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Manufacturer perspectives on content transparency and material health in the US building products industry

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For the degree of Master of Science

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Date

MANUFACTURER PERSPECTIVES ON CONTENT TRANSPARENCY AND
MATERIAL HEALTH IN THE US BUILDING PRODUCTS INDUSTRY

A Thesis

Submitted to the Faculty

of

Purdue University

by

Alexandra A Muller

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science

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West Lafayette, Indiana

To Paul, David, mom and to my dear ol' dad.

I love you all more than words can describe.

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GLOSSARY

Chemical Abstracts Service (CAS) Number: – a CAS# or CASRN is a unique numeric identifier assigned to “nearly every known chemical, compound or organic substance (ILFI, 2014, p. 70).

Toxicity: the degree to which a substance has adverse impacts on an organism’s health.

Toxicological profile: “an examination, summary, and interpretation of a hazardous substance to determine levels of exposure and associated health effects (US EPA Terminology Services, 2009).

Green chemistry: “an analytical framework that encompasses both the science of safer chemistry and the laws and policies that will motivate its development and adoption by society” (Wilson & Schwarzman, 2009, p. 1204).

Voluntary material health program: for the purpose of this current research, this refers to product inventory and material health assessment programs that “encourage industry to move away from all hazardous ingredients...towards ingredients that are inherently safer” (Heine, Kausch, Klosterhaus, Glass, & Lent, 2013, p. 6).

Optimization: for the purpose of this study, optimization refers to improvement of the toxicological profile of a product through the selection of chemicals established to be safer for human and ecological health.

Precautionary Principle – “When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically” (SEHN, 1998).

Chemicals of Concern – according to the US Environmental Protection Agency, Chemicals of Concern are those which raise “serious environmental or health concerns”

and in some cases “may present an unreasonable risk of injury to health and the environment” (Grossman, 2010).

Final manufacturer – herein defined as the consumer-facing manufacturer in control of the final point of assembly or production for a product.

Disclosure – herein defined as the act, or result, of sharing information about product content inventory at some level.

Threshold: “concentration(s) above which substances present within the material are itemized by the manufacturer or supplier” (HPDC, 2015, p. 55).

LIST OF ABBREVIATIONS

C2C: Cradle to Cradle

C2CPII: Cradle to Cradle Products Innovation Institute

CASRN or CAS#: Chemical Abstract Services Registry Number

EPA or USEPA: US Environmental Protection Agency

HPD: Health Product Declaration

HPDC: Health Product Declaration Collaborative

ILFI: International Living Future Institute

LBC: Living Building Challenge

LCA: Life Cycle Analysis

LEED: Leadership in Energy and Environmental Design

ppm: parts per million

RSL: Restricted Substances List

USGBC: US Green Building Council

ABSTRACT

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Flawed U.S. federal regulation of chemicals has resulted in a materials market that undervalues human and environmental health in favor of the more traditional attributes of price, performance and aesthetics. In the building products industry, global, dynamic supply chains and proprietary information concerns further complicate the task of assessing the material health of products.

Voluntary material health programs in the green building industry are intended to incentivize the manufacture and selection of safer products by getting companies to gather and assess ingredient, hazard and risk information from their supply chain. Building product manufacturers considered early adopters of the main material health programs of interest were interviewed and surveyed in order to identify the barriers they face to further program adoption and disclosure of product content and hazard information.

The research reinforced findings that data collection requirements should be further aligned between different material health programs in order to streamline the process for manufacturers. Release of appropriate levels of information for consumers is also crucial to incentivizing informed decision-making. Supplier engagement and consumer education were identified as pathways to accelerating the demand and release of better information. Addressing these barriers is important to progress, as voluntary measures are likely to remain the most efficient pathway to a healthier materials market.

CHAPTER 1. INTRODUCTION

1.1 Introduction

This chapter provides an overview of the proposed research. It discusses the justification for the subject of the study, the problem to be addressed and the significance of the study. It then outlines the research questions and scope of the study. Assumptions, limitations, and delimitations are used to further refine the research scope.

1.2 Problem Statement

Gaping holes in U.S. federal regulation of chemicals under the Toxic Substances Control Act (TSCA) have perpetuated a materials market that highly undervalues safety in favor of price, performance and function (Wilson & Schwarzman, 2009). Though it was designed to strengthen federal control of chemical regulation, TSCA lacks both the authority to mandate the release of the large majority of chemical hazard information from manufacturers, as well as the means to incentivize investment in better production and products (Scruggs, 2013; Wilson & Schwarzman, 2009). Thus, despite mounting evidence of the negative toxicological impacts of thousands of unregulated chemicals on both humans and the environment, the data gap of chemical information continues to widen over time, further stymying progress.

In the building industry, complex, often global supply chains, competition, and concerns about intellectual property further cloud an already opaque flow of chemical information. In the absence of mandated disclosure of product information or optimization of ingredients, a number of voluntary material health evaluation programs have been developed in an effort to narrow the hazard data gap and prioritize action. These programs also provide much-needed incentives for manufacturers to produce safer products and for architects to specify those products.

Increasing the quality and quantity of product and chemical data, and the sharing of that information, is particularly important for encouraging a healthier materials market. The flow of adequate and appropriate information is important for stakeholders both within supply chains and outside to consumers and policymakers, among others (Fransson, Brunklaus, & Molander, 2013; Kogg & Thidell, 2010). If a company is not fully aware of what is in its products it is impossible for them to confidently avoid toxic chemicals or ensure the delivery of products safe for human and environmental health.

A push for greater disclosure of chemical and hazard information, often described as transparency, is occurring globally, across many industries. Achievement of this outcome can be particularly challenging in the often conservative, and commodity-based building products industry (Hoffman & Henn, 2008; Kamrin, 2014). Theoretically, transparency should allow users to make informed, and thus rational decisions. However, the level, format and nature of that disclosure and transparency are of great debate in the industry. A product sustainability manager for a large US manufacturing company asked:

Is transparency a self disclosed list of raw materials? A self-disclosed list of what I think I know is in my product? A third-party vetted review of what is in my product as told by the raw material supplier? Declarations on the presence or absence of ‘Listed Chemicals’? Some combination of one or more of these? (Correspondence, 2015)

It is important to understand how manufacturers in the building industry are responding to the push for information disclosure within the framework of voluntary material health programs. Understanding how key stakeholders in the manufacturing supply chain interpret and act on principles of material health and transparency may help to identify where gaps exist between program intent and implementation, as well as between manufacturers and their consumers. In turn, identifying barriers currently impeding further program adoption may help lead to a materials market that values health alongside traditionally-valued product attributes.

1.3 Statement of Purpose

The purpose of this current research is to learn what manufacturers perceive as the main barriers to ingredient and hazard disclosure in the US building products industry.

Aggregating the voices of manufacturers to understand the motivation for and challenges to collecting and disclosing material health information will help to identify potential pathways forward to overcoming barriers and achieving broader adoption of voluntary material health programs with significant benefit to humans and the environment.

Additionally, how manufacturers are interpreting the concepts and standards of chemical hazard information in response to requests material health disclosure may reveal disparities between program intent and practice. Better design of voluntary material health programs based on feedback from manufacturers can lead to further harmonization and alignment between programs, better data, clearer interpretation of that data; all leading to healthier products.

1.4 Statement of Significance

There are more than 84,000 chemicals used commercially today, the toxicological impacts of which are known for only a small percentage (Scruggs, 2013). The presence of most chemicals has regularly been tolerated by consumers because of lack of awareness of some of the issues inherent in their use, and because of an assumption that legality of chemical use can be equated with safety (Scruggs & Van Buren, 2014). This incorrect assumption has persisted despite mounting evidence of the human and environmental toxicological impacts of many chemicals. It is an assumption that has been built into US federal chemical regulation (Scruggs, 2013).

Federal regulation of chemicals in the US falls largely under the TSCA's jurisdiction. Though the jurisdictional reach of TSCA is incredibly broad, significant gaps in enforcement, legal tools and market incentives, have largely prevented the statute from being effective (Scruggs & Ortolano, 2011). As a result, toxicological data and safety are still treated as an afterthought, rather than as key factor in product development. The act

has created direct barriers to the progress of green chemistry science and policy by allowing unsafe chemicals to remain competitive and legal.

In the absence of effective federal regulation, a number of regulatory and market forces have recently begun to push the industry to “green” products and operations (Lowell Center for Sustainable Production, 2009). These forces include, but are not limited to:

- green consumerism
- consumer demand for chemical transparency
- regulatory programs (i.e. international, state-level regulation)
- green building and green product certification programs

Voluntary green building certification programs provide a measuring stick for actions beyond regulation and are able to reward adherence to more restrictive standards than regulation. The shift in the green building industry towards broader material health considerations can be seen in some of the most prominent green building standards, including Leadership in Energy and Environmental Design Version 4.0 (LEEDv4) and the Living Building Challenge (LBC), among others. These certifications, among others, include options for pursuing **voluntary material health programs**, further incentivizing architects to select toxicologically preferable materials, and pushing manufacturers to comply with stricter standards for health, safety and transparency of products. The three particular material health programs studied in this current research are the *Health Product Declaration (HPD)*, *Declare Products (Declare)* and *Cradle to Cradle (C2C)*. This is due to their specification within the LEEDv4 standard and LBC in particular, and because some harmonization and alignment already exists between these programs (Heine et al., 2013). Each program aims to help manufacturers better understand what is in their product with the intent of ultimately improving the toxicological profile of products, though each takes a very different approach to this task; some simply aid manufacturers in taking stock of what is in their product and screening it to determine if problematic chemicals are present, all the way to requiring chemical assessments of ingredients, exposure analyses, and making improvements to the formulation.

The life cycle of a building product is often long and complex, involving a large number of stakeholders along the way. Final manufacturers of products are the main adopters of material health programs due to their consumer-facing position at the end of the manufacturing supply chain. They are the initial point of contact for architecture and design firms attempting to specify non-toxic materials and request information, and their products represent the culmination of complex, often global supply chains (Fransson & Molander, 2012). As the focal point of the supply chain in between supply and demand, final manufacturers are often the most familiar with material health programs and issues of disclosure and transparency.

The current research aims to contribute to a broader understanding about how manufacturers are interpreting the call for ingredient and hazard transparency in the building products industry. Previous research has explored the barriers faced by consumer product manufacturers in gathering information from their supply chain, as well as the motivations for proactive chemical policies in manufacturing companies (Lowell Center for Sustainable Production, 2008, 2009; Scruggs & Ortolano, 2011). However, no studies to date have focused specifically on transparency and disclosure in the building industry, nor the role voluntary material health programs are playing in moving the industry forward.

It may also be important for certification program developers to better understand how their tools are being used, in relation to the intent for their use. Manufacturer perspectives on the principles of material health and disclosure and their perception of each program's abilities to deliver these principles, may allow program developers to design more effective programs. Therefore the significance of the current work is its ability to inform the ongoing adaptation of existing programs; thereby encouraging broader adoption of material health disclosure and optimization, both individually, and also collectively, and consequentially benefits for human and environmental health impacts of building materials.

1.5 Research Questions

The following questions guided this research:

1. What are the barriers, both real and perceived for U.S. building product manufacturing companies to engaging with voluntary material health programs?
2. What is the manufacturer evaluation of the three main material health programs? What are the barriers to adoptions? What are the benefits to participation?
3. How do manufacturers define transparency? To what extent do manufacturers feel transparency is a prerequisite to achieving a building product industry that is safe for humans and the environment?

