UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation into the Use of Formaldehyde in Wood Paneling

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ABSTRACT

The objective of this investigation was to conduct a triple-bottom-line analysis of formaldehyde as a Red List Material in reference to the design of the new Student Union Building (SUB) at the University of British Columbia. Formaldehyde, as opposed to other Red List Materials, was examined because of its presence in indoor and outdoor environments everywhere and its harmful effects on human health. Formaldehyde is commonly found in the adhesives of wood products, which releases toxic vapors into the air over time. Due to the many different types of building materials containing formaldehyde, the focus of the investigation was narrowed down to wood paneling. With a global movement towards more sustainable building, several companies have recognized the market for formaldehyde – free wood paneling. Since there are several different varieties of formaldehyde – free wood paneling, however, a specific company in the northwestern region of North America was chosen to focus on: Columbia Forest Products. It is Columbia Forest Products' patented soy-based formaldehyde-free technology called PureBond that this report investigates for its formaldehyde-free analysis.

Research included sources from government health online resources, wood paneling companies and third party private councils and consulting firms, among others. The investigation concluded that formaldehyde-free wood paneling does not compromise the structural integrity of the building, especially since, in the case oft his analysis, wood paneling does not serve as a structural support, but more as an aesthetic attribute. It was also found that formaldehyde-free paneling is cost-competitive with its formaldehyde counterpart. Additionally, formaldehyde-free paneling has no harmful side effects to human health as formaldehyde paneling does.

It is therefore recommended that formaldehyde-free wood paneling be used in the new Student Union Building at the University of British Columbia.

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GLOSSARY

Melamine resin	A thermosetting resin made from melamine and an aldehyde; used in adhesives and coatings
Particleboard	A panel or building board made of wood particles, such as chips or shavings, that are bonded together with resin
Urea – formaldehyde resin	A thermosetting resin made from urea and formaldehyde; used in adhesives and finishes
VOC Compound	An organic compound that produces vapor readily at room temperature and normal atmospheric pressure. Forms photochemical oxidants that are harmful to health, damage materials and cause crop and forest losses. Many are also hazardous air pollutants

LIST OF ABBREVIATIONS

LEED	Leadership in Energy and Environmental Design
ppm	Parts per million
SF	Soy flour
SUB	Student Union Building
UBC	University of British Columbia
UF	Urea – formaldehyde
VOC	Volatile organic compound

1.0 INTRODUCTION

The widespread and abundant use of wood as a building material dates back to centuries ago. Wood is still widely used in the construction of buildings, but in a world of increasing awareness of sustainability and "going green", people are beginning to question how "green" the wood in their buildings truly is. The answer for most buildings: not very green at all.

The wood used traditionally and still most commonly today contains a urea-formaldehyde adhesive, which releases toxic formaldehyde vapors into the air over time. Formaldehyde is a known carcinogen used in pressed-wood products such as particleboard, plywood, fiberboard, glues & adhesives, paper product coatings and certain types of insulation [1]. Formaldehyde also enters the Canadian environment through natural sources (e.g., forest fires) and certain human activities, such as smoking tobacco and burning automotive and other fuels [1]. Formaldehyde vapors can cause adverse effects in humans at certain levels of exposure [1].

Formaldehyde is a Red List Material, meaning it has been deemed hazardous to the environment and human health. In order for a building to obtain Leadership in Energy and Environmental Design (LEED) certification, it must satisfy their rating system, which assigns points to each Red List Material. Clearly, if the building materials of the new Student Union Building (SUB) were formaldehyde-free, this would help to achieve LEED Platinum certification as well as improve the air quality for the UBC community.

Several companies have recognized the increasing demand for formaldehyde-free wood products. Perhaps the largest, most prominent company offering formaldehyde-free plywood is Columbia Forest Products, which promises non-toxic, soy-based, PureBond technology. Additionally, PureBond plywood is cost-competitive with traditional urea-formaldehyde plywood as well as other formaldehyde-free plywood.

Formaldehyde is used as an adhesive in wood paneling. The adhesives examined in our report are the urea-formaldehyde adhesive and the melamine formaldehyde adhesive. Since both of these adhesives release formaldehyde vapors, for the purposes of this report, both will be referred to generally as simply "formaldehyde" adhesives.

