a significant advantage over others.

The specifier's norm of using a 'palette of favorite products' (Emmitt, 1997) in the specification process has been found as a barrier against the introduction of new products unfamiliar to the designer. This is especially challenging for manufacturers due to information control procedures used by design/construction organizations to reduce the flow of information between product manufacturers and specifiers with the objective of avoiding information overload. Such gatekeeping procedures screen out marketing communication methods such as direct mailing and cold calls by sales personnel of manufacturers considering the need to study and experiment with unfamiliar materials as unworthy of the time (Emmitt, 1997). Therefore, it becomes clear that there are conscious efforts from building firms to keep the information about new products from reaching the specifier thus, creating 'noise' in the communication process (Figure 1).

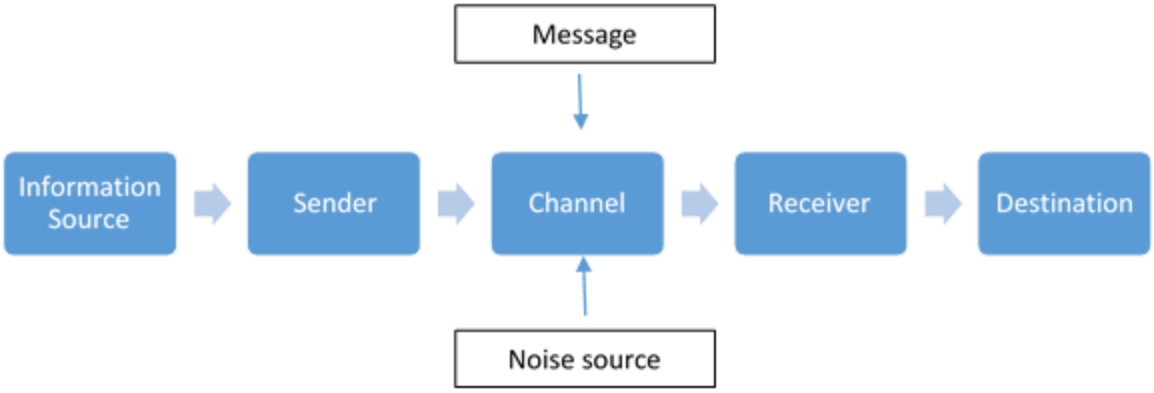

Figure 1. Communication process; Adapted from Shannon and Weaver's (1949) model of communication

In communicating the primary message about construction material to specifiers, a manufacturer has the options of personal selling, advertising, sales promotion, public relations and direct marketing communication. Traditionally, the forest sector suppliers to the construction sector have

been relying on personal selling (Hansen and Juslin, 2011) where maintaining relationships with clients is the main objective. However, with EWPs where the potential customers are not entirely familiar with products, this communication method could be ineffective and less beneficial. For companies venturing into producing MTPs, personal communication can only expect to result in organic growth given most of the products in the category of MTPs are in the initial stages of the product life cycle.

Although distributors of forest products who source and deliver the products are the main link between manufacturers and specifiers, the literature doesn't provide adequate information as to what role distributors play in introducing new products to specifiers. In addition, given the strong presence of distributors as intermediate agents between the manufacturers and specifiers, whether the manufacturers adequately look to educate specifiers and promote the products more directly remains a question that is largely unanswered in the literature.

One of the methods of how design and building professionals come to know about new products is through communication efforts made at sectoral and industry level as opposed to individual efforts by companies to reach specifiers by themselves. This method is particularly important in the forest products sector as a relatively higher number of stakeholders have a common interest of promoting sustainability. In this method, the communication message originates from national, regional or industry level stakeholders such as governments, certification programs and specific industry groups like timber building products groups. In the case of MTPs a valuable form of communicating the product messages can occur at sectoral or industrial level where

communication efforts are made to offer solutions to problems that occur in the building sector. Although there have been efforts made to reach specifiers through sector-to-sector communication efforts between the EWP manufacturing industry and specification industry, there is a substantial void in the literature that inquire the effectiveness of such exercises.

The highly fragmented nature of both the EWP manufacturing sector and construction sector leads to another barrier in communication between the sectors in the operating stages of building projects. As the construction sector is increasingly becoming reliant on IT systems in designing, structural analysis and project management tasks, it is necessary that stakeholders collaborating with them in those tasks be equipped with comparable technology. This is especially necessary when working with MTPs particularly in the prefabrication process where there is a need to share data and information. These automated systems, processes, and equipment have the potential to drastically reduce the time and cost of planning, design, and construction (Shen et al., 2010). In the construction sector, building information models (BIM) that enable the interpretation of data generated by specifiers such as architectural models constructed by computer aided designing platforms have become a key technology in information sharing in heterogeneous environments. When manufacturers use computer numeric control (CNC) machines for fabrication of MTPs, integration and interoperability of manufacturing and architectural models becomes a challenge.

The awareness of EWP manufacturers on the need to adopt such advanced information technologies, particularly small companies that have the potential for MTP manufacturing, has not been properly examined in the US context. Given the wide variety of options in the software and

relevant hardware which can either be off-the-shelf products or customizable products offered by different vendors, it is important that manufacturers obtain information from specifiers in order to decide on the products and systems to be established.

Introduction and adoption of MTPs to construction companies and EWP manufacturing companies require different levels of innovations for the two sectors. Innovations can take place along three main aspects; product innovation, process innovation and business model innovation (Chesbrough, 2007). Although nearly every company understands and practices product and process innovations to varying degrees, the concept of business model innovation is poorly understood (Bucherer, 2012). A business model essentially reflects the complexity of a company by outlining the core elements of the business and their interrelations; i.e., the core business logic of the firm. The core elements of the business model are value proposition, operational model, financial model and customer relations (Bucherer, 2012). As core elements are different from company to company, business models too are different between firms, and thus can be viewed as an asset to the company.

As above mentioned, core elements of a business are not static themselves, the business model is meant to be a dynamic concept that changes or needs to be changed according to the changes taking place in markets, technologies and economics of the firm. With changes in technologies and markets, companies will eventually undertake product and process innovations which in turn require modified value propositions. Thus the resulting process of change in the business model can be defined as business model innovation.

Companies can also decide whether the changes in external and internal aspects of the business should end up in a change in the existing business model. If companies realize that the changes in the said aspects cannot be fully functionalized on the existing platform, they may choose to formulate a new model that accommodates the changes. On the other hand, if the companies sense that the existing business model is in line with the changes occurring in the internal and external factors, they may choose to leverage the current business model to exploit those changes.

In the context of the present study, the changes that occur in the construction material technology, markets, society and economics, the use of MTPs can be perceived in two different ways by the EWP manufacturers and specifiers/ construction companies. In order to capture the differences, and thereby identify which approach for innovation fits best for the two parties, the innovation landscape map (Pisano, 2015) can be adopted. The map places innovation on two dimensions; business model innovation continuum and technological innovation continuum. Depending on the extent to which innovation takes place in technology and in business model, the innovation category is identified.

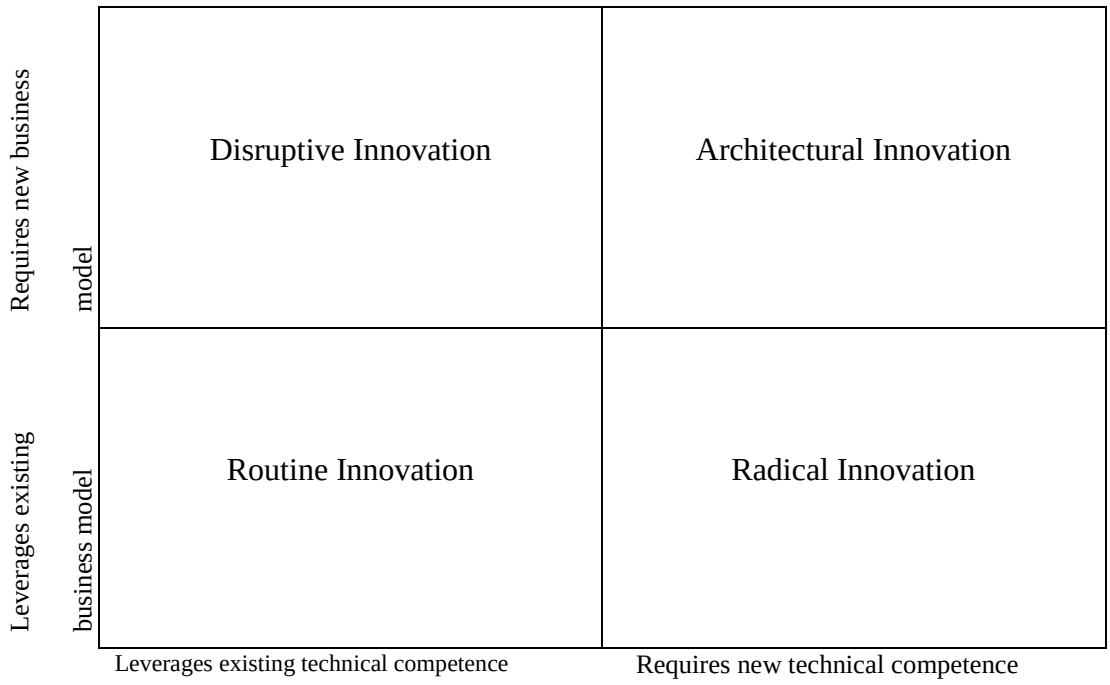

Figure 2. Innovation landscape map; Adapted from Pisano, (2015)

From the perspective of EWP manufacturers, the adoption of MTPs might challenge the existing technological competence depending on the types of products and relevant processes they have. A company manufacturing only glulam may not be as technologically challenged as a plywood manufacturer given the similarity in glulam technology and other MTP technologies. However, the introduction of a product like CLT may present considerable challenges to the existing business model because of the differences in market mechanisms, social dynamics and supply chain operations. Therefore, an adoption of a disruptive innovation strategy may be required for EWP manufacturers venturing into MTP production.