1.6 Assumptions

The following assumptions were made in this study:

- Manufacturers that are interacting with voluntary material health programs in the building products industry are industry leaders on issues of material health and transparency.
- Manufacturers, architects, tool developers, and other stakeholders along the product supply chain share a common goal of improving the toxicological profile of products

1.7 Scope and Delimitations

This research is not an exhaustive look at existing material health programs, nor does it attempt to rank those programs within its scope. All of the programs take a different approach, resulting in a different outcome.

The *Health Product Declaration* (HPD) standard, *Cradle to Cradle* (C2C) certification standard, and *Declare* are some of the main voluntary material health product programs in use right now, due in part to their inclusion green building certifications such as LEEDv4 and LBC. Therefore, this study will focus on analyzing the manufacturer

perspective on only these three programs. The existence of other programs and their competition for similar space in the materials market is acknowledged.

All of the programs share the goals of improving material hazard and chemical ingredient communication in the building industry, as well as supply chain integration. Based on their different philosophies, each program approaches these issues from a different perspective. The goals of the current research are to understand why manufacturer may prefer one pathway over another, what manufacturers perceive to be barriers to and benefits of each program, and to identify pathways for broader adoption industry wide.

The delimitations for this study were as follows:

- Participants were limited to manufacturers in the building material industry
- Manufacturers outside of the U.S. were not included in the study
- Manufacturers were proactive in the world of chemical assessments and disclosure, so that they would have greater insight into best practice
- The research focused on only three material health evaluation programs: *Health Product Declaration*, *Cradle to Cradle*, and *Declare Products*.

1.8 Chapter Summary

This chapter introduced the problem of inadequate chemical regulation in the U.S. and its impact in shaping a product market that undervalues human and environmental health in favor of price and performance attributes. Consumer interest in manufacturer transparency around product ingredient and hazard content, and the resulting trend towards increased information disclosure in the building products industry was discussed. The need for research to better understand key stakeholder perspectives on issues of material health and chemical transparency was raised. Parameters of the research were defined by presenting the research questions, deliverables and significance of the study. The assumptions, limitations and delimitations of the study were used to further refine the research scope.

CHAPTER 2. REVIEW OF THE LITERATURE

2.1 Introduction to the Review of the Literature

This chapter provides the reader with an introduction to the shortcomings of US federal chemical regulation. It describes the increasing push globally for product information and manufacturer transparency. The role of green building certification programs and material health programs in addressing human and environmental health concerns around building products is discussed. The chapter also introduces some existing research on the barriers to obtaining ingredient and hazard information for products and the complexity involved in publicly disclosing product ingredient and hazard information.

2.2 Ubiquity of Chemicals in Modern Society

Nearly everything we manufacture is been made from, treated with, or coated in chemicals in some manner. Synthetic chemicals “now constitute the primary material base of society” (Wilson & Schwarzman, 2009). The role of the U.S. chemical industry in shaping modern lives and the national and global economies cannot be overstated. Chemical innovation and production has, as a result, had innumerable direct and indirect benefits on the economy and modern society.

Chemicals created or used for one purpose may nonetheless also produce unintended consequences. These negative externalities of chemicals are “expressed as human and environmental risks” (Koch & Ashford, 2006). The potential for negative externalities exists throughout the full life cycle of a chemical, from raw material extraction to production and transportation, to application and disposal. Similar to carbon emissions and pollution externalities, our economy has long allowed producers to operate without taking these impacts into account.

This extreme dependence on chemical usage is very much at odds with a dearth of information and understanding about the impacts of the vast majority of chemicals throughout their life cycle. Manufacturers have been able to operate without sufficient knowledge of what their products contain and what impacts they might have. In turn, consumers lack the ability to make informed decisions about what products to use and how to use them.

In the wake of rising health issues tied to issues of chemical usage, it is important to recognize that of the over 84,000 unique chemicals used commercially today, toxicological data is available for only a very small percentage of these (Markell, 2010; Scruggs, 2013).

The presence of most chemicals in products has been largely tolerated by consumers a) because of a lack of awareness of some of the issues inherent in their use, b) because of an inability to determine what is in products or how to choose safer ones and b) because of an incorrect assumption that legality of chemical use can be equated with safety under US chemical regulation. The presumption of safety of existing chemicals was in fact written into US federal chemical regulation, despite mounting volume of scientific evidence to the contrary (Scruggs, 2013).

2.3 US Federal Chemical Regulation

In the late 1960's and early 70's, public perception of inadequate control of toxic chemicals was building support for increased regulation. The Council on Environmental Quality (CEQ) wrote that (1) toxic substances were making their way into the environment, (2) that the negative impacts of those substances was substantial, (3) that legal authorities lacked the ability to remedy this issue, and therefore (4) a new legal authority was required (Markell, 2010).

National media coverage around the role of Kepone, an insecticide, in causing neurological disorders in factory workers, fed public pressure to prevent these types of tragedies from being repeated. The incident helped to build consensus for the passage of TSCA, six years after its introduction in Congress. One of the bill's sponsors, Senator

Pearson, said at the time, “We can no longer operate under the assumption that what we do not know about a chemical substance cannot hurt us. Tragic results associated with too many toxic substances have taught us that lesson all too well. Chemicals, not people, must be put to the test” (Markell, 2010). TSCA was signed into law in 1976 (Kapp, 2014).

2.3.1 Gaps in Federal Regulation

TSCA was designed to broaden federal oversight a chemicals market that lacked “any form of accountability or oversight” (Wilson & Schwarzman, 2009). TSCA is the only federal regulation in the US “governing chemical manufacture, importation, distribution, and use” (C. E. Scruggs & Van Buren, 2014) intended to regulate chemicals both before and after entering the market. The thought was that TSCA would improve the “toolbox” available to the EPA (Markell, 2010), which at that point also included the Clean Water Act, Clean Air Act, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and others. The other laws are mostly limited to end-of-pipe statutes pertaining only to chemicals already on the market, and only covered 1,134 chemicals and pollutants as of 1997.

On paper, “TSCA has a potentially enormously...broad jurisdictional reach” (Markell, p. 352). The definition of chemical substances by Congress is inclusive of “[a]ny organic or inorganic substance of a particular molecular identity, including—(i) any combination of such substances occurring in whole or in part as a result of a chemical reaction or occurring in nature and (ii) any element or uncombined radical” which includes even microorganisms (Markell, 2010, p. 351-352).

However, while the scope of TSCA is technically inclusive of the approximately 84,000 chemicals in use today (Markell, 2010), loopholes and gaps in that same act have deeply undermined the ability of the EPA to adequately regulate those chemicals. TSCA’s impact on the great majority of chemicals it governs has been minimal. In fact, the act has all but prevented the assessment of hazard traits for most chemicals in use, the control of chemicals of concern, and the advance of green chemistry efforts.

Wilson & Schwarzman (2009) attribute this failure to three main gaps in the act:

- Data gap: regulation does not compel chemical producers to produce or disclose product hazard information
- Safety gap: the government does not have the legal tools necessary to “identify, prioritize, and take action to protect public and environmental health”
- Technology gap: lack of market incentives for innovation or investment in green chemistry efforts or safer chemicals.

At the time of its passage, TSCA grandfathered in a large majority of existing chemicals (approximately 62,000) “assuming them to be safe since they were already in use” without requiring toxicological or hazard information about them (Scruggs & Ortolano, 2011). The Environmental Protection Agency (EPA) lacks the power necessary to extract this vital information from producers and manufacturers. TSCA “creates perverse incentives for health and safety information about chemicals to be not produced, and if produced, not fully disclosed” (Kokai, 2014). The EPA is unable to close this data gap and is therefore unable to prioritize the removal of certain chemicals. Only about five chemicals or chemical classes have been significantly regulated under TSCA. These interlocking problems reinforce one another, resulting in a market that undermines health and safety and act as a direct barrier to green chemistry by keeping harmful materials price competitive with safer ones (Kokai, 2014; Wilson & Schwarzman, 2009).

After 40 years without significant updates to the act, the Frank R. Lautenberg Chemical Safety for the 21st Century Act was signed into law on June 22nd, 2016. The act is designed to remove some of the barriers preventing action by the EPA within TSCA and its bi-partisan passage has been celebrated by many politicians and by chemical and industry groups. The act gives the EPA more power to prevent dangerous chemicals from going to market and addresses some issues of prioritization of reviews, among other changes. However, other stakeholders including many environmental organizations, view the update as inadequate, citing a lack of funding for the implementation of the changes, and criticizing perceived added limitations to state-level regulation of chemicals (Kollipara, 2015; Fears, 2016). The efficacy of these changes in incentivizing the production and use of data, protection of consumers and investment in green chemistry remains to be seen.

2.4 A Growing Demand for Information

In the absence of strong top-down chemical regulation, global demand for information by a wide number of stakeholders has nonetheless grown in recent years (Kogg & Thidell, 2010). Many industries are thus beginning to grapple with the challenges inherent in gathering and disseminating this information.

The information demand generally focuses on product content, as “products are vehicles through which chemicals travel through our societies” (Kogg & Thidell, 2010, p.37). Products containing harmful chemicals have the potential to negatively impact individuals and the environment throughout their full life cycle, from extraction to manufacture to use and disposal. Therefore demand for information regarding product content and toxicological impacts originates from a large number of stakeholder groups. Self-imposed restrictions by manufacturers on the chemicals they purchase and use were found by the Lowell Center for Sustainable Production (2008) to be driven by:

1. **Regulatory Drivers** – US manufacturers may still be affected by state-level, as well as international, regulations (GC3, 2008).
 - a. In particular, the European Union’s REACH program (Registration, Evaluation, Authorisation and Restriction of Chemicals) program came into effect in 2007, and is being phased in through 2018. Designed to “ensure a high level of protection of human health and the environment from the risks that can be posed by chemicals, the promotion of alternative test methods, the free circulation of substances on the internal market and enhancing competitiveness and innovation”, REACH addresses some of the gaps inherent in TSCA (European Commission, 2013). In a global market, US manufacturers are not insulated from these regulations. REACH requirements apply to imported goods as well as those produced within the EU.
 - b. California’s Proposition 65 is an example of state-level regulation that has had impact beyond its borders. One of the purposes of the act was to

protect the public from CMRs (Carcinogens, Mutagens and Reproductive Toxins) (Lowell, 2008).

2. **Marketing Drivers** – Purchasing programs are popping up in a number of industries, from food stores to “big box” stores to building material retailers. Compliance with a retailer materials program is required for a company to sell their products within that store. Walmart “Preferred Chemicals” program is one of the best known of these initiatives. Walmart began tracking hazardous chemicals sold in their stores in 2004, and moved from a purely restricted substances list approach in 2008 to a third-party screening process using a tool called GreenWERCS. These can be huge incentives for manufacturers selling consumer products.
3. **Advocacy Drivers** – NGOs and advocacy groups play a large role in changing how manufacturers approach the use of chemicals. In particular, their ability to create product standards and certification programs that go beyond regulation satisfies a demand for standardization and communication with consumers.

This current research focuses on the role of advocacy in motivating manufacturers to gather and disseminate chemical and hazard information through voluntary certification programs and standards.

2.5 MSDS and SDS

The U.S. Occupational Safety and Health Administration (OSHA) require that information about potentially harmful substances handled in the workplace be made available to employees. This previously took the form of the Material Safety Data Sheet, or MSDS, standardized information transmission sheets used to communicate “performance characteristics, safe handling and transport, and basic hazard and toxicological information” (Lowell, 2009, p. 4). However, many MSDSs are woefully incomplete in terms of chemical ingredients and toxicological data.