This report outlines a triple-bottom-line analysis of two types of wood paneling: one containing the traditional urea-formaldehyde adhesive, and the other formaldehyde free.

2.0 SOCIAL ANALYSIS OF FORMALDEHYDE IN PANELING

Many individuals would state that there are two main social concerns with the presence of formaldehyde in wood paneling. Arguably, the more important of the two relates to the effects towards human health. The other concern relates to the effectiveness of formaldehyde presence in wood paneling. Generally, these two concerns fall on opposite ends of the spectrum. If an individual is more concerned about their wellbeing and personal health, then he or she may argue that formaldehyde-free panels are a better option. On the other side, if an individual accepts the possibilities of the health problems but believes that the advantages of using formaldehyde panels outweighs the disadvantages, then typically he or she would argue that formaldehyde-free panels are *not* the way to go.

2.1 FORMALDEHYDE WOOD PANELING

Humans are exposed to formaldehyde on a daily basis through a wide variety of natural and man-made resources. A few of the most common sources of natural and man-made resources are:

- Automobile Exhaust
- Tobacco products (cigarettes)
- Foods (Cheese, Grains)
- Plants
- Furniture, Laminate
- Cleaners – shoe, carpet, dish-washing liquids
- Manufactured Wood Products (Wood Paneling, Paper)
- Glues and Adhesives
- Resins, Molds, Plastics
- Photographic Film
- Cosmetics
- Fertilizer

One of the most common sources of formaldehyde in both natural and man-made materials is manufactured wood products, which release formaldehyde into the air. Fortunately, humans do have a level of immunity for protection against low levels of formaldehyde. This immunity, however, is very different for each person. Some individuals are very sensitive to formaldehyde

while others will display no reactions to the same level of exposure.
"On average, an individual is exposed to approximately 0.02 parts per million (ppm) of formaldehyde per day from manufactured wood products. When formaldehyde levels exceed 0.1 ppm, most individuals will experience some adverse effects from the formaldehyde" [2]. These effects may range anywhere from watery eyes and a sore throat to nausea, coughing, and skin irritation.

More serious adverse effects are caused by long-term exposure; in severe cases, long-term exposure can sometimes lead to death. Severe exposures can also often lead to chemical burns in the lung and throat swelling. Additionally, acute cases of narrowing of the bronchi and accumulation of fluid in the lungs have been reported. In rare instances, long-term exposure to formaldehyde has been known to cause nasopharyngeal, leukemia, and lung cancer.

2.2 FORMALDEHYDE – FREE WOOD PANELING

Given the extensive, and possibly quite serious, health problems that formaldehyde can cause humans, many would argue that the use formaldehyde-free wood panels are a better option than their formaldehyde counterparts. There are many benefits, however, of using wood paneling containing formaldehyde. The Cherokee wood panels yield many attributes that consumer's desire. A study from the Commonwealth of Massachusetts outlined some of these attributes:

Formaldehyde Wood Paneling:

- Dimensional Stability
- Hardness and Abrasion Resistance
- Toughness
- Fast Curing
- High Chemical Resistance

Formaldehyde-Free Wood Paneling:

- High Water Resistance
- High Thermal Stability
- High Resistance to Creep
- High Flame and Smoke Resistance

Formaldehyde paneling has been proven to be marginally superior in toughness, hardness and abrasion to that of UF panels; however, formaldehyde-free panels do provide much higher water

resistance than UF panels. Generally, the biggest wear on wood paneling is due to physical damage. By providing a higher hardness and abrasion resistance, these panels have been reported to last sometimes one and a half times that of formaldehyde-free panels. By providing longer life spans for this wood paneling, houses and other infrastructure are able to remain in use much longer. This reduces rebuilding and upgrading costs as well as the levels of construction and demolition waste.

Besides the physical characteristics of formaldehyde, formaldehyde construction plants provide many individuals with employment. Below is a brief summary of how formaldehyde in wood paneling relates to the wood product fabrication industry.

- In 2009, global production and consumption of melamine formaldehyde in paneling and resins was approximately 1.75 million metric tons (approximately 6% of total global consumption) [3].