From the perspective of construction professionals, MTPs will offer formidable technical challenges especially for those who have not previously had experience with structural wood construction. Due to the numerous technical specifications associated with each type of MTP, the application of products requires a different set of skills and knowledge than those of conventional building materials. However, working with MTPs may not significantly challenge the existing business models presuming that MTPs will be viewed as yet another new material that specifiers and construction professional are introduced to, and once the technical challenges are overcome, a product that will fit the current business model. This description fits into the radical innovation quadrant.

2.2 Organizational culture of EWP manufacturers and specifiers

In the context of the construction industry, which is characterized by project-based and contractual arrangements, partnering and collaboration between members of the value chain means that organizations are often heavily influenced by the internal cultures of the interacting organizations. The involvement of a number of experts from various professions, fields and backgrounds with their own cultures and ways of working, can create conflicts in forming a culture for the project they work on collectively (Wiewiora et al, 2014). The construction industry is generally known for operating in a traditional environment that maintains a conservative corporate culture. This has been identified as one of the reasons for the relatively low rate of innovation and new product adoption in the construction sector (WEF, 2016).

Corporate culture in architectural practices is influenced by the size of the organization. Small practices tend to have informal control procedures which are carried out through empathy between organizational members and through direct personal contact (Ankrah and Langford, 2005). Company leadership in general, plays a major role in shaping the culture within an entity. Similarly, architectural practices, largely retain the vision and intentions of the founder or founding partners regardless of the size of the firm, and hence can be a significant influence in the established culture within the firm especially with regard to the degree to which decision-making is decentralized. Architectural firms, by and large, employ highly trained and skilled individuals (Ankrah and Langford, 2005). These individuals possess expert power which results in higher degree of control and influence in decision making processes. Therefore, decisions of such firms typically tend to be an outcome of authoritative figures, as opposed to joint-decision making. Thus the paradox in flexibility of decision making in small firms and the perceived higher degree of control, given the power of individuals within architectural firms, offers an opportunity to investigate and explain the actual process.

Architectural and engineering professions are knowledge intensive fields which ideally utilize expertise from multiple fields and diverse occupational groups (Svetel and Pejanovic, 2010). As such, the process of knowledge sharing, which allows exchange and distribution of organizational and project knowledge, and provides access at the right time and the right place (Koskinen et al., 2003) to the right person is critical in maintaining competitiveness and being relevant in the changing landscapes in the construction sector. The knowledge base of an architectural firm largely exists in the form of tacit knowledge in employees. In such firms, centralized command

and control in organizations typically set the background for low innovation and adoption if the leadership is not proactively driving an effort to promote knowledge sharing. If acquisition of new knowledge and maintaining that knowledge are not strategically carried out within an architectural organization, adoption of sophisticated material and technology in design projects could be hampered by the limitations in the skill set and experience of the architects.

For specifiers, building construction and EWP manufacturing companies, working with MTPs require radical and transformational changes to either their systems or technologies, or both systems and technologies, depending on the existing products and processes. This demands a systematic approach to identifying ways of mitigating uncertainties and overcoming challenges that are presented in timber construction. In order for such transformational changes to be successful in the long run, it is important that companies are able to manage the driving forces and address the restraining forces for change (Lewin, 1951). Additionally, instilling a culture of continuous improvement by way of making small incremental improvements after making transformational changes are necessary on a project-to-project basis as well as within projects. However, neither the nature of change management in the context of adopting timber construction technologies nor the interaction of cultures in terms of incremental changes in a post transformation change situation have been investigated properly.

The most salient difference between manufacturing firms and construction entities is the timescale involved. While a construction firm is project-oriented, and has fixed durations between projects, which lasts for a relatively short period of time before the company is exposed to a new project

environment, manufacturing firms generally experience a long-term, stable environment (Riley and Clare-Brown, 2001). EWP manufacturing firms are included in the forest sector companies which are generally viewed as conservative, with limited knowledge transfer and weak focus on innovation where, market opportunities are not fully exploited (Hansen et al., 2014). This indicates a hesitancy to take risks and more focused on the production side rather than focusing on the market. It is also speculated that the forest sector is still emerging from a production orientation (Hansen and Nybakk, 2016) towards more customer orientation, after the global financial crisis occurred in mid to late 2000s.

Organizational culture has been at the center of management studies and is defined as,

> *"a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way you perceive, think, and feel in relation to those problems."*
>
> - Schein, (1985)

Cole (1997) defined organizational culture more broadly as "shared values, norms and beliefs within an organization". Those shared values, norms and beliefs that are explicit in nature are reflected in the organizational structure and communications while those that are implicit remain beneath the surface but are considered important by management and staff. Organizations with implicit and explicit dimensions that are harmonized tend to have a strong culture whereas organizations with those dimensions opposing each other tend to have a weak culture (Cole, 2002).

Organizational culture consists of different levels as visible to an observer (Figure 3). Identifying these levels allows an understanding of the definition of culture without confusion. These levels range from readily apparent and visible manifestations to deeply embedded basic assumptions. The three fundamental levels at which culture manifests are; 1) observable artifacts, 2) espoused values and 3) basic underlying assumptions (Schein, 1992).

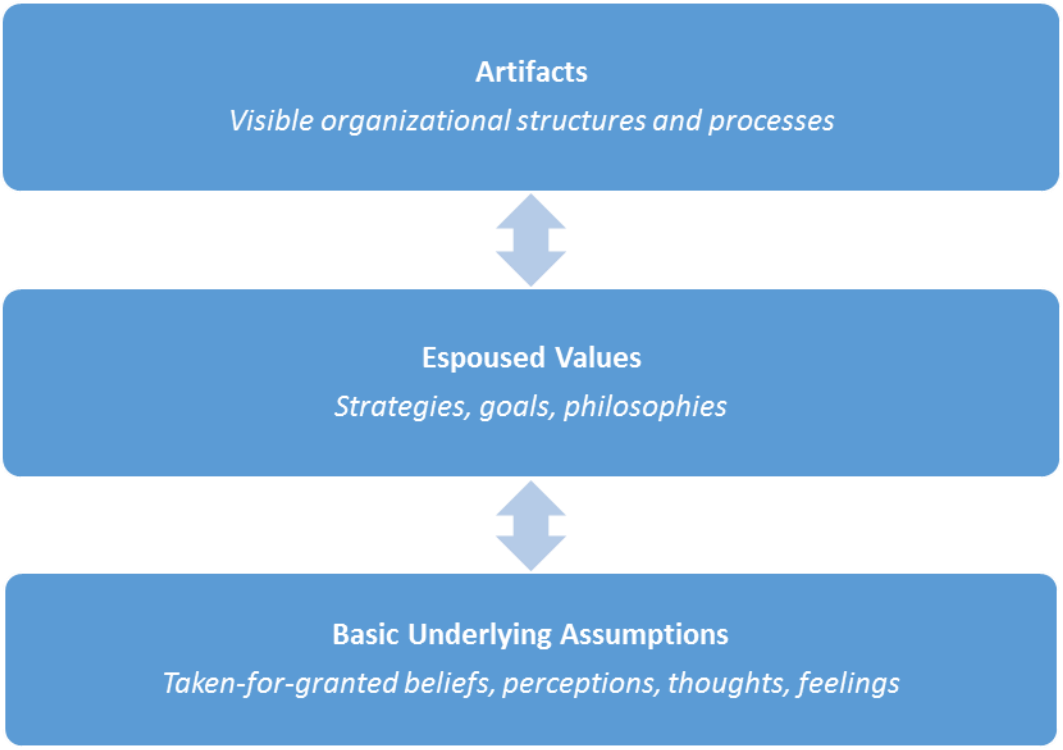

Figure 3. Adapted from Schein (1992)

Artifacts are the organizational structures and processes that could be observed when one encounters a group (Schein, 1992). Typically, artifacts would include visible products of the group such as the architecture of the physical environment, technology, products, published values and

statements. Artifacts also include the visible behavior of the group and organizational processes which morph such behavior such as language, rituals and ceremonies, clothing styles, manner of addressing, emotional displays etc. (Schein, 1992).