Following the UN Conference on Environment and Development in Rio de Janeiro in 1992, the U.S. was one of 65 countries so far to adopt a globally harmonized system of

classification and labeling of chemicals. The MSDS thus became the Safety Data Sheet, (SDS) which now follows a more standardized 16-section format covering information from human and environmental health hazards, exposure control, protective measures, and safety precautions (OSHA, 2016).

2.6 Hazard vs. Risk

MSDS and SDS were “primarily designed to provide information on mostly acute occupational health hazards, not those throughout an entire product lifecycle” and are therefore inadequate for informed decision-making in selecting safer materials and products (Lowell, 2009, p. 4). Approaches to material health generally revolve around two these concepts of hazard and risk. Hazard refers to a substance’s inherent “potential to cause adverse health or environmental effects” (Rossi, 2015). These characteristics are intrinsic, regardless of the context in which the product is manufactured, used, or disposed of. The likelihood that a substance will cause harm within a certain context is a question of risk. Hazard exists regardless of risk, but risk *cannot* exist without hazard. Risk “is defined as a function of hazard and exposure” and is therefore dependent on the amount, timing, duration, and pathway (i.e. inhalation, ingestion, touch) of exposure, as well as its interaction with other environmental factors (Rossi, 2015).

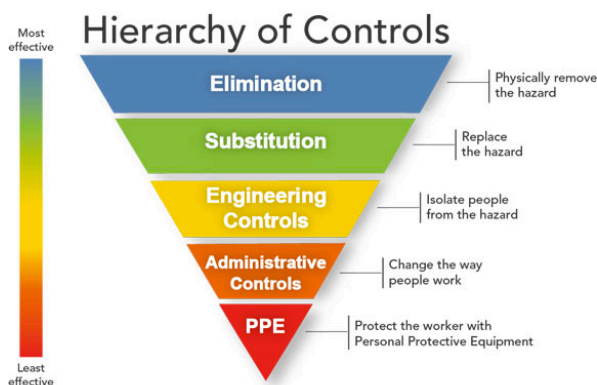


Figure 2.1. Hierarchy of Controls. (Rossi, 2015)

Therefore an approach that physically removes hazards is considered by the Center for Disease Control to be the most effective, rather than minimization of risk and exposure (Figure 2.2).

2.7 Green Building and Health

The construction industry has arguably the largest environmental impact of any economic activity. The industry accounts for 40% of the world's greenhouse gas (GHG) emissions, and uses 40% of global total primary energy (Assefa et al., 2007; Ding, 2014). From raw material extraction, through construction and maintenance, renovation and end-of-life disposal, buildings cause both direct and indirect harm to the environment.

Green building began as a narrowly-focused attempt to increase the efficiency of the built environment (Espinoza, Buehlmann, & Smith, 2012; Isnin, Ahmad, & Yahya, 2012). The movement was mainly triggered by the fear of fossil fuel dependence in the wake of the 1973 OPEC oil embargo and capitalized on an increased awareness of the environmental impact of human activity and construction (Cassidy, 2003; Ding, 2014). Over time, our evolving understanding of what it means to be sustainable has built a more holistic picture of green building beyond the narrow focus of energy efficiency. The U.S. Office of the Federal Environmental Executive defined green buildings as resource efficient, and also those “[reduce] building impacts on **human health and the environment** through better siting, design, construction, operation, maintenance, and removal - the complete building life cycle” (Cassidy, 2003, p. 4).

While indoor air quality and daylighting have been considerations for a relatively longer period of time, the health impacts of the products that comprise a building have more recently become a focus of green building efforts. The average American spends over 90% of their time indoors, thus the requirement that buildings be healthy, in addition to efficient, has emerged as a new driver in the green building movement (Ding, 2014). Today, “reducing the toxicity of building materials is part of the ‘greening’ process, and avoiding the use of materials that release pollutants is one of the principles of eco-efficient construction” (Pacheco-Torgal, 2012, p. xv).

A number of voluntary material health evaluation programs have thus arisen out of the demand for product and chemical information and assurance of product safety in the building industry. Their recent incorporation into well-known green building

certifications like LEEDv4 and LBC further incentivize manufacturer involvement with these platforms, and the collection and dissemination of material health information.

The LEED green building standard has been particularly effective in introducing building designers and contractors to the concepts of energy efficient building design since the 1990's (Lee & Kim, 2008). As of April 2016, LEEDv4 now has a "Building Product Disclosure and Optimization – Material Ingredients" credit, pathways to which include product compliance with material health programs including *Declare*, *Cradle to Cradle (C2C)*, and the *Health Product Declaration (HPD)* Standard.

The Living Building Challenge (LBC), a green certification and advocacy program administered by the International Living Future Institute (ILFI), is considered to be one of the most stringent green building certifications in existence. The Challenge is comprised of seven performance categories called "Petals": Place, Water, Energy, Health & Happiness, Materials, Equity and Beauty.

One of the biggest barriers to achievement of the Living Building Challenge is the Red List. The Red List is a restricted substances list, which bans the use of 22 classes of chemicals, or 777 individual CASRNs in Living Building projects. Therefore, projects pursuing the Materials Petal of LBC must make sure all products used have been screened against the Red List and do not contain any Red List materials. The goal is to push the principles of transparency and move the materials market to "eliminate the use of worst-in-class materials/chemicals with the greatest impact to human and ecosystem health" (ILFI, 2014, p. 6). The Red List continues to evolve, intended to act as a means to transform the materials market (S. Wright, personal communication, 2014). The *Declare* product ingredient transparency program was created by ILFI as a companion to the Red List in order to aid project designers looking for products free of Red List ingredients.

2.8 Voluntary Material Health Programs

The number of ecolabels across many industries has exploded over the last few years (Basu & Bidanda, 2014). A number of these now approach the issue of material health in some form. A finished product is the synthesis of different materials, and those materials

in turn, are composed of different chemicals. There is significant debate over the best level at which to analyze a product, to determine a product's hazard profile, and to communicate content and hazard information. Kokai (2014) describes this 'design hierarchy' (Figure 2.2) and the degrees that often separate the makers of a final product from the chemicals from which it is built. Each of the programs studied in this research takes a different approach to the issue of material health.

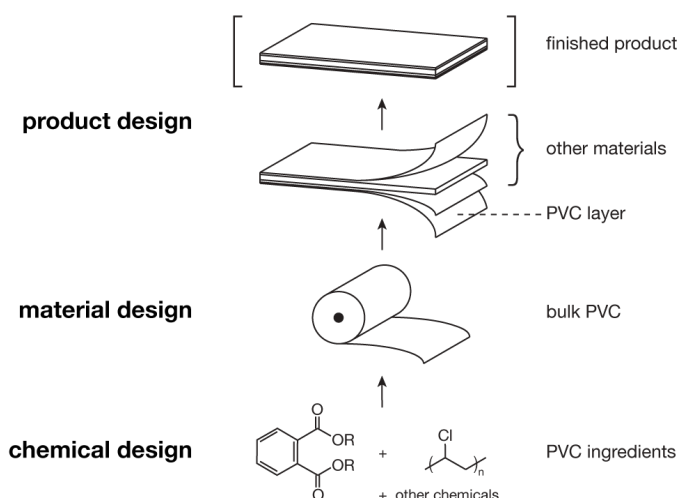


Figure 2.2. Design hierarchy (Kokai, 2014)

Within the building industry, the three programs selected for this current research (*HPD*, *Declare*, and *C2C*) were selected based on a) the ability of all building product manufacturers to engage with them, b) ongoing program harmonization efforts between the groups, and c) their inclusion as a pathway for material health in the LEEDv4 and LBC standards.

Both LEED and LBC thus incentivize the pursuit of certain voluntary material health programs, designed to inform the production of safer materials in the supply chain, and encourage the selection of better products by design teams, thereby rewarding manufacturers engaging with these programs. Material health programs are designed to facilitate “informed judgment,” at different levels, standardizing and adding rigor to how

we compare and select chemicals, materials and products (Kokai, 2014). Each of the programs studied within this research approaches the issues of material health and ingredient disclosure differently, particularly by incorporating hazard and/or risk.

Each of the programs studied in this current research and their approach to material health are described in the following sections.

2.8.1 GreenScreen for Safer Chemicals

Although *GreenScreen* is not a standard for final products, and was not studied specifically in this research, it's important to acknowledge the role of *GreenScreen* because of its use in ingredient assessment and as a tool within other standards.

GreenScreen is a Chemical Hazard Assessment program developed by Clean Production Action. The standard is freely and publicly accessible. The standard looks at 18 different hazard endpoints (Figure 2.3) to determine the hazard levels for each.

Figure 1: GreenScreen™ Hazard Ratings for 2-Ethyl-1-Hexanol

Group I Human					Group II and II* Human								Ecotox		Fate		Physical		
C	M	R	D	E	AT	ST		N		SnS*	SnR*	IrS	IrE	AA	CA	P	B	Rx	F
						single	repeated*	single	repeated*										
L	L	<i>dg</i>	M	<i>dg</i>	M	<i>dg</i>	L	<i>dg</i>	<i>dg</i>	L	<i>dg</i>	M	H	M	<i>L</i>	<i>vL</i>	<i>vL</i>	<i>L</i>	M

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated values and lower confidence. Hazard levels in **BOLD** font reflect values based on test data (See Guidance).

Figure 2.3 GreenScreen Assessment example (Clean Production Action, 2016)

Based on these endpoints, an overall benchmark for chemicals on a scale of 1-4 (Figure 2.4) is then provided. Chemicals that lack enough information to make a determination are labeled U for undetermined. Benchmark 1 chemicals should be phased out of production, while Benchmark 4 chemicals are considered inherently safer.

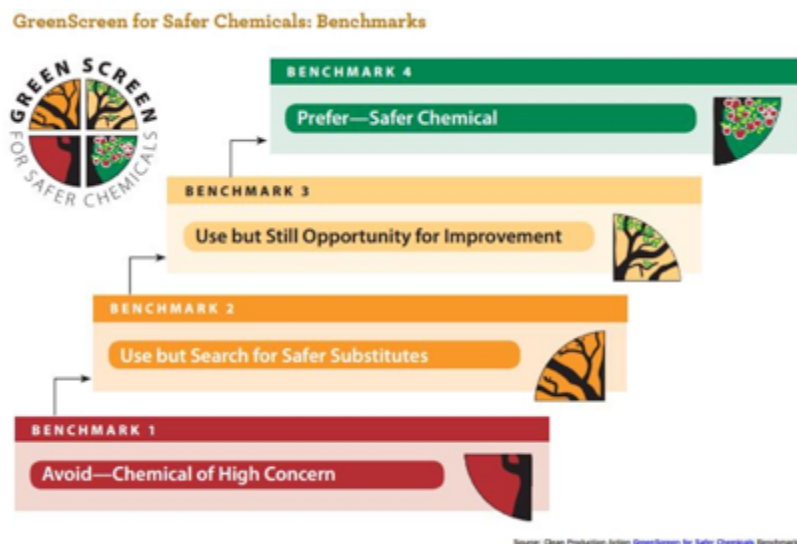


Figure 2.4. GreenScreen Benchmarking Scale (Clean Production Action, 2016)

The assessment encourages users to: assess and clarify ingredient hazards, apply the overall benchmark system, and make informed decisions about which chemicals to use.