- In 2009, Stanford Research Institution (SRI) conducted a study that suggested approximately 7.85 million employees either directly or indirectly work with formaldehyde [3].

- Ten percent of the total number of employees worked directly with wood products – approximately 750,000 employees [3].

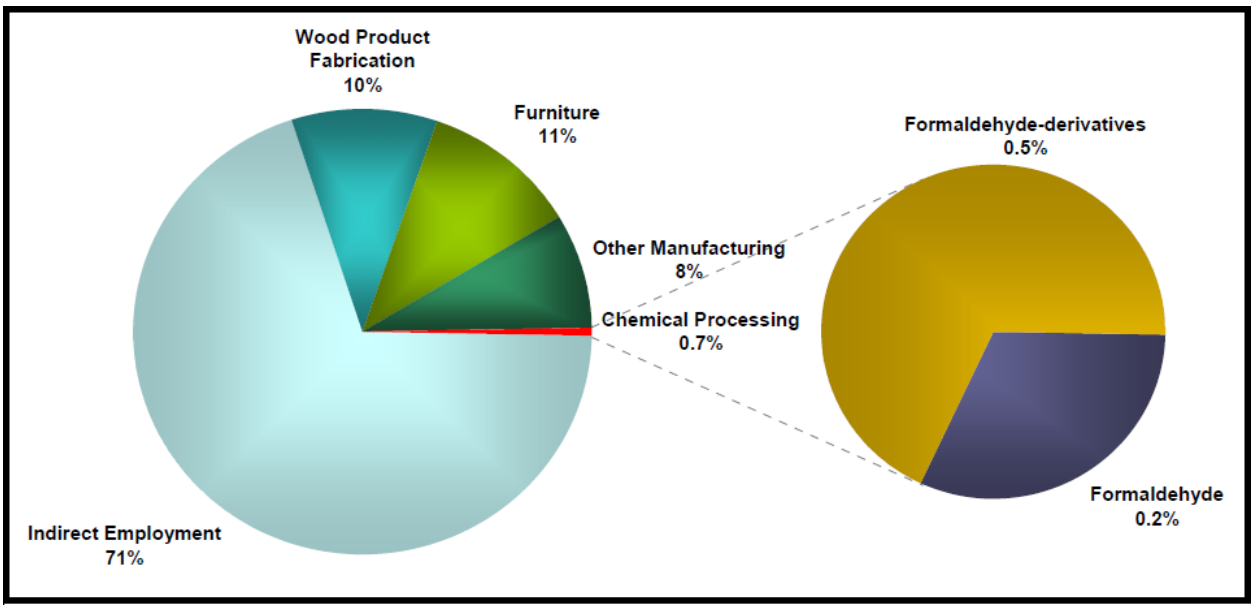

Figure 1: Employment breakdown for direct and indirect uses
SRI Consulting, "Melamine-Formaldehyde (MF) Resins." [2010], Available at: http://www.sriconsulting.com/WP/Public/Reports/mf_resins

Ultimately, the health effects appear to be the most prominent social issue. While the formaldehyde wood paneling does provide some marginal superior physical traits, the PureBond (formaldehyde-free) still provides a much safer and healthier alternative. Switching to PureBond will also cause very little disruption in the work force. These formaldehyde-free panels still require labor work to manufacture as well as it follows the same installation process, which is currently being used with formaldehyde panels in today's construction industry.

3.0 ENVIRONMENTAL ANALYSIS OF FORMALDEHYDE IN PANELING

Formaldehyde is a natural occurring substance in the environment, yet it is toxic to the human body. As a result, formaldehyde does not pose a threat on the environment as it does on the humans. The Formaldehyde Council, a group of formaldehyde producers and industrial users in North America, states that formaldehyde is normally present at very low levels, approximately 0.03 ppm, in both indoor and outdoor air. It breaks down under the sunlight within a few hours of being release and hence, does not accumulate in the environment. The Formaldehyde Council also suggests that formaldehyde in its natural form does not present any major risks at regular exposure levels since human body is capable of metabolizing it within a short period [4]. Other scholars such as Joao M. M. Ferra studied the nature of industrial formaldehyde. She concluded that industrial products generated from formaldehyde, including urea-formaldehyde resin, melamine resin, phenol formaldehyde resin and many others, are toxic and have chronic effects in the human body [5] as discussed in the previous sections.