Although there are arguments supporting the notion that one could draw conclusions about deeper underlying assumptions of the culture through artifacts (Gagliardi, 1990), artifacts alone may not reflect the deepest level of the culture and can even lead to incorrect interpretation of artifacts into basic assumptions. This is often possible when the culture that is familiar to the observer does not have the same association between artifacts and basic assumptions as they really are within the organization in concern (Schein, 1992). For example, the chaotic nature of the research and development group of a tech company may be interpreted by a person as an unsystematic way of approaching innovation whereas in reality, the management may have consciously shaped the culture in such a way to foster innovation. Therefore, unless the researcher is familiar with the culture of a group and the relationship between artifacts and underlying assumptions in the context of that group, inferences should not be made (Schein, 1992) about the deep assumptions by mere observations of artifacts.

Espoused values are conscious strategies, goals and philosophies (Schein, 1992) which leaders desire to be operationalized through artifacts, often through published form such as slogans and statements. Values are strongly related to leadership of a group who influence the group to adopt a particular approach to address a problem and hence, they reflect the leadership's own assumptions and perceptions about what's right or wrong. Even though the proponent of a solution

may be confident of the approach, from a group's perspective it would not become a shared value if the members have not witnessed a successful outcome through that approach (Schein, 1992).

Once the group is convinced by the leadership to follow a particular approach and if they are adequately impressed by the success of the approach, then a shared perception begins to form which reinforces the fact that the approach to the problem worked. Thus perceived values gradually go through cognitive transformation to become shared values and beliefs and ultimately, shared assumptions (Schein, 1992) which represent the deepest level in the organizational culture. In the process of transformation, the shared beliefs, norms and rules are articulated explicitly with the purpose of guiding members of the group in certain situations and training new members. Those articulated values are supposed to predict the behavior of a group at artifact level, given that the values are articulated through prior learning. If they are not based on prior learning, there will be an incongruence between values and underlying assumptions. In such situations, observers are able to predict what the members will say in different situations but not what they will actually do under those circumstances (Schein, 1992). For instance, a company may say that quality is given high priority in production whereas in reality, the quality record may be subpar and thus not adhering to the espoused value regarding quality achievements. Therefore one must carefully distinguish between those espoused values that are congruent with underlying assumptions and those that are simply aspirations for the future (Schein, 1992).

Even the values that are congruent with underlying assumptions may not be entirely consistent with the observed behavior. In order to investigate this unexplained behavior and predict the future

behavior correctly one must dig deeper in to the culture to analyze the basic assumptions embedded in it.

Basic assumptions come into formation when the group witnesses repeated success with a particular approach to a problem. The cognitive transformation taking place in group members with respect to the associated value makes it fully acceptable and undebatable (Schein, 1992). Basic assumptions are therefore implicit assumptions that really guide the behavior of members. Once formed and held strongly within a group they are difficult to change, and become so taken for granted (Schein, 1992) that the member's behavior would not be based on any other alternative assumption. For example, a company with basic assumption of intolerance towards product defects wouldn't debate about designing a process that causes products to be defective.

Although management literature often suggests that shared values form the basis of organizational culture, certain studies highlight the values in an organization do not necessarily need to be shared between all of the members to be incorporated to the culture. Researchers argue that organizational practices which are shared by everyone in the organization play a critical role in defining the culture (Hofstede, 1998), contrary to the previously mentioned notion that artifacts including practices by themselves cannot be used to interpret the culture. Such studies, while acknowledging that practices are designed according to the values of organizational leadership, argue that those values do not need to be shared by the members. Instead, members strictly adhere to the rules and practices purely in the interest of remaining in the organization (Hofstede, 1998) and secure their position. The principal reason for the disparity of thoughts can be understood from the fact that

the majority of studies which conclude that shared values form the basis of culture have drawn their information about company values from the management (Hofstede, 1998) and not from employees at lower positions in the hierarchy.

Organizational culture is an intangible concept which is observable only through its manifestations in verbal and behavioral forms (Hofstede, 2001; Ankrah and Langford, 2005). Such intangible concepts are referred to as constructs (Hofstede, 2001). In order to assess the constructs of a culture it is necessary to identify the aspects of the culture. These aspects are viewed as dimensions of culture. When analyzing and comparing two organizational cultures cultural dimensions define the areas within which differences exist between the organizations. However, there is no universal agreement on which dimensions to use in identifying those differences. A variety of studies introduce different dimensions of culture resulting from what different researchers deem as revealing significant points of difference (Ankrah and Langford, 2005).

In a cross organizational study, Hofstede (1998) identified six cultural dimensions; process oriented vs. results oriented, employee oriented vs. job oriented, parochial vs. professional, open system vs. closed system, loose vs. tight control and normative vs. pragmatic. Another study defined universalism vs. particularism, individualism vs. collectivism, affective vs. neutral relationships, specific vs. diffuse relationships and achievement vs. ascription as important cultural dimensions (Trompenaars, 1994). Schein (1985), based on classic cultural studies in the US southwest (Kluckhohn and Strodtbeck, 1961), developed broader dimensions of reality and truth,

time, space, human nature, human activities and human relationships around which he asserts that basic assumptions form.

In organizations with dominant process-oriented cultures, employees tend to avoid risks while putting a limited effort on their jobs. People are mainly concerned with the question of how to carry out daily tasks where the tasks themselves are also routine. In contrast, in results-oriented cultures, employees strive to achieve internal goals or results and perceive themselves as being comfortable in unfamiliar situations. New challenges are accepted and maximal efforts are put to overcome those, even if they are associated with considerable risks (Hofstede, 1998).

The relative importance given to people compared to the tasks are identified as a dimension of a company culture (Hofstede, 1998). In employee-oriented cultures, the management is concerned about personal problems of employees, thus bearing a responsibility for employee welfare. Decision making is also carried out collectively in such an environment. Job-oriented cultures on the other hand, tend to exert pressure on employees towards getting the tasks accomplished while not giving enough consideration to personal issues that employees face. Decision making is also done at the individual level.

The way employees identify themselves within the organizational context is included in Hofstede's dimensions. Employees in a parochial culture feel that their behavior on the job as well as off the job are governed by norms of their work place. In such a culture employees feel that they are short-term directed. In professional cultures, employees are identified with their competence in their

respective professions where, a clear line between private life and professional career is drawn. Professional cultures also direct their employees with long-term prospects and plans (Hofstede, 1998).

Openness of the organization toward new comers and outsiders is considered as a dimension of the culture (Hofstede, 1998). Open cultures welcome new comers into their culture who will soon be integrated with the company culture in a short period. In closed-systems however, organizations tend to be inaccessible to outsiders. Even employees may be kept from knowing all of the details of the company and hence, newcomers typically take a longer time to be a part of the company culture.

Based on internal structuring and level of control in an organization a company culture could be either loosely controlled or tightly controlled (Hofstede, 1998). In loosely controlled environments employees have more freedom in carrying out their tasks with relatively less supervision. Unpredictability is a key feature in such environments as different people do not often behave in the same way in similar situations. In tightly controlled environments, however, every aspect of the job is controlled, especially financial matters. Strict discipline is expected from employees at all times (Hofstede, 1998).

Lastly, organizational culture includes the dimension of the level of focus on the customers/ clients of the company (Hofstede, 1998). In pragmatic cultures, satisfying customer needs is given high priority and therefore employees are customer-oriented, whereas in normative cultures, emphasis

is on organizational processes, hence process-oriented. Business ethics are given high priority in normative culture and standards of honesty are expected to be strongly upheld (Hofstede, 1998).

Alternative to different dimensions, some studies have defined typologies of cultures in order to simplify the process of comparing cultures. Study of cultural typologies is premised on the belief that there exists ideal types of culture, each of them easy to imagine, against which the culture being assessed is compared (Hofstede, 2001, Ankrah and Langford, 2005). Handy (1993,) identified the power, role, task and person typologies while other studies have defined clan, adhocracy, market and hierarchy typologies of culture (Graves, 1986, Cameron and Quinn, 1999). Clan cultures usually display loyalty and tradition linked to the values of the leader also emphasizing on mentoring and long-term success. Adhocracy cultures are dynamic workplaces that display risk taking while market cultures are those that emphasize on competitiveness. Firms with a dominating hierarchy culture display adherence to structures and procedures (Cameron and Quinn, 1999).

The definition of a business model captures certain social aspects within organizational perimeters such as value proposition and customer relations and, operational model elements such as control procedures. Financial elements such as incentive mechanisms that clearly reflect the organizational culture are also included in defining a business model. However, it does not include all elements of an organizational culture that are described at three levels by Schein (1992). In other words, a change in business model can morph the business culture but it will not change all aspects of a culture. The reverse logic of that would be, that the business model can stay completely intact or

only change in a small way, even if a number of cultural aspects change. Since the cultural elements that are intertwined with a business model are visible organizational structures and processes that are considered as some artifacts and values, the remaining cultural elements and underlying assumptions should be separately identified.