Benchmarking chemicals can make the chore of finding a substitute chemical easier, by only having to locate a chemical with a better benchmark score. However, by combining all of the hazard endpoints into one final score, users cannot see whether a chemical performs higher or lower on specific endpoints, which can be an issue if certain endpoints are more important to the user than others based on use, location or some other factor (Kokai, 2014). Also, when chemicals are examined at the ingredient level, one is only able to look at the inherent hazards present in the ingredient, and the system does not take into account the risk of exposure in the ingredient's state and combination with other chemicals in a product. The Health Product Declaration uses the *GreenScreen List Translator* tool to represent the known hazards for ingredients disclosed on the standard. *Cradle to Cradle* uses a similar method to *GreenScreen* for assessing chemicals, however *C2C* only looks at 14 hazard endpoints, and the program also takes into account product-level risk and exposure.

2.8.2 Health Product Declaration

The *Health Product Declaration (HPD)* form provides manufacturers with a standardized format for content and hazard disclosure and communication. The standard was developed and is overseen by the Health Product Declaration Collaborative (HPDC). *HPDs* can either be self-disclosed or third party certified.

The *HPD* screens product ingredients against more than 30 separate hazard lists and the *GreenScreen List Translator* benchmarks. There is a greater emphasis on disclosure of *GreenScreen* hazard ratings than ingredient CAS #s. *HPDs* do not require a minimum level of disclosure, but the form allows manufacturers to specify the level at which they are disclosing. Figure 2.7 shows an example of an *HPD*. Within the continuum described above in figure 2.5, the *HPD* is considered a tool for content inventory and screening.

Nylon Modular Carpet Tiles on EcoFlex™ NXT by Mohawk Group

CLASSIFICATION: 09 68 13
 PRODUCT DESCRIPTION: MOHAWK GROUP ECOFLEX NXT MODULAR CARPET TILES HAVE A COMPOSITE CONSTRUCTION OF A TUFTED NYLON FACE, PRIMARY BACKING, FIBERGLASS SCRIM, PRE-COAT POLYMER WITH AN EXTRUDED POLYOLEFIN MODULAR BACKING. IT ALSO INCORPORATES AN AVERAGE OF 54% RECYCLED CONTENT. THE ECOFLEX MODULAR CARPET TILES WITH SOLUTION-DYED NYLON ARE ALSO LIVING BUILDING CHALLENGE RED LIST FREE.

Health Product Declaration v2.0
created via: HPDC Online Builder

☰
Section 1: Summary

CONTENT INVENTORY

Threshold per material
 100 ppm
 1,000 ppm
 Per GHS SDS
 Per OSHA MSDS
 Other

Residuals and impurities considered in
 1 of 1 materials
 see Section 2: Material Notes
 see Section 5: General Notes

Based on the selected Content Inventory Threshold:

Characterized.....
 Are the Percent Weight and Role provided for all substances? Yes No
 Screened.....
 Are all substances screened using Priority Hazard Lists with results disclosed? Yes No
 Identified.....
 Are all substances disclosed by Name (Specific or Generic) and Identifier? Yes No

CONTENT IN DESCENDING ORDER OF QUANTITY

Summary of product contents and results from screening individual chemical substances against HPD Priority Hazard Lists and the GreenScreen for Safer Chemicals®. The HPD does not assess whether using or handling this product will expose individuals to its chemical substances or any health risk. Refer to Section 2 for further details.

MATERIAL | SUBSTANCE | RESIDUAL OR IMPURITY
 GREENSCREEN SCORE | HAZARD TYPE

NYLON MODULAR CARPET TILES ON ECOFLEX™ NXT | FLY ASH LT-UNK 1-OCTENE, POLYMER WITH ETHENE LT-UNK POLYETHYLENE TEREPHTHALATE (PET) LT-UNK ALKENES, ETHYLENE-MANUF.-BY-PRODUCT PIPERYLENE-CUT, POLYMD. LT-UNK BUTADIENE ACRYLATE LT-UNK GLASS / MINERAL FIBER LT-UNK NYLON 6 LT-UNK NYLON 6.6 LT-UNK LIMESTONE; CALCIUM CARBONATE LT-UNK 2-PROPENOIC ACID, BUTYL ESTER, POLYMER WITH ETHYL 2-PROPENOATE, N-(HYDROXYMETHYL)-2-PROPENAMIDE, 2-PROPENAMIDE AND 2-PROPENITRILE LT-UNK 2-PROPENOIC ACID, 3,3,4,4,5,5,6,6,7,7,8,8,8-TRIDECAPFLUOROCTYL ESTER LT-UNK 2-PROPENOIC ACID, 2-METHYL-, 3,3,4,4,5,5,6,6,7,7,8,8,8-TRIDECAPFLUOROCTYL ESTER LT-UNK SODIUM POLYMETHACRYLATE LT-UNK

Number of Greenscreen BM-4/BM3 contents..... 0
 Contents highest concern GreenScreen Benchmark or List translator Score..... LT-UNK
 Nanomaterial..... No

INVENTORY AND SCREENING NOTES:

The EcoFlex NXT modular carpet tiles are up to 40% lighter than similar competitive products. The tiles does not contain plasticizers and has an average of 54% recycled content.

VOLATILE ORGANIC COMPOUND (VOC) CONTENT

VOC Content data is not applicable for this product category.

CERTIFICATIONS AND COMPLIANCE

Self-Published* VERIFIER: SCREENING DATE: March 4, 2016 EXPIRY DATE: March 4, 2019
 Third Party Verified VERIFICATION #: RELEASE DATE: March 4, 2016 * or within 3 months of significant change in product contents
*See HPDC website for details

Figure 2.5 Example HPD (Mohawk, 2016).

Manufacturers have the option to choose the level at which they want to disclose. One option is to disclose all known hazards without listing all of the chemicals in the product. The other option is full chemical disclosure, in which 99% of the product by weight must be accounted for. *HPDs* are intended *HPD* documents are intended to make clear what a material contains, but they are also clear about what is withheld.

HPDs do not rate products, and are not directly linked to a building standard in the way a Declare label is. They are intended to promote standardized sharing of information in order to encourage a conversation on hazard reduction and continuous improvement (*HPDC*, 2011). At the time of this research the *HPD* is in the process of transitioning to the 2.0 standard, which makes some changes to the format of disclosure and the options available to manufacturers regarding how they report their product contents.

2.8.3 Declare Products

Begun as a companion to the Living Building Challenge, *Declare* is often described as a “food label” for building products. The label was developed as a tool for transparency and market transformation, and aids LBC project teams pursuing LBC by providing a clear way to understand whether a product does or does not contain the Red List chemicals prohibited from use in LBC projects. *Declare* was also designed to encourage ingredient transparency and change norms of proprietary and trade secret claims.

Declare itself is a content inventory and screening tool, however it differs from *HPD* in a number of different ways. First, hazard ratings are not disclosed on the label or in the *Declare* database. Second, all participating manufacturers are required to disclose the ingredient name and CAS# for 99% of all intentionally added ingredients at the same threshold of 100ppm in the final product. Third, the standard is tied to the LBC standard, and therefore the presence or absence of Red List chemicals in a product determines whether a product can be used in an LBC project. Any *Declare* labels that disclose 99.9% of their ingredients now meet Option 2 of the Building Product Optimization and Disclosure credit of the LEED v4 standard, incentivizing transparency.

Manufacturers are asked to self-disclose at least 99% of intentionally-added ingredients in the product. Products then fall into one of three categories, or Declaration statuses:

- **Red List Free:** 100% of the final product content is disclosed at 100ppm and the product contains no chemicals named on the LBC Red List
- **Red List Compliant:** At least 99% of product content is disclosed. The product of makes use of a temporary exception outlined in the LBC standard. This exception may have to do with a) a product containing chemicals on the LBC Red List that are allowable due to market realities or b) the product withholds up to 1% of the product content to allow for retention of some proprietary information
- **Declared:** The product is 100% disclosed, but contains some Red List materials. These products are generally not allowed for use in LBC projects.

The *Declare* product labels and online database were designed to make the selection of products for Living Building Challenge projects easier, and to increase manufacturer product transparency. Products are assigned a “nutrition label” of ingredients (Figure 2.6), making it easier to select LBC Red List-free building materials (ILFI, 2014). The label is simple, and easy to read. Labels list the chemical names of ingredients, rather than CAS numbers, or hazard ratings as the *HPD* does.

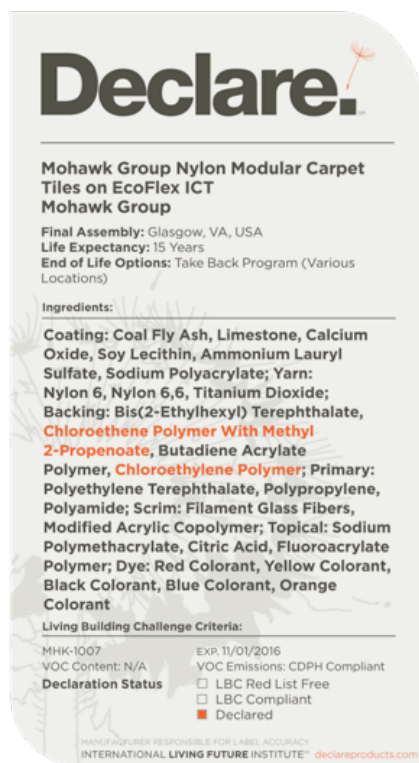


Figure 2.6 Example Declare Label (ILFI, 2016)

Here, ‘optimization’ of products is *indirectly* encouraged because of a) automatic qualification for Living Building Challenge projects if a product is Red List Free or Red List Compliant and b) the Living Building Challenge mandates that project teams advocate for manufacturer transparency when trying to obtain materials for LBC projects. The label itself, however, does not require any optimization, nor does it require that materials comply with the Red List.

2.8.4 Cradle to Cradle

Cradle to Cradle certification began in 2005 in order to certify products across industries (not just building industry) and rates products on five impact categories:

- Material health
- Material reutilization
- Water stewardship
- Renewable energy and carbon management
- Social fairness

Cradle to Cradle uses third party accredited assessors to collect, analyze, and evaluate product data. Products are then given a rating from bronze to platinum in all five categories, as well as an overall rating (Figure 2.7).