3.1 FORMALDEHYDE WOOD PANELING

Formaldehyde is a volatile organic compound (VOC), which slowly releases toxic gas at normal room temperatures. Formaldehyde, used in adhesives, is usually released from wood panels in houses and other buildings. Most wood panels contain added urea-formaldehyde adhesives. The California melamine panel, offered by Cherokee Wood Products, is a typical wood panel that is comprised of urea-formaldehyde adhesives. The Cherokee Wood Products website is often a good reference as it helps to understand the benefits of UF resin-bonded panels. They claim that their melamine panels “are highly resistant to moisture, stain, soiling and scuffing and have superior durability and wear resistance”[6]. For obvious marketing reasons, however, Cherokee Wood did not mention the issues associated with UF resins. Prasittisopin Lapyote and Kaichang Li proposed that there are two major problems with UF resins. Firstly, UF resins are derived from non-renewable petrochemicals and, second, carcinogenic gas is released in the production and the use of wood panels bonded by UF resins [7]. As mentioned in section 2.0 and 2.1, despite the considerable long-term health effects, formaldehyde exposure has a series of short-term effects as well. On the other hand, formaldehyde has the same effects in many animals as in humans when inhaled.

3.2 FORMALDEHYDE – FREE WOOD PANELING

To resolve the health issues of formaldehyde-based adhesives, the wood industries have sought after for alternatives acquired from renewable resources. Out of all the formaldehyde-free wood adhesives, soy flour (SF) has been a favorable alternative in the recent years. Columbia Forest Products manufactures wood paneling with their exclusive formaldehyde-free wood manufacturing technology called PureBond. PureBond hardwood plywood panels do not require added UF components. It replaces the traditional adhesive UF resin with SF contributing to an air-friendly indoor environment [8]. The SF adhesive has two basic ingredients — defatted SF and curing agent or hardener. By replacing UF resin with SF, VOCs and offensive odors are reduced. Although low-VOC SF adhesives may not replace the VOC emission issue completely, they do allow the wood product manufacturers to move toward the growing world demand for sustainability.

The manufacturers adapted a two-part contact system in which SF adhesive replaces half of the phenolresorcinol-formaldehyde normally being used. This halving of the use of VOC reduces the total emissions in the environment. The primary raw material of SF adhesive, soybean, is widely available and is a renewable natural resource. In addition, SF adhesives do not produce hazardous waste like UF resins do. In their untreated form, they are liquid solutions that can be washed away easily with just water [7]. SF adhesives have a high viscosity, so particleboard panels made with SF are usually quite strong. It is very difficult, however, to apply the SF adhesive onto wood particles, so a particular method must be used. The common method used is to spray the curing agent onto a mixture of wood particles and defatted SF. The disadvantage to this method is that it requires a much longer press time than the conventional method used with UF resins [7]. A longer press time would lead to a lower production rate and a higher price of wood panels. The economic aspects of SF adhesive are discussed in the follow sections.

4.0 ECONOMIC ANALYSIS OF FORMALDEHYDE IN PANELING

4.1 FORMALDEHYDE – FREE WOOD PANELING

PureBond wood adhesive produced by Columbia Forest Products and is a direct cost-competitive alternative to the use of urea-formaldehyde wood paneling, which is associated with many toxic and environmental concerns. PureBond wood products are produced in North America throughout Canada and the United States. Having Columbia wood products nearby gives PureBond a cost incentive, opposed to buying a similar product from overseas and incurring the cost of transportation. The Columbia Forest Products processing and manufacturing plants shown in Figure 2 are LEED500 certified, two located in Canada and another plant located south of British Columbia in the western United States.