With this revelation, it is important to picture how these non-business model-cultural aspects, which are more or less social competencies of an organization, could change or stay intact when the organization undergoes a change. Similar to how Pisano (2015) has included technical competence as leveraging force for a business undergoing a change (Figure 2), we suggest that the social competencies can be identified as a necessary ingredient for a business undergoing change. Thus the addition of a third dimension to the innovation landscape map (Figure 4) leads to additional types of innovation patterns.

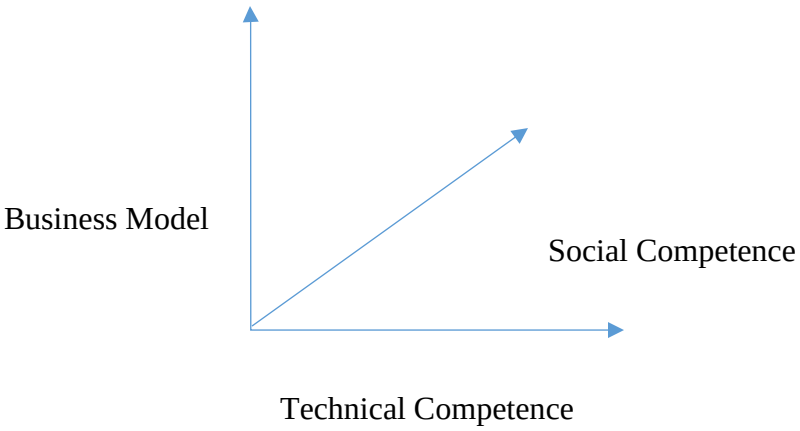

Figure 4 Innovation landscape dimensions with social competence (adapted from Pisano, 2015)

Therefore, the present study offers an opportunity to look at a magnified version of a paradigm in which two models concerning innovation and organizational culture meet and interact. While it is likely that information regarding technical competence may be revealed during the initial process of getting to know a manufacturing company or a specifier, detailed information of the current business model and the companies' aspirations for the future is required to understand whether or not a change in business model is required. The existing level of social competence can only be identified by complete examination of all levels of the current culture within manufacturing organizations and specifiers, which would also allow to postulate any existing disparities in the social competence between the two types of entities.

3 Methodology

The study targets EWP manufacturers and construction specifiers in the Pacific Northwest to identify the specific cultural traits of the two groups. One of the primary goals of this exercise is to examine the hypothesis that there is a gap between the cultures of the specification profession and EWP manufacturers. This essentially requires use of measures of cultural dimensions to analyze both types of entities. There are various methods used in practice to extract the culture of individual organizations. Apart from the models available in the literature, in the corporate world, culture analysis of organizations commonly takes place in the event of mergers and acquisitions where, cultural fit between the two organizations in concern is crucial to reap the expected benefits out of the transaction (Bouwman, 2013).

While there's no question that one or more of these methods can be used to decipher the culture of subject companies and individuals in the present study, the use of the deciphered information and making generalized conclusions at an industry level should be carefully done because, only when patterns of behaviors and underlying assumptions are clearly observable across entities, can one generalize it to the industry and/or profession.

The level of researcher and subject involvement (Schein, 1991) in the exercise of unravelling the culture of an organization is a basis for the selection of the appropriate method to decipher the cultural traits. Such an exercise can be presumed to be carried out successfully and fruitfully when the involvement of both the researcher and the members of the subject entity are fully engaged. In studies where companies consult a researcher to assist with solving a problem within the company,

the involvement of both researcher and the subject can assumed to be very high because, the participants understand that full engagement is contributing towards solving the problem and therefore be worth the time and effort spent on it and the researchers are given the liberty to search for reasons within the company in order to solve the problems (Schein, 1992). Although researcher involvement is supposed to be high in this study, the researcher will not be exposed to all the information that can be drawn from organizations, especially if the subject companies reserve some space for sensitive information, in which case the researcher participation could be somewhat constrained. Therefore, the level of involvement of the researcher can range from medium to high.

		Level of Researcher Involvement	
		Low to medium	*High*
Level of Subject Involvement	*Minimal*	Demographics	Participant observation; content analysis of stories, myths, rituals, symbols, other artifacts
	Partial	Questionnaires, ratings, objective tests, scales	Projective tests; Interviews
	Maximal	Total quality tools	Clinical research

Figure 5. Categories of research on organizations, adapted from Schein (1992)

The level of involvement of subjects should also be predicted. The clinical research model proposed by Schein (1987), is only appropriate to use when the goal of the exercise is organizational development and hence, the subjects are committed and highly willing to participate. However, given the objectives of the study, it is fair to assume that participants would not be as willing to engage in as the above scenario since they will be aware of the fact that the study is not exclusively beneficial to their respective organizations, thus the level of involvement of the subjects was assumed to be 'low to medium'.

Having identified the predicted levels of involvement, the different approaches to study an organization proposed by Schein (1992) was used to identify the most appropriate option (Figure 5). This expected combination of involvement levels of the researcher and subjects leads to the use of participant observation, content analysis and assessment interviews. Given that demographics and experimentation through questionnaires are possible with minimal or partial involvement of subjects, these methods were used for deciphering cultural elements.

3.1 Sample

The area of interest for the study was the Pacific Northwest states of Washington and Oregon in the US. EWP manufacturing companies currently manufacturing at least one mass timber product were targeted. Firms representing large, medium and small scale operations were included in the sample. Firm size was measured by the output and number of employees. Some of the companies selected were operating in both states.

Table 3.1 Number of companies from each sector used in the study

Sectors	Number of Companies
Manufacturers	7
Architects	6
Engineers	3

Selection criteria of specifiers was based on their association with MTPs. Interview recruits from each entity were selected based on their involvement in designing and construction of projects that have significant applications of MTPs. Design-build firms, architectural practices of large to small scale and engineering firms from large to medium scale were selected.

Initially, the subjects were chosen based on established contacts and available resources. These were industry professionals from both sectors who have experience in manufacturing or specifying the EWPs in concern. After interviewing the selected professionals, more subjects were chosen through snowball sampling method where, referrals from already recruited subjects are used to recruit new subjects (Miles et al., 2014). At the end of each interview, a request was made to the participants for potential recruits who possess the knowledge and experience required to successfully face the interview process. Thus, the sampling procedure was a non-probability sampling method. This is beneficial as participants will have gained an understanding of the required level of knowledge and organizational/ industrial experience once they have faced the interview and may be in a position to refer the researcher to potential recruits who may offer different views to the problem being inquired. This also avoids potential bias of the researcher to

select subjects based on convenience. However, in order to ensure adequate variability of subjects, the initial participants were chosen from companies operating in different scales and associated with different products.

3.2 Data

Face-to-face interviews were carried out within subject organizational premises. All of the interviews were audio recorded and transcribed. In addition, field notes were taken before, during and after the interviews. A semi-structured interview protocol was followed (Annex 1). Identification of main artifacts by systematic observation and through interviews was done. Questions were focused on deciphering the meaning behind the identified artifacts. After the questions framed to extract the articulated values within the company, informally constructed follow-up questions were asked to discover underlying assumptions which form the artifacts and values.

The interview protocol was developed based on the three levels of organizational culture (Schein, 1992). Questions were developed under categories of artifacts, values and basic underlying assumptions. Following the questions about internal culture, the focus shifted towards the key stakeholder (EWP manufacturers for specifiers and vice versa). The subjects were requested to provide information on the apparent culture of the key stakeholder group based on their experience. The protocol was tested with pilot interviews conducted with an architect and a former employee of a wood composite manufacturing firm. Based on the pilot interviews, the questions were reformulated for increased clarity.

Interviews also covered areas beyond the boundaries of the organization in order to get a view, within and outside the respective industry domains in the context of the use of EWPs. Interviews with specifiers were especially focused on values and assumptions that govern the culture in the professional sphere. A key component of the interviews was to extract a perceptional view of the culture in the manufacturing sector from specifiers and vice versa.

In order to assist the exploration process of basic values within companies, an assessment tool was administered to one or more members of the executive team of each company. In smaller companies and practices, the senior most personnel was asked to take the assessment. The aim of this assessment tool was to excerpt the view of the people at the top of the hierarchy on the company culture which will help to ensure that the findings of the basic value exploration and subsequent conclusions are not shaped by the opinions of just an individual of each company. Moreover, it is reasonable to assume that often times a complex phenomenon such as organizational culture cannot be fully understood at a given level of the hierarchy of a company alone.

Although many culture assessment tools are available in the literature, the major limitation of using one for this study is to make it fit the context of the industries in concern and the requirement for comparability with Schein's cultural hierarchy. Cameron and Quinn's (1999) organizational culture measurement tool named "Organizational Culture Assessment Instrument" (OCAI), is regarded as an established and a validated measure of organizational culture (Arditi et al., 2016).