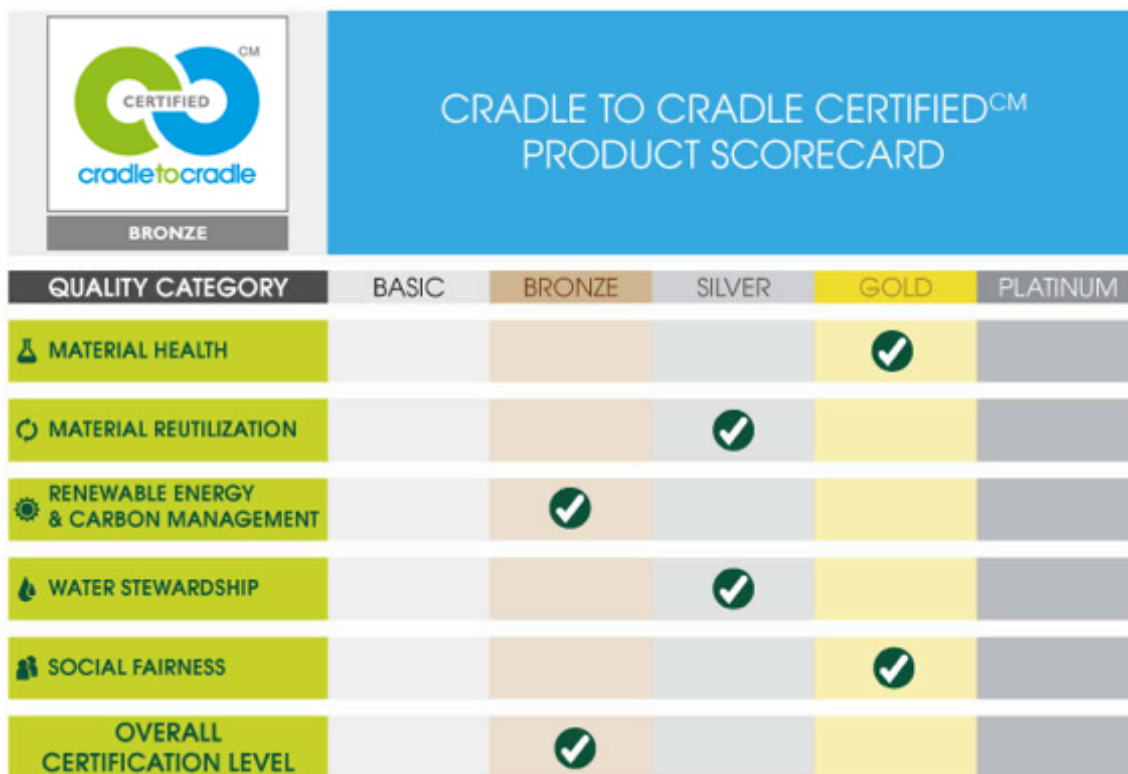


Figure 2.7 Cradle to Cradle Product Scorecard (C2CPPII, 2016)

Cradle to Cradle was a relatively early program in the material health arena. The program requires inventory screening, and a minimum percentages chemical assessments in the product to achieve each level of certification. The highest levels of *Cradle to Cradle* require that the product is fully assessed and optimized. Optimization here refers to the product being free of risk from exposure to Carcinogens, Mutagens or Reproductive Toxicants (or CMRs), which are particularly problematic chemicals.

Cradle to Cradle is very different from the other two programs described as it neither requires disclosure of product content, nor is the standard itself fully transparent. According to Kokai (2014) the standard was initially “proprietary and inscrutable,” though standard details have been revealed further over time, and the methods are available for public review. Use of a third party to gather information from the supply chain often allows manufacturers to maintain the confidentiality of product makeup or intellectual property. This may attract manufacturers who are less comfortable with

ingredient or hazard disclosure, or have a more proprietary supply chain, but who still want to engage with material health considerations for their product. *Cradle to Cradle* is also one of the most expensive material health programs. The multi-attribute, third party assessment of the product means that the certification cannot be carried out in-house. *Cradle to Cradle* began awarding Material Health Certificates in 2014, which look at only the material health portion of *C2C* certification rather than all 5 categories, in an effort to engage manufacturers who might not be ready to pursue the whole certification.

2.9 Program Approaches

Each of the three programs studied in this research have very different program attributes. However, these programs are all being used as a pathway for product selection for green building programs.

One way to illustrate the differences between the three programs is by representing them along a material health assessment continuum. In figure 2.8, **Inventory** refers to determination of product content; **Screen** refers to cross-referencing ingredients against Restricted Substances Lists (RSLs); **Assess** refers to assessment of all product ingredients by looking at ingredients based on a number of hazard endpoints; **Optimize** refers to required ‘improvement’ of products—specifically, that products be free of certain problematic materials or free of risk of exposure from those materials.

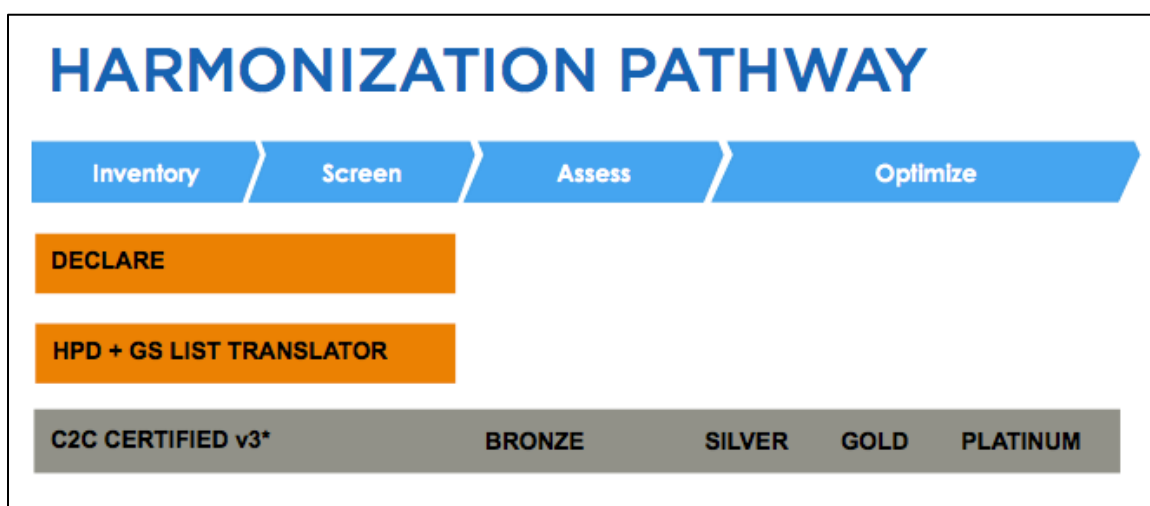


Figure 2.8. Harmonization Pathway. Continuum representing the different functions of the different voluntary material health programs (Adapted from Heine et al., 20120.

This representation makes clear that Cradle to Cradle is the only program that requires higher levels of product assessment. However, the graphic does not look at the programs more broadly. Figure 2.9 attempts to represent each program based on a larger set of program attributes.

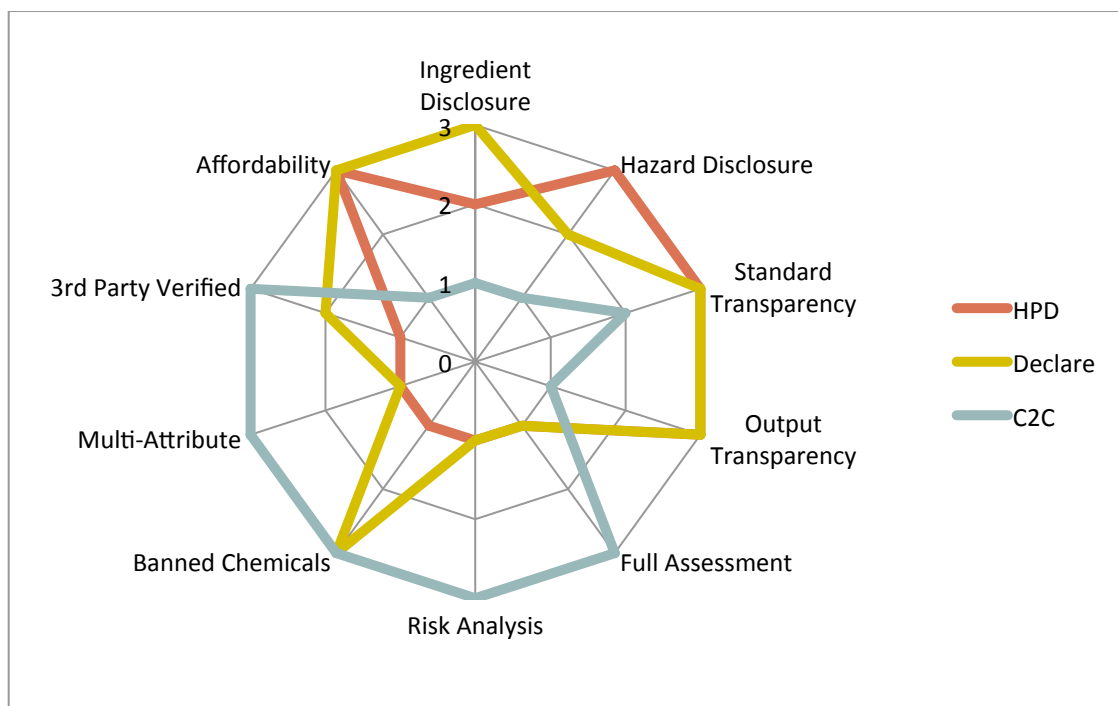


Figure 2.9. Program Attributes of HPD, Declare and C2C relevant to the research.

2.10 Barriers to Gathering Information from the Supply Chain

Each of the programs described previously require manufacturers to gather information from their supply chains. Depending on the vertical integration of a company, the nature of products and complexity of the supply chain, this can be fairly straightforward, or incredibly complex and difficult. This struggle to gather information from one's supply chain has been studied both in the US and EU for a number of types of products. In the EU, a number of studies have looked at the introduction of REACH regulation and how it is affecting manufacturers.

Scruggs (2011) interviewed twenty consumer product companies from both the U.S. and EU in order to better understand information challenges faced by these companies in attempting to product safer products. The research was conducted in 2009 when REACH regulation was relatively new and had not had much impact yet on the regulation of chemicals in Europe in order to determine what barriers companies face in trying to obtain information from their supply chain. The main barriers to obtaining chemical information were as follows:

- Trouble finding reliable sources of information on chemicals used in products
- Data is often unclear or conflicting (i.e. risk may be different at chemical level than when it is incorporated into a product)
- Difficulty of identifying appropriate chemical substitutes in order to avoid regrettable substitutions
- Scarcity of data on ecotoxicology, nanotechnology and endocrine disruption
- Trade secrets and confidentiality claims made by producers and manufacturers
- Communication and information flow through complex, global supply chains can be difficult and time consuming

Lack of routine information about chemical use and identity was a large barrier for manufacturers. Each manufacturer had developed their own strategy for attempting to combat these issues and create safer products. The most mentioned actions by the downstream manufacturers included:

- Developing restricted substance lists (RSLs)
- Phasing out chemicals/products
- Working with suppliers and
- Developing a chemicals database

Most of their approaches focused around avoidance of particular chemicals, rather than requiring full disclosure. While useful as models, these individual and unique approaches require a significant amount of “reinventing the wheel”, where a standardized approach would perhaps allow for more efficient use of time and resources and more comprehensive protection for consumers (Scruggs, 2011).

2.11 Barriers to Communicating Ingredient and Hazard Information

A wide variety of stakeholders are requesting information from supply chains. A number of studies have emphasized the importance of considering who the request comes from, and what level an depth of information is appropriate to communicate to that stakeholder (Fransson et al., 2013; Fransson & Molander, 2012; Kogg & Thidell, 2010). Information about chemicals in products often needs to be different depending on which stakeholder needs to interpret it (Kogg & Thidell, 2010). Chemical and hazard information may be useful to one trained or educated in these areas, but perhaps is not useful, and even problematic, when provided to the layman.

Fransson et al. (2013) used a case study exploratory approach to study the flows of chemical risk information in the consumer paint product chain. Safety Data Sheets (SDSs) were found to be the main tool for communication of chemical risk downstream in the product chain. In Europe SDSs are required for substances that “meet criteria for classification as hazardous to human health or the environment.”

In particular, the study highlighted “the need for evaluation of how chemical risk information is used in different contexts and the importance of directing the right information at the right target group” (Fransson et al., 2013). SDSs are used for communication between many different stakeholder groups with very different knowledge bases (i.e. toxicologists and factory workers). Therefore documents useful to some stakeholders may be burdensome for others and act as a barrier to decision-making. The authors concluded that only the most necessary information should be communicated to certain parties, such as simplified risk information to installers.