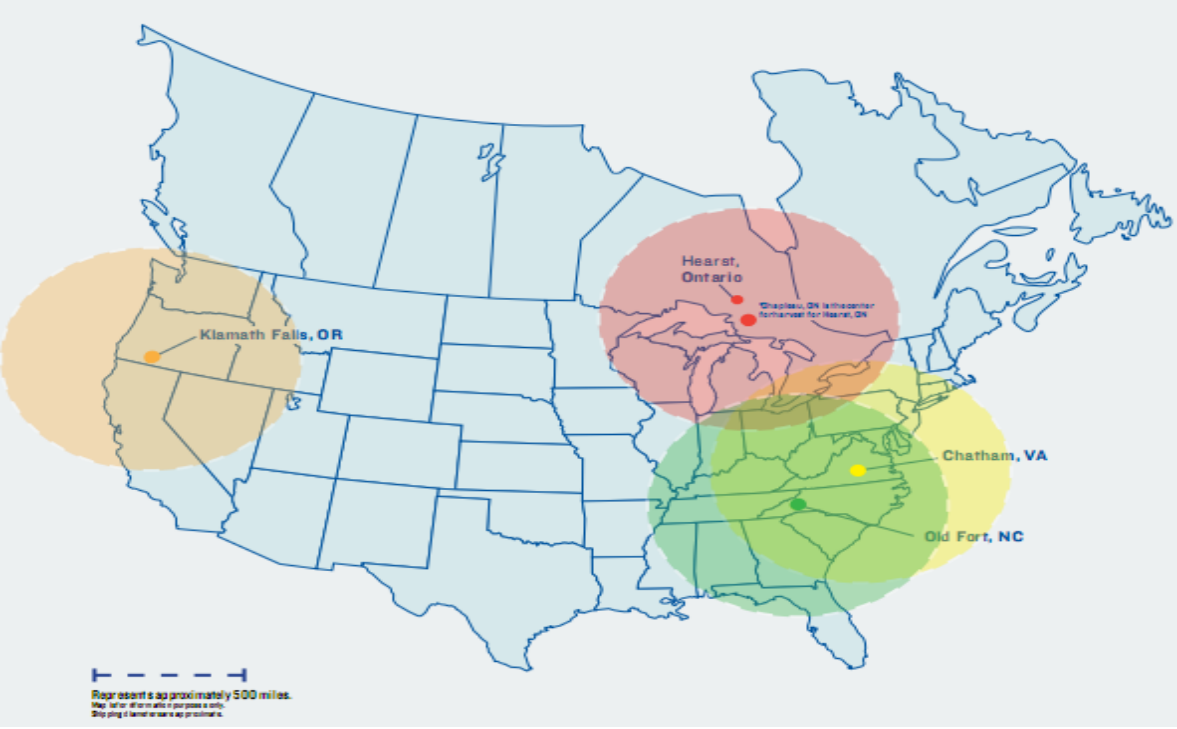

Figure 2: Locations of Columbia Forest Products LEED500 manufacturing plants
Columbia Forest Products, "Hardwood Plywood Shipping Mill Locations in Noth America." Available at: http://columbiaforestproducts.com/Content/Documents/CFP_Mill_Locations_Map_LEED500.pdf

Purchasing wood paneling from nearby manufacturing plants would reduce transportation costs as well as the new SUB's carbon footprint, as opposed to having it shipped from other countries

across the world. It also promotes spending in the Canadian economy, which strengthens this country overall by keeping domestic spending in Canada instead of importing.

Forest products account for the largest exports in Canada, which are diminishing every year. The production of PureBond could help revive wood paneling exports since it is a safe and clean product that comes with LEED certification. Below is a graph of Canadian forest exports.