The tool has been used extensively in a variety of organizational settings across industries to assess a variety of phenomena, and is one of the most frequently used tools to assess organizational culture in the world (Cameron and Quinn, 2011). The tool has been specifically used in a number of studies investigating culture related issues in both construction and manufacturing related companies.

The key cultural dimensions measured in the OCAI and the associated cultural typologies are in good congruence with the deep levels of culture that will be explored in this study; values and basic underlying assumptions. The OCAI tool assesses six key dimensions of organizational culture namely, dominant characteristics, organizational leadership, management of employees, organizational glue, strategic emphasis and criteria for success. These dimensions are explicitly given in the instrument along with four statements under each dimension. This instrument was adopted as is for the cultural assessment of EWP manufacturers and specifiers. Respondents were asked to rate the four statements that measure each attribute. For each attribute, the scores of clan, adhocracy, market, and hierarchy type cultures add up to 100%. In addition to the above criteria, an additional question was included regarding the respondent's view about the culture of the key stakeholder industry/ profession (Annex 2).

The OCAI tool requires respondents to rate the statements under the existing cultural setting as well as the preferred cultural setting. As the purpose of this study is to assess the current cultural profile of organizations, executives of companies were only be asked to rate the statements in the existing setting.

Supplementary data such as company history, types of projects involved, and business model were obtained through company reports, web sites, questionnaires and specific questions in the interview. The raw data was therefore consisting of field notes that mostly contain observations, audio recordings of interviews and responses to the questionnaire. Audio recordings were transcribed enabling them to be qualitatively analyzed.

3.3 Analysis

Analysis of data was done concurrently with data collection as a prudent approach to not rule out the possibilities of collecting new data and addressing emerging problems throughout data collection. Transcribed interviews were the primary data for qualitative analysis along with formal write-ups of initial field notes incorporated to the transcripts. These were initially subject to first cycle coding, which is assigning symbolic meanings to chunks of data and thus, essentially condensing the data (Miles et al., 2014). These data chunks included both pages of texts and paragraphs of varying sizes.

Following first cycle coding, further breakdown of information was undertaken through pattern coding, a second cycle coding method. This involved identifying categories/ themes, causes, relationships among people and theoretical constructs (Miles et al., 2014). The responses to the questionnaires were also integrated to construct narratives of data which formed the basis in developing themes of basic cultural assumptions for the two sectors. These themes were then used to identify the specific dimensions of the culture of each sector within the theoretical framework. A comparison of the cultural dimensions was carried out to identify the disparities.

Data gathered from the OCAI tool was analyzed individually and was categorized later into companies. Computing the scores of each key dimension of the tool was the initial data processing step. The scores of each computed dimension and assertions made on the scores were used in second cycle coding to identify recurring themes or new themes.

Where the researcher was uncertain whether the assertions portrayed the views of the interviewee, a summary was constructed and communicated to the subjects for verification and feedback.

4 Results and Discussion

This section is organized based on the identified themes that emerged from the analysis of the transcribed interviews and the resultant narratives of the data. Under each theme identified sub-themes are included. The results and observations are described under sub-themes with relevant quotes from respondents of both manufacturing and specifying sectors, followed by a discussion for each theme, comparing and contrasting the manufacturers and specifiers. Table 4.1 indicates the key issues and changes that need to take place in the EWP value chain that are discussed under different themes.

Table 4.1 Major themes and associated issues

Major themes	Key issues
Basis for the culture	Utilizing architectural freedom
	Creation of contemporary EWP knowledge
Artifacts of the cultural interface	Increasing profit margins
Interaction with specific key stakeholders	Dependence on distributors
	Meeting specifier expectations
	Facilitate EWP specification

Table 4.2 includes the rankings for internal cultural typologies by different sectors using the responses to the OCAI. From the four architectural and two engineering firms that returned responses, the rankings were not contradicting among individual firms. However, the three

manufacturing companies that responded indicated conflicting dominant cultures. The ranking of cultures were obtained from the overall average points allocated to each typology by firms in a given sector.

Table 4.2 Overall rankings of cultural typologies

Cultural typology	**Overall Rank***		
	Manufacturers	Architects	Engineers
Clan	2	1	2
Adhocracy	3	2	4
Market	1	3	1
Hierarchy	4	4	3

**Dominant culture for each sector indicated by rank 1.*

4.1 Basis for the culture

4.1.1 Perception of the value provided through EWPs

In all of the EWP manufacturing companies, the primary raw material that they work with is central to the creation of their organizational culture. In other terms, the notion of working with the material ‘wood’ can be considered as an influential factor on how employees perceive working for the company. There was evidence of employees joining EWP manufacturing companies because of their affection towards the material and related products. For the majority of the managerial level employees, the workability of wood and the type of applications of the products made are what had attracted them to the EWP industry in the first place. The abundance of forest resources in the Pacific Northwest and the associated sustainability related benefits of EWPs were also mentioned by manufacturing professionals when asked about the reasons for their apparent

enthusiasm for working with wood products. These observations were commonly shared by all manufacturers regardless of the size of the firm or the relative position they held in their respective companies.

Specifiers have different perceptions of the value provided through EWPs depending on a number of factors. Firms working on a high proportion of projects that have significant applications of EWPs share the same view as manufacturers about the importance of wood in the built environment and their personal enthusiasm for working with wood. Three, out of a total of nine specifying companies, in their marketing efforts tend to project their companies as wood design and building enthusiasts. According to the respondents most of the employees in such firms share the same values about the use of EWPs. Another fraction of companies employ design and engineering professionals, who are experts in wood design and construction. Such employees are attached to large specifying companies with multiple divisions and a wide geographical presence, therefore the same values about the use of EWPs in projects are not shared companywide.

4.1.2 Work environment and employee development

It was found that the physical work environment and the nature of the work have a direct impact on the ability of companies to recruit suitable employees. The work environment in manufacturing facilities were described by many interviewees as ‘not the most pleasant’ environment. The fact that the processes involve working under intense noise, sawdust and glue is considered as a major limiting factor in making the workplace a comfortable one for employees. Management offices of small to medium scale companies are also located on the same premises as manufacturing facilities. These offices are also reflective of the rough conditions and manufacturing processes in

the facilities. The nature of work was described as mostly repetitive, reflecting the requirement for consistently producing a target level of quality and quantity. Glulam manufacturers find it challenging to hire and retain employees to work in gluing processes mainly due to the physical demands of the jobs involved. Money is the pure incentive for people who get hired for these operations.

Opportunities for professional development and career development seem limited for employees in the manufacturing field. One interviewee responded that attending the meeting of North American Wholesale Lumber Association was the only key event that he could think of in a given year. A company that produces similar products at a larger scale mentioned that monthly safety meetings and quarterly performance review meetings are key events to everyone working at the company. In fact, most interviewees identified production and safety meetings as important events that contribute to employee development and add value to the experience. An interviewee from a large manufacturer also stated that annual regional meetings and an event associated with corporate social responsibility of the company are key events. Overall, the focus of employees at manufacturing companies tends to be on consistently meeting production targets and quality targets.

"It's manufacturing at its core, and nothing more than that."

- *Manufacturer*

Contrastingly, the work environments in specifying companies were described as attractive and comfortable places to work. Office spaces have been designed with careful consideration for

human dynamics both physical and mental. Aesthetics have been given high priority as well as ergonomics. Employees also tend to actively take part in social events in the workplace.

> *"On the social side we enjoy happy hour on Friday. We have an annual holiday party, a summer party"*
>
> *- Engineer of a design firm*

> *"We often get together and talk [about] some of the fun project work that's been going on or the interesting aspect of a particular project. People also look forward to starting new projects. It's a change; it's a new and an exciting time to jump into something that hasn't been defined yet. As problem solvers and engineers we really like to have new problems to solve and new buildings to engineer"*
>
> *– Engineer of a design-build firm*

In business related events, completing a given phase of a project and advancing to the next phase was deemed as a significant achievement by multiple engineering and architectural companies. This was cause for celebrating team progress and client satisfaction. Winning a new client was also noted as a key moment in all three engineering companies.

Furthermore, internal opportunities for professional development are more frequent at specifying companies than in manufacturing companies, indicating a gap in maintaining or gaining capabilities and competencies. As with manufacturing companies, quarterly to annual staff reviews were considered as significant opportunities in many specifying companies that indicated learning requirements. Also, specifying companies support employees financially, by mentorship or by providing exposure to relevant work in meeting their professional development goals or those that

help gain contemporary knowledge in engineering and design. One company noted that acquisition of new capabilities are considered as significant moments relating it to the opportunities they bring to the employees for learning and advancement.