This opens the question of the format and extent of product information pertaining to hazard and risk. Though more information about product content is undoubtedly needed, there remains the question of how much information, what type of information, and who should receive what. If a product can be deemed safe by third party assessors that better understand the regulatory demands and toxicological implications of chemicals and products, is a lack of transparency in that situation worse, or better than receiving a list of the raw chemicals used in a product? To rephrase this: how important is transparency—

defined in this research as *ingredient and hazard disclosure*—in trying to achieve healthier products?

2.12 Qualitative Research

Originally used solely in the social sciences, qualitative research methods are now employed across a broad range of research areas. Where quantitative research looks for “causal determination, prediction, and generalization of findings”, qualitative research goes in search of “illumination, understanding, and extrapolation to similar situations” (Golafshani, 2003). Qualitative studies are able to recognize and articulate “the complexity of a situation” without trying to distill events (Creswell, 2009, p. 4). This type of research allows for emerging questions and more flexible procedures.

- Natural setting: data is collected in the field rather than in contrived environments
- Researcher as key instrument: the experience of the author collecting data throughout the study is often central to the findings, as opposed to studies that rely on tools and instruments of data collection defined by others.
- Multiple sources of data: rather than relying on one source of information, the researcher often combines surveys or interviews with observations or documents, and analyzing those sources as a whole.
- Inductive data analysis: raw data is gathered from multiple sources and organized and analyzed to slowly build up patterns and themes.
- Participant’s meanings: the researcher tries to avoid only bringing their interpretation to the research, and instead try to focus on interpreting what the participants see as issues.
- Emergent design: because qualitative research is exploratory in nature, plans and phases of the research process may change over time.

2.12.1 Interviews

Open-ended interviews allow the research an in-depth view into a participant’s experiences and perspectives surrounding a particular topic. Turner (2010) describes a

few forms of interview design commonly used. These are the a) informal conversational interview b) general interview guide approach, and c) standardized open-ended interview.

As the name suggests, the informal conversational interview is the most free-flowing and spontaneous. In this type of interview, the researcher does not have predefined questions and relies almost entirely on interaction with the participant to guide the conversation.

The last method, the standardized open-ended interview is very structured in comparison to the other types. Identical questions are used to allow for greater consistency and comparability between the different interviews.

The general interview guide approach, which uses pre-defined questions and topics, is most appropriate for this study. The researcher has the flexibility to probe deeper in certain areas or ask follow-up questions based on the content of the responses. Follow-up questions or prompts may be crucial in any type of interview, as participants may misinterpret a question, choose to answer the question in a different way, or may in fact answer a question that the researcher had planned to ask later. Flexibility is important in order to gather the information necessary to the research. This approach can allow tailoring of an interview to the participant and context; however, its relative success lies in the researcher's ability to gather data on relatively consistent topics.

2.12.2 Thematic Content Analysis

Thematic content analysis is often most appropriate when particularly theories on a subject are limited, as is the scientific literature. In this type of analysis, the researcher dives into the raw data, generally the interview transcript, and through repeated and active reading, forming codes and patterns which are built into themes ultimately (Braun & Clarke, 2006).

Thematic analysis is appropriate to reflect the rich and nuanced data produced in qualitative research. Braun & Clarke (2006) argued that the analysis should be a method in its own right rather than considered a subset within a larger method. They warned against the description of "emerging themes" which gives the impression that the researcher is a passive participant in the identification of themes, where this is often far

form the reality. Researchers are active and deeply embedded in their role of studying, grouping, and analyzing data.

Braun & Clarke (2006) describe six steps to conducting thematic analysis, though they emphasize the flexibility of the data analysis methodology overall as an advantage of this process.

1. Familiarize yourself with the data
2. Generate initial codes
3. Search for themes
4. Review themes
5. Define and name themes
6. Produce the report

Braun & Clarke define a ‘theme’ as that which “captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set” (Braun & Clarke, 2006). However, ultimately this determination cannot necessarily be quantified (i.e. number of mentions) or even defined qualitatively across studies (i.e. which topics are most important), therefore the judgment of the researcher is really the ultimate determinant of what becomes a theme.

2.13 Reliability and Validity in Qualitative Research

In qualitative research, both the data collection materials and the researcher act as the ‘instruments’. Addressing reliability and validity in qualitative research is important to instill confidence in the results of a study. Reliability refers to the consistency of constancy of an instrument, or “the degree of consistency or dependability with which an instrument measures the attribute it is designed to measure” (Long & Johnson, 2000). Definitions found by Long & Johnson (2000) “all relate to confidence in data collection” (p. 30).

- Stability: does asking the same questions at the same time produce consistent answers?

- Consistency: within a single interview does the respondent's answer remain the same?
- Equivalence: asking the same question a few different ways

Validity is defined as “the determination of whether a measurement instrument actually measures what it is purported to measure” (Long & Johnson, 2000, p. 31). Three main aspects of research are generally considered in relation to validity: content validity, criterion-related validity and construct validity.”

- Content validity “refers to the degree to which the entirety of the phenomenon under investigation is addressed”
- Criterion-related validity: “compare the instrument and findings with an established standard to determine correlation between measured performance and actual performance.
- Construct validity: “consideration of the proximity of the instrument to the construct in question.”

Qualitative research often also employs ‘triangulation’ as a method for testing and improving the reliability and validity of a study. Triangulation is used to limit bias by combining different methods. For example, different types of methods or data can be used to show that both are pointing to the same answer. This can include the use of both qualitative and quantitative approaches to a study (Golafshani, 2003).

Long and Johnson (2000) outline some means by which to establish rigor in qualitative research:

1. Self-description and reflective journal - by reflecting on one's own beliefs and opinions, the researcher makes their narrative explicit “rather than engaging in futile attempts to eliminate the effects of the researcher” (p. 33)
2. Respondent validation (member check) - findings are checked with members of the studied group. However, relying on solely participant opinion to validate a study is not enough, as the memory of a participant may not be reliable, and opinions may change with time.

3. Prolonged involvement and persistent observation - spending more time in the research environment may allow for “emerging concepts to develop and for potential implications to be recognized” (p. 34)
4. Peer debriefing - “exploring one’s analysis and conclusions to a colleague or another peer on a continuous basis” (p. 34)

2.14 Chapter Summary

This chapter explored the issues with US federal chemical regulation and how its gaps put human and environmental interests at risk. Engagement with voluntary material health programs was discussed as a method for addressing issues of understanding content inventory and making better chemical, material and product choices. The main material health programs studied in this current research were described. Previous research on the motivation for engagement around gathering chemical information was discussed as was research on the barriers to gathering information from supply chains. The use of qualitative methods in gathering complex, nuanced information in exploratory research was discussed.

CHAPTER 3. METHODOLOGY

3.1 Introduction to the Methodology

Demand for transparency and disclosure under voluntary material health programs is being driven largely by consumer demand, regulation, and green building standards (Lowell Center for Sustainable Production, 2008). This research focuses largely on the incorporation of material health programs into green building standards. It strives to understand how they are being used, and what lies in the way of further adoption. Final manufacturers are the primary stakeholders in supply chains interfacing with these programs and grappling with these issues. Understanding their perspective and interpretation may provide greater insight into the effectiveness of these programs in decreasing the US chemical ‘data’ gap. The aim of this study was to investigate how manufacturers are grappling with requests for product ingredient and hazard disclosure, how they are interpreting the call for transparency around material health in the building product industry, and what the barriers are to delivering on these demands.

The concept of ingredient and hazard transparency is being implemented across a number of different industries, the definition and application of which will likely be different for each industry. The current research sought to contribute to what will surely be an ongoing discussion and reshaping of the concept of transparency, material health and green chemistry in the building industry by presenting the manufacturer perspective on these issues. Architects are designing green buildings and so their voice of demand is often heard, with manufacturers seemingly on the defensive. This study is an effort to give a voice to those manufacturers and further open up the conversation between supply and demand to determine where there is common ground.

This chapter presents the methodology used in the study, identifies the population and sample, describes the tools used for data collection and data analysis techniques, and finally discusses procedures for checking both the reliability and validity of the results.

3.2 Research Design

Inadequate chemical regulatory measures in the U.S. have resulted in a healthy materials movement that relies heavily on voluntary measures to incentivize content disclosure and product assessment (Waage et al., 2005). In the building products industry, these programs, and the incentive to participate in them, are closely linked to the green building movement. This research centers on the perspectives of U.S. building product manufacturers perspective on material health and transparency, with the goal of better understanding how they interpret these concepts and how they are acting on them. It also looks to outline the broad barriers to further transparency, disclosure and ultimately a healthier materials economy.

Due to the exploratory nature of this study, the investigation of material health evaluation programs is by no means exhaustive. Many chemical information databases, material health programs and chemical identification systems exist beyond the three programs studied in this research. All of these will take a different approach to the issue of material. The sampled companies have been highly, and intentionally, delimited by the researcher to include those programs that have a) been accepted as an acceptable compliance path for LEEDv4 building product disclosure and optimization credit and b) as perceived by the industry professionals as the most widely used and relevant to the conversation.

The *Health Product Declaration* (HPD), *Declare*, and *Cradle to Cradle* (C2C) are three programs specified as a pathway to achieving the LEEDv4 disclosure and optimization credit. Other programs were touched upon during the research due to their prevalence in certain industries (i.e. the *Level* program for the furniture industry) or their incorporation in other programs (*GreenScreen* and the *GreenScreen List Translator* are used to obtain hazard ratings for chemicals in some programs).

This study used primarily qualitative research methods, though it also employed minor quantitative techniques to aid in analyzing survey data. The study was conducted over two stages.

1. **Interviews** – semi-structured open-ended interviews were held with manufacturers after gathering expert input and refining the research instruments. Individuals in product sustainability (or similar) positions in manufacturing companies with awareness of all four main material health programs were invited to participate in semi-structured open-ended interviews in order to have an in-depth discussion about the process of program compliance and the role of transparency in their company and in the industry as a whole.
2. **Surveys** – A small pilot survey was sent to interview participants who expressed particular interest in the study. Manufacturers were invited to take the survey and provide feedback either at the end of the survey or by email. Based on their input, some survey questions were amended. Full survey distribution took place after the pilot survey. Surveys distributed to a larger sample similar in nature to the interview participants.

The research process is further illustrated in figure 3.1.