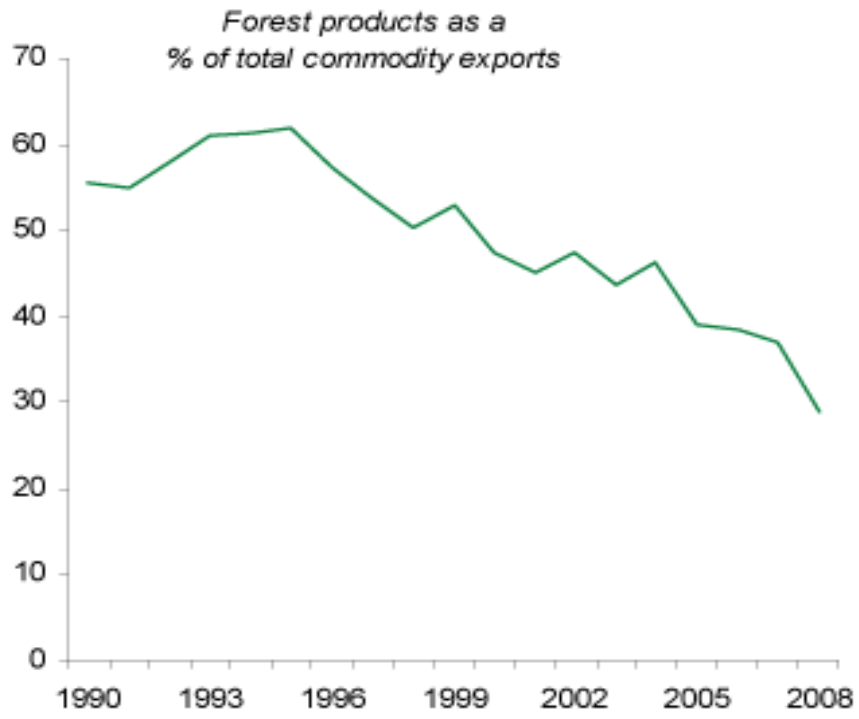

Figure 3: Forestry exports of Canada
BC Stats, "Forest products as a % of total commodity exports." Available at: http://www.guidetobceconomy.org/major_industries/foresty.htm

As shown in the graph, in only a short twenty year span, the exports of Canada's wood products has diminished from a peak of just above sixty percent to about thirty percent of Canada's commodities.

Woodrose is a supplier of Columbia Forest Products and is located in Vancouver, not far from the University of British Columbia. Having a supplier so close to UBC would greatly reduce the construction costs of building the new SUB. Woodrose has also worked with UBC in the past on

the construction of the Liu Centre. They produced the “wall paneling, doors and frames, reception desk and staff room cabinets” [9]. A continued partnership between the Woodrose and UBC could result in a reduced price for the wood products on a large scale.

According to the Portland Cement Association, LEED certified buildings offer “increased labor productivity, job retention, and days worked” [10], which directly relates to the economic profit of companies. The increase in productivity of workers in LEED buildings could be contributed to the cleaner and livelier environments resulting in a more cheerful attitude. This can be seen in a lot of computer science and engineering workplaces where companies make the environment more outdoors feeling to enhance productivity.

4.2 FORMALDEHYDE WOOD PANELING

There are, however, negative economic problems with switching to the use of PureBond wood products. Since urea-formaldehyde has been used for many decades, it has a fully built up infrastructure in place for its mass production. If urea-formaldehyde was to be eliminated from production and the focus was on soy-based PureBond technology, a complete switch over of the manufacturing process would be required, which would incur a huge cost. Another con to using PureBond in the new SUB would be paying for the LEED certification simply for a green title when the money could be spent on other things. It would be cheaper overall to stick with the current wood products offered by the economy than focusing on a complete switch over.

We were unable to produce a life cycle cost for the wood paneling. We attempted to contact experts to assist in the calculation but were either unable to make contact or they were unable to assist. Should our recommendations be considered further, it would be useful to complete the life cycle calculations for economic analysis.

Since UBC is looking to use wood paneling in the new SUB that comes with a LEED certification switching to Columbia Forest Products Purebond wood adhesive would be a sensible solution. Since Purebond is cost-competitive with current urea formaldehyde wood products. As well the production facilities that Columbia Forest Products uses are LEED certified, it would continue with the theme of using LEED products that are not only implemented but produced as well.

5.0 CONCLUSION AND RECOMMENDATIONS

There are many advantages to using formaldehyde-free wood paneling in the new SUB at UBC. Firstly, it does not compromise the structural integrity of the building as compared to wood paneling containing formaldehyde adhesive. Secondly, it is a cost-competitive alternative to formaldehyde panels and is increasingly available in Canada and the United States. Most importantly, using formaldehyde-free panels would avoid the release of toxic vapors into the air, which would benefit both the natural environment as well as human health. It is therefore recommended that formaldehyde – free wood paneling be used in the new SUB at the University of British Columbia.

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