> *"Every time we invest in new tools, software, hardware….. like scanning systems, they would be big events if we were to bring on new capabilities for us because it gives people a lot of opportunity."*
>
> *-Manager of an engineering firm*

4.1.3 Organizational structure and employment characteristics

A majority of privately owned small to medium scale manufacturers are tightly controlled by the ownership. Decision making at strategic and sometimes even at an operational level are made by the owners of the company. Participatory management was only being practiced at one such manufacturing company where the manager was empowered to participate in important decision making processes. At large manufacturing companies, the relative autonomy given to employees vary from company to company. Only one of the three large scale manufacturers in the study had a flat enough hierarchy and a management philosophy where participatory management and team work was embraced.

All interviewees from the manufacturing sector acknowledged that their workforce is male dominated. They attribute it to the rough work conditions and the locations of the manufacturing facilities. Employment at technical and managerial level positions is particularly dominated by

middle-aged men. Although it was observed that employees at manufacturing companies react favorably to women in leadership roles, they believed that the industry suffers from an image problem that keeps potential female employees from applying for jobs at manufacturing firms. However, companies involved in more sophisticated products and processes state that young individuals who like to be intellectually challenged are somewhat more attracted to positions meeting those criteria. Overall, manufacturing companies state that the workforce is aging even at the managerial level and it is increasingly difficult to replace them with younger employees.

While most architectural practices have more equitable ratios of male to female employees, engineering firms consist of mostly male professionals, and the presence of female employees becomes even less among those who are involved in EWP related design and construction. One senior manager from an engineering company thought that having a more inclusive and diverse workforce that is empowered to push the boundaries is the way forward for engineering companies to tackle engineering and business related problems efficiently and effectively.

> *"If we operate the same way as we did before we are going to be stagnant and not add more to our customer base. I don't think we can run a company in the future without adopting some of the new employment and empowering practices that other industries are picking up"*

All the specifying companies regardless of the size, embrace the concept of a flat organizational hierarchy. It is particularly facilitated by the team-oriented work environment in specifying

organizations. Especially the engineering companies which at the beginning had many layers of management, had eliminated a few of those to make the decision making process leaner.

> *"I came to the company because it has a reputation as a cutting edge, forward thinking company that reinvests in itself and has a very low turnover. It is an employee owned company with a lean structure. We are never two or three phone calls away from speaking to the global head of our company. That's what's kept me here over ten years."*
>
> *-Project engineer at an engineering firm*

It was evident that manufacturers who had better employee relations and were strongly motivated at the workplace, were effective in communicating organizational goals and objectives. Manufacturers vary in the level of emphasis given to internal communication. The differences were mainly prominent in the type of information that is communicated; strategic vs operations related information. Most manufacturers tend to give significant attention to communicating goals and performance indicators to employees at the operational level.

> *"Employees at the factory level know what the key performance indicators are. We have a very open communication link with our employees on a daily, hourly and situational basis. And we review those every month. It's an open, honest and a clear communication system."*
>
> *-Executive at a manufacturing firm*

However, some manufacturers tend to give less attention to communicating strategic direction of the company to even managerial level employees. A respondent from such a company stated that strategic decisions are made at executive level and managerial level employees rarely get involved in the process. Respondents of the three companies that indicated strong levels of motivation and

attachment to the workplace were aware of the strategic direction of the company and were able to describe reasoning behind the decisions taken at the top.

4.1.4 Discussion

Specifying companies that did not attempt to give any preferential consideration for wood, indicate that there is a strong influence by the leadership of the companies that had resulted in them taking such stance. The values established by the founders or the current leadership of these companies play a crucial role in project architects and engineers adhering the practices of selecting material for a project. According to Handy (1993), the power culture is observable in environments where a central figure shapes the values and activities of a company. Since the neutrality towards wood comes from the top, it is reasonable to state that there are elements of power culture present in these organizations. However, neutrality towards wood suggests that the emphasis is on getting the job done using the material that is most appropriate for the project which indicates the task culture (Handy, 1993) dominates in these types of organizations.

It's also important to note that intentional preference for wood in certain specifying companies too, percolates from the leadership. Employees consider the founders of those companies as visionary leaders who try to compete against the odds to push the company to the cutting edge in wood design and construction. In the context of EWPs, the predominant culture could be defined as a 'high to low' mixture of power culture and task culture respectively since, the emphasis on wood comes mainly from the leadership and to a certain extent from the employees who joined the company primarily due to their enthusiasm for designing and constructing with wood. Therefore an important revelation would be the existence of two types of specifying companies

that are distinguishable by their risk taking abilities with regard to wood design. As manufacturers look to build relationships with specifiers, it may be more effective to reach specifying companies that are more receptive to wood design than other companies.

The work environment may have direct implications on the demographics of employment in respective industries. As it was mentioned by the interviewees, both the specifying and manufacturing sectors are dominated by male professionals. While small to medium manufacturing companies employ women mostly at administrative positions, large companies have women working at technical positions such as research and development and, quality control. This is most probably due to the fact that only large scale manufacturing companies have technical positions that do not involve rough work conditions and physically demanding. As a number of studies (Harrison and Klein, 2007; van Knippenberg and Schippers, 2007, Richard et al., 2013) have indicated more inclusive management teams and recruitment policies, especially in terms of gender balance may lead to better decision making at manufacturing companies and might be an influential factor in improving the image that the industry has as a male dominant industry, and thus improve the social competence of firms. Also, adding more sophistication to products and processes such as introduction of CLT, fabrication and material optimization may be helpful in attracting more talented employees to companies.

The contrasting levels of emphasis given for professional development and learning advancement in the manufacturing sector and in specifying companies indicate a potential issue with regard to innovation in the EWP value chain. As it was indicated in the results section, specifying companies were providing more opportunities for professional development, exposure to relevant contemporary knowledge and support the maintenance of engineering or design competency of

their employees. However, on the manufacturer's side, opportunities were limited, internally or externally, for advancement in learning. This hinders innovation at manufacturing firms and limits the ability of firms to respond to market changes or create new opportunities. A negative impact of lack of innovation at manufacturing firms, and lack of contemporary knowledge in EWPs could mean that design and engineering professionals lack areas for development in the EWP construction sector. This may be causing specifiers to focus on other materials and methods where they could gain new knowledge and competencies. Therefore, when a EWP manufacturing firm is culturally inclined to focus more on routine operations and less on attaining new knowledge and capabilities, it is likely that manufacturers miss potential opportunities to collaborate with the specifying sector in broadening EWP applications.

4.2 Artifacts of the cultural interface

4.2.1 Products and customers

As far as the product is concerned, standard glulam products are produced by all but one manufacturing company included in the study. This also happens to be the largest company among those selected in terms of turnover. The company manufactures its own brand of EWPs. While they offer a diverse range of wood products along with their EWPs, the remaining companies offer a product range limited to only a few products, and in certain cases just glulam. However, product differentiation and customization is done to a limited extent by all glulam manufacturers through using varying timber grades, thicknesses and shaping of the beams.

EWP producers target different customer groups. Companies that are predominantly producing commodity scale products are mainly focusing on distributors and sales outlets. Interaction with

contractors or specifiers only occurs occasionally. Companies target distributors, contractors and specifiers to promote and sell their products. Out of the companies studied, only large and medium scale companies engaged in targeting all these customer groups, often customizing their products.

Specifiers describe themselves as knowledge workers (Svetel and Pejanovic, 2010) who pointed out that they don't sell products. Rather the value that is sold to clients is the experience and design services which are at times repetitive but mostly different from one project to another. An engineering consulting company working on a number of projects with significant applications of MTPs stated:

> *We don't represent particular products. We don't represent mass timber in any way. In that way we are completely independent. We are hired by architects to design every aspect including structural, mechanical, electrical and plumbing systems. We are also consultants to architects in acoustics; how to build the walls to provide sound separation, what finishes to use so that the room sounds good, etc."*

While many architectural companies are involved in a wide range of project activities, it was observed that most of the companies have capabilities, experience and organizational values to focus on different markets. Large architectural practices in major metropolitan areas such as Portland and Seattle are involved in both residential and commercial projects, while small to mid-size practices have developed their niche markets and specialized areas such as designing with wood. Small to medium sized practices outside these metropolitan regions focus on designing for small communities and local governments.

4.2.2 Innovation and risk taking

Process innovation is given a higher priority than product innovation in all responding manufacturing companies. The largest manufacturing company also happens to possess technologically advanced equipment and software that enables them to approach designing, manufacturing and selling in a more sophisticated manner. Sophistication goes as far as automation of manufacturing and offering its own proprietary software to specifiers. Technology at medium-sized manufacturers was limited. Many glulam manufacturers use automation in manufacturing but are technologically limited in designing and selling.

Level of innovation and risk taking varies from company-to-company in the manufacturing sector. It is not necessarily the size of the company nor the resources at disposal that determine the risk level. When it comes to new products in medium- to small-scale companies, it is exclusively the top leadership that determines whether or not the company should venture into new products. A manufacturer currently working on a product that is new to the company responded that the risk appetite of the leadership trumps the availability of resources. As expected, the responses to the OCAI instrument from this company allocated a highest percentage values for statements describing Clan and Adhocracy cultural typologies, indicating a high entrepreneurial and risk taking culture. By the same token, the interviewee from a company of similar size that has been producing glulam for decades and a leader in that product category mentioned that the leadership is not interested in taking the risk of producing a new product like CLT. The responses to the OCAI from this company indicated the leadership is emphasizing on meeting daily operational and sales goals rather than having long term growth targets hence, creating a market culture.