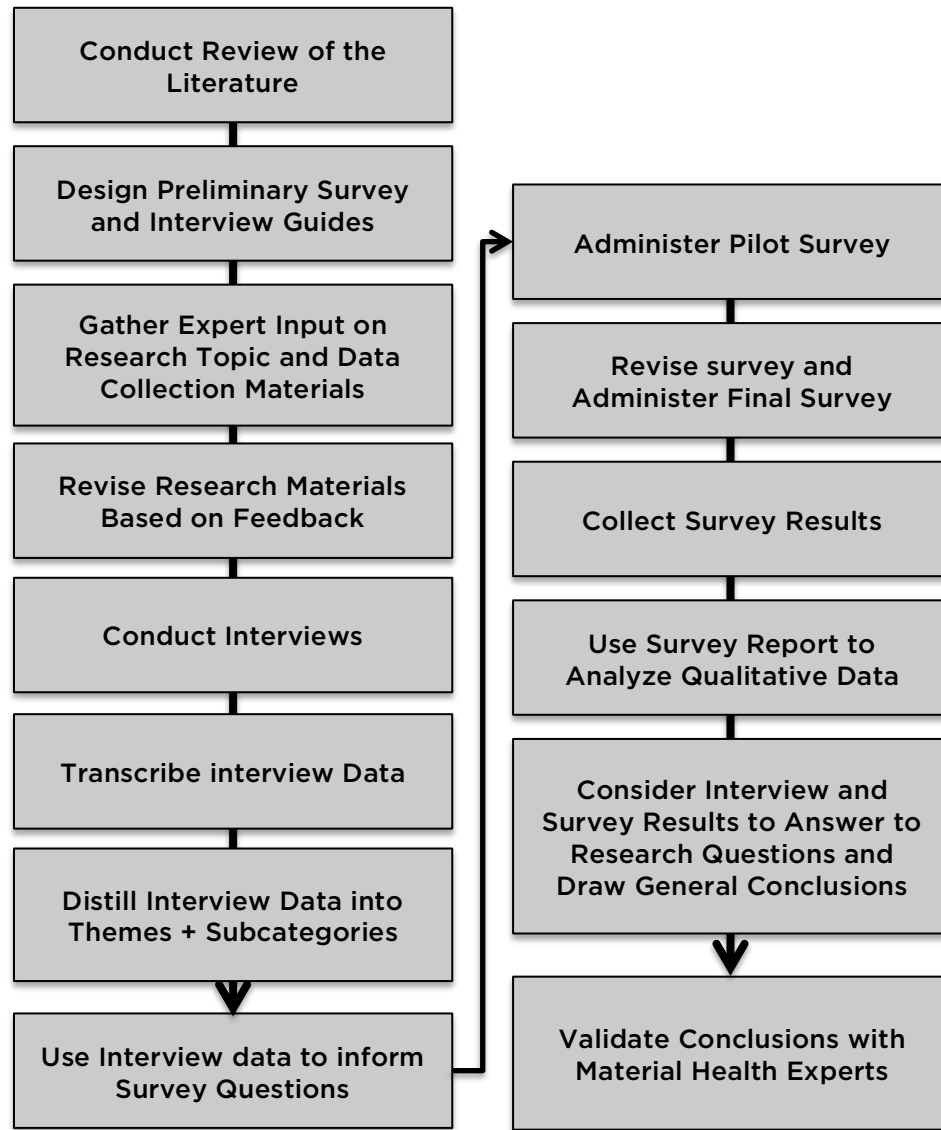


Figure 3.1 Flowchart of Research Process

3.3 Population and Sample

This study was concerned with the perspectives of manufacturers of building products who were based in the US. Rather than looking to obtain a sample representative of the full population of building product manufacturers in the U.S., purposeful sampling of participants was used. Selecting the participants based on key attributes suits the nature of qualitative research. Rather than trying to look for a random, representative sample, the

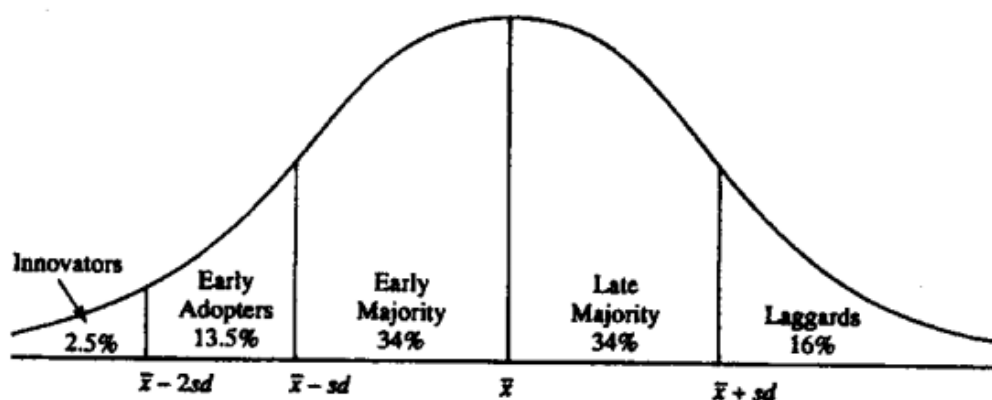
researcher tries to “purposefully select participants or sites (or documents or visual material) that will best help the researcher understand the problem and the research question.” (Creswell, 2009).

In looking to understand how transparency is being interpreted in the building supply chain, final manufacturers were determined to be the most suitable subjects. Final manufacturers sit at a pivotal point at the end of the supply chain. They are often a first point of contact for architects requesting information about a product and, at this point, are in charge of gathering and synthesizing chemical data from within their product’s entire supply chain. Their perspective, therefore, on the programs, the process of gathering the information, and on the nature of transparency, is informed by stakeholder relationships on both the supply and demand sides, and they are often ultimately responsible for labeling/certification of products and/or compliance with standards. Also, being consumer-facing, they are more likely to be easily reachable and open to a conversation, and would have directly interfaced with the issues looked at in this study.

Final manufacturers are defined in this the current research as consumer-facing manufacturers that control the “final point of fabrication or manufacture of an assembly or building material” (LBC, 2014). These manufacturers supplied the primary population for this study. However, suppliers and manufacturers of chemicals were ultimately not excluded from participation. Though their perspective is likely to differ from manufacturers that are selling products directly to consumers, many large suppliers may also sell final products in addition to chemicals and components. What is more, previous research has identified the inability to gather information from suppliers as a major barrier to further material health disclosure (Fransson, Brunklaus, & Molander, 2013; Lowell Center for Sustainable Production, 2009; Scruggs & Ortolano, 2011). Therefore, a glimpse into their perspective and how it may, or may not, differ from the more consumer-facing manufacturers was of interest in gathering the fuller picture.

Overall the sample was selected by identifying those manufacturers that have differentiated themselves through their involvement with the different voluntary material health programs. This was because they will have the best insight into how the programs

work and what the barriers to compliance and adoption of principles of material health and disclosure are. Another reason for studying the leaders in the material health field is that they are the best indicators of where the industry as a whole will head. The Roger's Curve of Innovation Adoption (Figure 3.1) shows the importance of approaching innovators and early adopters first, rather than focusing on the majority or on the laggards. Working to lower the biggest barriers faced by the leading edge of the curve may contribute to reaching a critical mass of adoption faster. This research looks to provide insight into what manufacturers believe these barriers are and how to lower them, and it intends to provide a foundation for future research that delves deeper into the identified barriers.



The innovativeness dimension, as measured by the time at which an individual adopts an innovation or innovations, is continuous. The innovativeness variable is partitioned into five adopter categories by laying off standard deviations (sd) from the average time of adoption (\bar{x}).

Figure 3.2. Roger's Curve of Innovation Adoption (Rogers, 2003).

3.3.1 Interview Sample

Participants for the interviews were employees within building product manufacturing companies, generally at a senior sustainability level, who have played a role in interacting with the main material health evaluation programs studied in this research. Generally, participants involved in product stewardship and sustainability and had a strong knowledge of the product content and the attributes of each material health evaluation

program. Knowledge of the main material health evaluation programs studied in this research was a prerequisite for participation, although the manufacturer only had to have engaged with a minimum of one of the programs. Initial participants were selected consulting with individuals working within the material health programs and from leading architects and manufacturers heavily engaged in issues of material health. Each participant was contacted by email with details about the study and offered the opportunity to participate as an interview subject. Snowball sampling was used to obtain further participants, as participants offered up other potential manufacturers to speak with. All participants willing to participate in the 45-60 minute interview made up the sample.

3.3.2 Survey Sample

Survey participants were pulled from a similar population as were the interviewees. Participants were sustainability directors or product stewardship employees at U.S. manufacturing companies with familiarity with issues of material health and transparency. Potential participants were identified through looking at the websites of the different material health programs studied and identifying manufacturers who appeared to be involved in at least two of the programs. The sample represented a diversity of product types. Specific contacts were identified through interaction with people working at material health programs, making it easier to deliver the survey to the right person at the company.

3.4 Data Collection

This study used human subjects to collect qualitative data. The study was conducted on the condition of anonymity, therefore recordings were destroyed after transcriptions of audio were made and identifiers were created for participants so as to remove identifiable information in the transcripts. As described above, the research was conducted in three main parts, beginning with interviews and followed by the distribution of first a pilot survey, and then a full online survey.

3.4.1 Interview Data Collection

Interviews are rich in data and are able to provide greater insight into the complexity of material health issues and transparency. Semi-structured, open-ended interviews were conducted with individuals in senior product sustainability, or similar, positions at US manufacturing companies.

Participants were contacted via email. Participants who agreed to be interviewed as part of the study were asked to commit 45 minutes – 1 hour to the interview process. Interviews were conducted over the phone and WebEx was used to record the phone calls to allow for playback and transcription at a later time. Recording allowed the interviewer to take handwritten “strategic and focused notes” during the interview. According to Patton (2002), these notes serve the interviewer in a number of ways, including:

1. Helping the interviewer create new questions based on the conversation
2. Allowing the researcher to use insight from an interview for the next interview before transcribing all of the text
3. Making later analysis easier by highlighting key points and determining when a point of interest was made
4. Acting as a data backup in case of technology malfunction.

Marginal notes were also taken by the researcher during the phone interview to record researcher observations of participant responses, and any points of particular interest. Raw data was then transcribed into Microsoft Word soon after the interview was complete. Recordings were deleted once transcription was complete.

3.4.2 Survey Data Collection

Outreach to survey participants was also conducted using email. Emails clearly identified the intent of the researcher, the purpose of the study, and the researcher’s position within their university.

Survey content was informed by research by Scruggs (2015) on manufacturer potential for REACH compliance. A small pilot test of the survey materials was also carried out. The survey was presented to manufacturers who participated in the interviews and

expressed interest in the research. This was done to determine whether the length, format and content of the surveys were appropriate. Qualtrics was used to distribute the surveys, collect survey data, and conduct a primary analysis of the results. The survey was designed to take under 25 minutes to complete.

3.5 Data Analysis

Interviews:

Analyzing raw interview data relies on the recognition of patterns, and organization of codes into themes. (Braun & Clarke, 2006). Marginal notes taken during the interview were used to provide more context regarding the researcher's observations of participant responses and points of interest, in order to add depth to the data available for analysis.

Each interview was 45 minutes to 60 minutes long. Recorded interviews were transcribed using Microsoft Word. Each interview produced approximately 8 to 12 pages of raw data. Interviews were collected over a period of approximately two months. During this time, a separate document was used by the researcher as a reflective journal, allowing for externalization of observations and opinions (Long & Johnson, 2000). Notes were added to and rewritten in an iterative manner, allowing the researcher to note emerging themes and refine future interviews based on previous interview and informal conversations. Though interview questions were outlined prior to beginning this research, once the interviews began it became clear fairly quickly that those questions needed to adapt to each conversation, and would evolve over time (general interview guide can be found in Appendix A). A more inductive approach to analysis was used, in which the research questions ultimately evolved alongside the coding process.

Thematic analysis was used to distill and organize the data. The process followed Braun & Clarke's (2006) description of thematic analysis. First, once all of the interviews were complete, the researcher read through all of the interviews from beginning to end, allowing them to view the narratives as a whole (Braun & Clarke, 2006). Next, initial codes were generated in order to assign "tags or labels" to the raw data. Due to the amount of data and breadth of the responses, the researcher incorporated two additional

distillations of the data. The original codes were distilled into 1-2 page lists of categories to make the number of items more manageable. Those categories were then linked to construct the overarching themes. Themes were reviewed and reorganized as necessary, then titled and defined. Themes generally incorporated a large number of perspectives thus 'subcategories' were used to represent key perspectives within a larger theme. Interpretive analysis of the themes was used to describe the results obtained.