Large companies have mixed responses on product innovation. When asked about CLT from a large-scale manufacturer, the interviewee stated that the company is closely monitoring what current players in the region involved in CLT are doing, rather than exploring the possibility of manufacturing by themselves. In case CLT becomes attractive to produce, the interviewee says, the company is likely to leverage its resources and manufacturing capabilities to enter the competition.

Another large-scale manufacturer of LVL responded that CLT will not be produced at the company since the company's specialization is only in producing LVL. Furthermore, the interviewee responded;

> *"It's very difficult to introduce a new product to the EWP industry. I haven't seen a new product being introduced to the industry in twenty years. We have very similar products in all of our competition."*

4.2.3 Discussion

When it comes to innovation, it is evident that most manufacturing companies take a precautionary approach and display a conservative mindset. As the responses to the OCAI given by the executives indicate, the culture created by the leadership at these companies have values embedded in them that emphasize short term goals. As these companies are mostly producing standard, stock products that are traded as commodity products, it could be expected that low profit margins do not allow these companies to invest resources in innovating and experimenting. Large companies with adequate resources for investment, on the other hand, display risk averseness by different means. Due to the skepticism in the specifier community with regard to the use of MTPs in the

region, the leadership in these companies are not willing to take the risk of investing in developing and producing new MTPs such as CLT. Both these findings indicates that a significant barrier to product innovation is the market culture being the dominant culture of most EWP manufacturers and the leadership's risk averseness. As it was mentioned in the previous section, the knowledge gap and lack of learning opportunities in the EWP sectors are also contributory factors to relatively low levels of innovation.

4.3 Interaction with specific key stakeholders

4.3.1 Products for sale vs services for sale

A fundamental difference in the business model between manufacturers and specifiers is the value provided to their respective clients. While manufacturers provide a physical product to the end customer, specifiers think of the delivered value as a service provided to the end client. Further to this fundamental difference in value, the two sectors also differ in the obligations to the end-customer that is associated with the primary value provided.

> *"Some of the value that we bring to our clients is our independence. While we specify certain products, that relationship can never be too exclusive or too closed, because we need to maintain our independence. We need to be bringing the best possible product or design option to our clients. We often partner with suppliers on a project level but never more than that."*
>
> - *Project engineer at an engineering firm*

While manufacturers recognized this obligation as delivering the products that meet a certain quality and cost, on time, specifiers mentioned their obligation was to be independent in providing the service to the client. The independence that engineering professionals emphasize, thus acts as

a significant barrier that keeps manufacturers from developing close relationships with them in order to convince them to use EWPs in construction projects.

> *"It's an industry policy that when you hire a consulting engineer there's an expectation that we are independent. We also try to get into a trusted advisor relationship with the owner. We'd undermine trust if we had a close relationship with a supplier. In the consulting world there are ethics and moral rules that are written down and remaining independent is one of them."*
>
> - *Manager at an engineering firm*

As it was mentioned above, distributors of EWPs are one of the customer groups of manufacturers. Standardization of products results in less need for interaction. Also, due to companies that buy the products and add value to them (such as fabricating trusses), the interaction between the original manufacturer and specifiers becomes somewhat limited. Some producers of standard products solely interact with distributors in getting their products to construction projects and have had no intention of interacting with specifiers directly.

> *"We don't deal directly with specifiers. They call us with questions regarding our products. There's a middleman working with engineers and contractors. They put the package* [*of multiple products*] *together for the customer"*
>
> *- EWP Manufacturer*

> *"We have an approved list of beams that comes to us (from specifiers) through the contractor. Occasionally when communication seems to be a significant issue and somebody's not understanding something we will work directly with specifiers to figure out what the problem is"*

- EWP Manufacturer

Manufacturers' dependence on distributors is largely due to acceptance of the construction industry practice of sourcing material mainly through distributors. When exploring the reasons for dealing only with distributors, some interviewees responded that it is an industry norm to follow that procedure while some mentioned that it has always been the way they had done business. When asked about an alternative business strategy of dealing directly with specifiers, most respondents displayed some resistance without adequate explanation, often citing the company practices and policies. A few respondents indicated it was due to the inability to invest in human resources that are required in dealing directly with specifiers. Companies also depend on distributors as a defensive approach to doing business. One company attributes this to a financial strategy of minimizing the cash conversion cycle.

> *"We like getting payed when our products ship. Contractors often do not pay you until they get payed. So, we normally do not work directly with contractors. I'm sure we can get more sales if we go and work direct with anybody, but we've had issues getting payed previously"*
>
> *- EWP Manufacturer*

4.3.2 Facilitation of interaction

The engineering and design proficiency of employees at manufacturing companies are effective in communicating with specifiers and are better positioned to collaborate with specifiers on solving problems than companies that do not have adequate engineering proficiency within the company. Medium- to small-scale companies who work with distributors rarely employ in-house engineering

experts on structural or mechanical design. Such companies state that quality control and third party certification of the products largely substitute the role of engineers. However, a manufacturer having an in-house engineer states that the engineering position has enabled them to communicate better with specifiers and resolve problems faster than their competitors without such an engineering position. This was apparent when a non-engineer who interacts with specifiers at a different company (producing the same product) stated;

> *"I don't really know how they (specifiers) work, and how they come up with what they come up with, but I don't deal with them, so I don't know I could answer that question well. Lot of their work involve[s] math and sometimes, I feel dumb."*
>
> *- EWP Manufacturer*

Many manufacturers do not see a requirement for a major transformations to the way they have been interacting with specifiers nor to the practices within the specifier community. When asked about how specifiers should change in order to better collaborate with manufacturers, an employee from a manufacturing firm responded saying that;

> *"Specifiers need to check their specifications from time to time, at least every five years because sometimes design values change."*

However, intense competitiveness within the manufacturing industry and lack of coordinated efforts from manufacturing companies to facilitate the specification process could be a major barrier, and hence a necessary change in the EWP manufacturing sector. The differing perceptions

of manufacturers on strategies to better position EWPs against alternatives to EWPs such as lumber, concrete and steel hurt the industry, according to one manufacturer. Lumber here was considered not as a product that offers competition to EWPs but as a reason for some negative perceptions about EWPs in the specifying community. According to the respondent, specifiers who are not adequately aware of the characteristics of EWPs and how they are different from solid lumber wrongfully assume that EWPs have the same mechanical properties and negative characteristics of lumber such as defects, durability issues, and moisture related problems.

> *"We have made [it] very difficult for specifiers to specify EWPs. There's no standard for EWPs for specifiers. They are dependent upon each individual manufacturers' technical guides and support, and many times our products differ from each other. So [the] specifier is challenged to put the right product on a project. We [each] target fellow EWP producers as not good suppliers and say our products are superior to others', instead of being collaborative and unified and saying all EWPs are better than solid lumber".*
>
> *- EWP manufacturer*

4.3.3 Education and promotion

Manufacturers do lag behind in promoting their products among the specifier community and educating them on new capabilities. Several specifiers stated that the EWP industry is suffering from a lack of salesmanship compared to other material suppliers, specifically in promoting and educating the specifying community on their products. One architect noted that the EWP manufacturing community is lagging behind in creating opportunities to communicate with

architects about their products. While trade shows, exhibitions and conferences are platforms to meet each other, the respondent says they are not as effective in drawing the full attention of specifiers and make a compelling case on the product. Several architects also argued that it has become a norm for other material suppliers to make formal visits to architectural companies, arrange lunch for the participating team of architects and spend a few hours educating and discussing the products.

The engineering community indicates a general resistance to the sales processes followed by manufacturers and prefers to view the promotion of EWPs as traditional sales pitches. While some engineering firms do admit that the manufacturing community is lagging behind in promoting the products as aggressively as other material suppliers, they also consider it as an appropriate way to interact.

> *There's much less salesmanship going on with the EWP industry. Wood folks are selling a commodity product. It's less so in the mass timber side. The manufacturers I guess have less to pitch you on other than they meet your expectation of quality. It's positive in a way that they are not salesmen necessarily which I like as a technical engineer who view it as a commodity product.*
>
> *- Design engineer of a consultancy*

4.3.4 Discussion

The independent view of engineers when working with project clients dictates to a large extent the nature of the relationship that a specifier prefers to have with a material supplier. This can be

identified as an organizational cultural conflict (Wiewiora et al, 2014) arising from opposing values of the two sectors. From the responses of specifiers, especially engineering firms clearly indicate that not all engineers have a 'palette of favorite products' (Emmitt, 1997) that act as a barrier for EWPs to be used by engineers. It is rather the obligation of engineers to their clients to provide an independent view and material options that acts as a barrier for manufacturers to get specifiers to use their products.

According to the responses of specifiers, the lack of salesmanship in the EWP manufacturing community can be primarily due to the role of the distributor in acting as an intermediary between specifiers and manufacturers. While it's an important role, especially from a contractor's point of view to source material from a distributor, it may be that manufacturers should not depend on distributors to take their products to the specifying community. As the distributors may not necessarily have an interest in promoting a particular manufacturer's product, the manufacturers could benefit if they proactively interact with specifiers. Specifically, there is more opportunity for educating the architectural community on specific products as architects enjoy a sense of freedom in designing that is a degree higher than engineers who design for specifications. There may be additional resistance coming from engineers due to their role as independent agents to building owners.

EWP manufacturers who operate on thin margins have limited room for experimentation with products and business systems. By looking at the responses extracted from companies, it appears that companies have struggled to execute changes in business systems and respond to market changes through innovation. It has become an accepted basic assumption (Schein, 1998) that manufacturing professionals take for granted, that distributors of EWPs are responsible for being

the intermediary who is responsible for sourcing the appropriate material and passing on the information and products to specifiers. It was apparent that this has become an accepted norm for most producers of standard products since the reason as to why producers do not bypass the distributor to reach specifiers to inform about products often was a matter of maintaining the status quo of the company and the industry. The explanation of reducing the cash conversion cycle is again an indication that the low margins of standard products demand upfront payment. Therefore it could be suggested that one way to respond to market changes in the region is to find ways to increase profit margins through value addition to the whole supply chain of construction. More value addition will result in increased prices and margins which would make it more affordable for companies to extend the cash conversion cycle. These value additions could be customization and product optimization for individual projects.

Having identified the key issues pertaining to each of the identified themes, Table 4 indicates at which level each individual issue can be best addressed (given in the ‘Response’ column).

Table 4.3 Key issues and required levels of response

Major themes	Key issues	Response
Basis for the culture	Utilizing architectural freedom	At company level
	Creation of contemporary EWP knowledge	At EWP industry level
Artifacts of the cultural interface	Increasing profit margins	At company level
Interaction with specific key stakeholders	Dependence on distributors	At company level
	Meeting specifier expectations	At company level
	Facilitate EWP specification	At EWP industry level

5 Conclusions and Recommendations

Engineers tend to be more conservative than architects as acknowledged both by architects and engineers, especially in experimenting and designing with a new material. Gatekeeping procedures for information on new materials do exist in the specifier world. It was found that engineer's obligation to be independent and not be biased toward a particular material is a major reason for this tendency. Therefore manufacturers may be more effective in reaching out to architects than engineers to promote products.

A gap between specifiers' expectations for new EWPs such as MTPs, and the actual capabilities of products and processes causes specifiers to be skeptical of the applicability of these products. As it was found, through collaboration and working partnerships with selected specifiers, manufacturers have been able to improve products to match expectations. The selected specifiers in this case are those who display entrepreneurial traits with regard to wood design. Therefore, manufacturers should focus on identifying and building relationships with such specifying institutions.

The traditional EWP business model leads manufacturers to depend on distributors to engage with specifiers. The current business model causes information to be relayed by the distributor between the two stakeholders. The resultant lack of a direct communication channel may inhibit innovation since manufacturers would not be able to efficiently solve design and engineering problems with specifiers. Therefore, manufacturers should challenge the current business model and look to create a direct communication channel with specifiers.

Existing thin profit margins of EWP manufacturers were identified as a main reason for manufacturer dependence on distributors. More value addition to products and customization could potentially be an effective method of increasing profit margins. Increased profits would give manufacturers the ability to have financial resources that are necessary to work directly with specifiers. This will also open up new positions in manufacturing firms, especially in engineering and design related fields that would also help with the lack of talent and younger demographics in the EWP sector.

Sector-to-sector communication efforts are currently employed to educate the construction industry about EWPs and also to create networking opportunities. Although such efforts are effective in providing design inspiration and be up-to-date on new products and capabilities, they often fail to provide adequate learning experience to specifiers on a given product, in order to use them in a project. Therefore, manufacturers need to adopt organized communication and sales tactics to educate specifiers about new products.

There's an identified learning opportunity gap between specifiers and manufacturers. Manufacturers are lagging behind in providing or creating opportunities for learning and development for their employees. Specifying companies do support employees to gain exposure in relevant contemporary fields of knowledge and thus are able to work with cutting edge technology and material whereas, the manufacturing sector fails to make EWPs a contemporary body of knowledge for specifiers.

Lack of coordination and high competition among manufacturers may be causing difficulties in promoting EWPs among specifiers. The current level of competition and market shares of large EWP manufacturers causes engineers to rely too much on individual company specifications

instead of industry-wide specifications. A coordinated effort by the manufacturing sector to create industry-wide standards could potentially position EWPs to offer better competition to concrete and steel.

Although it was evident that the leadership at each company ultimately decides the type of culture, business model and the nature of relationship that they would want to have with stakeholders, initiatives at sectoral/industrial level could potentially be significant in transforming the way the EWP value chain has been operating. Traditional business practices of established firms, both in manufacturing and specifying sectors, can also be challenged by demonstrated success of new MTPs in the Pacific Northwest region as new technologies and regulations would demand such changes in order to successfully compete in the building construction market.

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7 Appendices

Interview Protocol

An opening question about the history and mission of the company and how the subject's association with the company began followed by a question about his/ her time with the company up to now.

Questions about Artifacts

1. Describe your typical day, week, a project cycle and a year in the company.
2. What are the key events of the company during the year?
3. What are (visible) features of this organization that you think have an impact on the performance of the company?
4. What characteristics of this company attract new employees and customers?

Questions about Values

1. What is the nature of goals that are given to you, and what are your means of accomplishing those goals?
2. What happens when the goals are achieved/not achieved, or when you feel that goals are not going to be achieved?
3. What constitutes your relationships with peers, sub-ordinates and superiors?
4. How do you view the decision making process in the company?

Questions about Basic Assumptions

1. During your time with the company, what do you consider as the most important/ decisive moments for the company, and you personally?
2. What are the future aspirations for the company, and you professionally?

View on the key stakeholder

1. What was the nature of relationship between your company and the key stakeholder and how has it evolved? If there's no relationship, why do you think it is?
2. What do you think the culture of stakeholder organizations is?
3. How do you compare your organizational culture to theirs?
4. What changes in key stakeholder industry/profession would facilitate better collaboration with them?

Organizational Culture Assessment Instrument adapted from Cameron and Quinn (1999)

Each of the six items in this assessment is an organizational cultural dimension under which four statements are given. Read each statement and then divide 100 points over four alternatives according to how accurately each of them describes the company you work at.

1. Dominant Characteristics

A. The organization is a very personal place. It is like an extended family. People seem to share a lot of themselves.

B. The organization is a dynamic and entrepreneurial place. People are willing to stick their necks out and take risks.

C. The organization is very results oriented. A major concern is with getting the job done. People are very competitive and achievement oriented.

D. The organization is a very controlled and structured place. Formal procedures generally govern what people do.

2. Organizational Leadership

A. The leadership in the organization is generally considered to exemplify mentoring, facilitating, or nurturing.

B. The leadership in the organization is generally considered to exemplify entrepreneurship, innovation, or risk taking.

C. The leadership in the organization is generally considered to exemplify a no-nonsense, aggressive, results-oriented focus.

D. The leadership in the organization is generally considered to exemplify coordinating, organizing, or smooth-running efficiency.

3. Management of Employees

A. The management style in the organization is characterized by teamwork, consensus, and participation.

B. The management style in the organization is characterized by individual risk taking, innovation, freedom, and uniqueness.

C. The management style in the organization is characterized by hard-driving competitiveness, high demands, and achievement.

D. The management style in the organization is characterized by security of employment, conformity, predictability, and stability in relationships.

4. Organizational Glue

A. The glue that holds the organization together is loyalty and mutual trust. Commitment to this organization runs high.

B. The glue that holds the organization together is commitment to innovation and development. There is an emphasis on being on the cutting edge.

C. The glue that holds the organization together is an emphasis on achievement and goal accomplishment.

D. The glue that holds the organization together is formal rules and policies. Maintaining a smooth-running organization is important.

5. Strategic Emphases

A. The organization emphasizes human development. High trust, openness, and participation persist.

B. The organization emphasizes acquiring new resources and creating new challenges. Trying new things and prospecting for opportunities are valued.

C. The organization emphasizes competitive actions and achievement. Hitting stretch targets and winning in the marketplace are dominant.

D. The organization emphasizes permanence and stability. Efficiency, control and smooth operations are important.

6. Criteria of Success

A. The organization defines success on the basis of development of human resources, teamwork, employee commitment, and concern for people.

B. The organization defines success on the basis of having the most unique or newest products. It is a product leader and innovator.

C. The organization defines success on the basis of winning in the marketplace and outpacing the competition. Competitive market leadership is key.

D. The organization defines success on the basis of efficiency. Dependable delivery, smooth scheduling and low-cost production are critical.