Surveys:

Surveys contained a series of questions with varying response formats (Yes/No, multiple choice, and Likert style scales) as well as some open-ended questions where respondents had the opportunity to define a term or elaborate on their answers. Preliminary data analysis took place in Qualtrics. Where appropriate, tables or graphs were used to represent survey results. The survey results have been used to supplement themes found among the interview results, however, the survey is considered to be more of a model for future work than standalone results.

3.6 Reliability and Validity

Expert engagement through a series of phone calls with architects, manufacturers, and material health program designers, was used to first validate the research scope, as well as the survey and interview format, content and scope, prior to beginning the research. This allowed the researcher to further confirm the relevance of the study, and determine the appropriate format and length of surveys and interviews in order to avoid participant fatigue or bias.

Triangulation was employed in this study by investigating the same topic in both surveys and interviews. Surveys also combined qualitative and quantitative methods.

As per the recommendations of Golafshani (2003), a reflective journal, peer debriefing and some respondent validation were all methods used by the researcher. The third recommendation, prolonged involvement, was not an option for this type of study, nor

within the researcher's timeline. The results of this current research were also presented to an expert involved in the healthy materials movement.

Surveys

As the survey was created for this research, a pilot survey was used to check the methodology and content of the survey before full distribution. The pilot survey was administered to participants in the same way the full survey would be. Subjects were asked to take the survey and provide feedback on the questions, and the overall survey content. The time taken by participants to complete the survey was also taken into account and found to be reasonable. Questions were reworded as necessary where participants identified confusion or issues with rating scale.

3.7 Summary

This chapter described the specific methodology used to conduct this qualitative research. Development and implementation of the research tools, namely interviews and surveys, were described. Sampling methods, data collection and use of thematic analysis were discussed. Additionally, methods by which the researcher validated the research methodology and outcomes were outlined.

CHAPTER 4. RESULTS

4.1 Introduction

This chapter guides the reader through the results obtained in data collection. Deviations from the intended methodology are explained, and the specific methodology of analysis is described in-depth. The results of the interviews and overarching themes obtained are then presented, followed by an analysis of the survey data.

4.2 Methodology Deviations

Methodological adjustments are a common course of action in exploratory, qualitative research (Creswell, 2009). Interview questions, although based around the same general interview guide, were adapted in each interview to recognize the varied experiences and perspectives of participants. Flexibility was important in order to allow for examination of issues most important to interviewees and the creation of more personal interviews (Turner, 2010). It quickly became clear that the very specific interactions with material health programs or methods of data communication were highly varied and company-dependent. Those types of questions were therefore eschewed in favor of questions that explored perceived barriers to material health considerations in the interviewee's industry, and their perspectives on larger industry issues.

This research originally proposed to distribute the survey to the approximately 280 manufacturers represented in the Pharos Project, which is a database used for identifying health hazards associated with products and aggregates information and certifications from a number of other programs. During the course of this research, it became clear that getting up-to-date manufacturer contact information for survey distribution would be challenging. Instead, contact information for 76 manufacturers engaged with material

health programs were identified through leveraging industry contacts and formed the outreach sample.

4.3 Use of Expert Input

In order to gauge industry interest in the research and to help shape the direction and scope of inquiry, five experts in the field of building products and material health were consulted prior to beginning the interview and survey processes. This outreach was done in collaboration with a master's student at UC Berkeley studying similar issues of transparency and disclosure from the perspectives of architects rather than manufacturers. Participants were sent the research objectives, a draft interview guide, and some discussion questions.

The goal was to speak with representatives from a few stakeholder groups in the building product industry. Therefore, a manufacturer and an architect, both possessing significant working knowledge of material health evaluation programs were contacted by phone. It was also critical to speak with the people developing the material health programs studied by this research. Therefore, conversations were held with a representative from each program to understand the philosophy behind the program, the motivation of their work, program requirements, and how they each fit into the marketplace

The experts' input was used to delimit the number and types of programs studied in this research. It was determined that *GreenScreen for Safer Chemicals* should not be studied alongside *HPD*, *C2C* and *Declare* because *GreenScreen* is considered more of an internal, ingredient-level toxicology assessment, rather than a consumer-facing product-level assessment or standard. *GreenScreen* was nonetheless touched upon in some conversations and in the survey, due to its role in the field of ingredient assessment and toxicology, and because of it is used as a tool for screening ingredients within other standards such as the *HPD*. This work also confirmed significant industry interest in the issues of transparency and disclosure.

4.4 Interview Sample

Experts contacted in preliminary research approved the use of snowball sampling for the interviews, and they suggested the first round of 5 interviewees based on the research parameters and their knowledge of the main companies working on these issues. From there, snowball sampling was used to reach the other 7 participants. Ultimately, 20 invitations to participate in the research interviews were sent by email, and 16 responses were received. Out of these, 12 interviews were ultimately conducted.

Participants' companies represented a number of different sectors in the building products industry. The companies were also positioned at different places in the supply chain. Some manufacturers were downstream producers of final products ready for sale to consumers (hereon described as final manufacturers); other manufacturers operated upstream in the supply chain, manufacturing inputs such as coatings and chemicals (suppliers); many operated at both levels. Table 4.2 shows the breakdown of participant company sectors and participant roles.

Table 4.2

Participant company role, and manufacturer sector by interview

#	Sector Description	Participant Role
1	Paints and finishes	Technical Sales Manager
2	Carpet	Director of Sustainability
3	Architectural products	SVP of Sustainability; Sustainability Coordinator
4	Furniture + Office products	Global Environmental Sustainability
5	Exterior building products (shading)	Director of Sales and Marketing, Sustainability
6	Chemical and coatings (S)*	Global Product Stewardship
7	Insulated panels	Director of Education and Sustainability
8	Furniture + Office products	Head of Sustainability
9	Chemicals + Coatings (S)*	Sustainability and Education
10	Office furniture	Sustainability Strategy
11	Carpet	Sustainability Leader
12	Doors and Locks	Director of Sustainability

Participant's companies had demonstrated engagement with one or more of the voluntary material health programs focused on in this research. This was demonstrated either through formally publishing the output of the program engagement, by participating in pilot processes for the programs, or through representation on the program's website. Interview participants were familiar with all three programs (*HPD*, *C2C*, and *Declare*), and had formally or informally participated in at least one of programs. Participant roles ranged from technical sales manager, to toxicologist, to SVP of Sustainability. All had directly or indirectly worked with the material health evaluation programs and information gathering process within their company and were therefore the most, or one of the most, qualified individuals at their company to participate in the study.

Types of manufacturers interviewed did not represent all sectors of the industry as there is a wide range of products produced for the built environment. Also, some sectors are better represented by their engagement with these programs than others. For example, the leading carpet companies are all heavily involved in these efforts.

The sample was composed of 3 manufacturers who produce paints and coatings, 2 carpet and flooring, 3 furniture and office products, 1 exterior building product company, 1 insulated panel company, and 1 door and lock company. It should be noted that two of the coating companies, participants 6 and 9, generally act more as suppliers to other companies than as final manufacturers, though they may also be consumer-facing at times. This distinction was taken into consideration in the data analysis for this research. Based on working knowledge of the industry and interview results, the position of a company in the supply chain and the nature of products and manufacturing process are likely to influence a company's perspectives on transparency and disclosure. Some of the benefits, or barriers, to program participation, were certainly influenced by the types of products made, along with a number of other factors.

4.5 Interview Analysis

As discussed earlier, the line of questioning used in the interviews evolved as the research progressed, and was dependent on the content of each interview. Therefore, it is

important to address the general line of questioning used by the researcher. Participants were asked about the following areas:

- Background on their company's role in the supply chain and the participant's involvement in issues around material health
- Company and participant involvement with voluntary material health programs
- Manufacturer process for gathering information from their supply chain
- Aspects of material health they felt were most important to communicate to their consumers about their products
- Barriers they face to further disclosure of their product content
- Relative importance of transparency in leading to a healthy materials market.

The use of a general interview guide approach built flexibility into the process and allowed for data that was very rich in its content. While conversations varied in specific content, they invariably provided useful information around the central issues of transparency and material health in the building products industry. This approach also allowed the researcher to probe unanticipated topics brought up by the participant when appropriate. The researcher elected to qualitatively analyze the data in order to tease out broad themes and experienced realities within the healthy materials economy. Given the diversity of responses received and the breadth of their content, thematic analysis offered a flexible approach to distillation of the data that preserved the context and complexity of the issues.

4.6 Interview Themes

Interviewee's perspectives were influenced by both their company's approach to material health and disclosure issues, and also by their own personal views. Factors potentially affecting their perspective included, but were certainly not limited to:

- Company mission
- Company size

- Industry sector (type of products affects materials used, types of suppliers, amount of intellectual property, etc.)
- Company position in supply chain (e.g. consumer-facing downstream vs. upstream suppliers)
- Company's consumer demand for disclosure and transparency
- Material health program participation and relative understanding of each program (*C2C*, *HPD*, *Declare*, or other programs)
- Relative internal/external success interacting with programs
- Supply chain nature, structure and complexity
- Amount of internal or upstream proprietary information
- Interviewee's personal interests/beliefs as an employee or as a consumer

With these factors in mind, analysis of interviewee responses identified six overarching themes. Considering the range of companies and product types in this study, these factors led to very varied perspectives *within* each theme. Therefore, where appropriate, subcategories are used to break down the central issues raised. While different participants often presented diametrically opposite perspectives to each other within a theme, issues discussed in the interviews were ultimately very consistent from interview to interview. Manufacturers of very different products raised many of the same issues, even if their stance on a particular issue was different. These themes are key to understanding the potential of transparency and disclosure, frustrations and barriers in engagement, and opportunities for progress and improvement in the future.

The following section each overarching theme and its subcategories, occasionally using quotes from the raw text for support. Quotes or issues are attributed to specific interviews using superscript numbers. The five themes and their associated subcategories identified from the interviews are as follows:

1. Some content transparency in the industry is overdue
2. There is more information than education
 - a. Supplier education can improve data quality and quantity
 - b. Consumer education can increase demand and improve specification

3. Hazard vs. Risk is an important, but controversial topic
 - a. Restricted Substances Lists are scalable, but simplistic
 - b. Hazard ratings lack context
 - c. Risk and exposure assessment adds context, but is imperfect
4. Lack of standardization is stymying progress
 - a. Standardizing Content Inventory
 - b. Standardizing Screening
 - c. Standardizing Chemical Assessment and Optimization Efforts
5. Prioritization

4.6.1 Some Content Transparency is Overdue

Interviewees repeatedly pointed out how new the issue of transparency and disclosure are in the building industry. Product ingredient and hazard transparency were described as being in their ‘infancy’. At the same time, participant responses, along with the growth in adoption of disclosure standards such as *Declare* and *HPD* in the past few years point to increasing demand for, and industry comfort with, the concept of transparency. Even the *Cradle to Cradle* standard, which itself was not founded on the principles of disclosure and transparency, was described as moving towards a more transparent model.

All participants agreed that greater transparency and disclosure around material health was overdue in the building products industry—“I think it’s an important part of the evolution of our industry, to kind of clean ourselves up a bit”⁵. Opinions about the nature and extent of that disclosure varied widely among all participants.

Some manufacturers felt that transparency was the foundation of a healthier materials market, because “as long as you can hide behind not being fully transparent, there will be no pressure to change.”⁵ Others held a more moderate view: that transparency alone is enough to fight for, but should not be considered in isolation. Yet others expressed opinions closer to “transparency on its own doesn’t do anything.”⁸ Due to the complexity of chemistry, the life cycle of building products, and the difficulty of interpreting ingredient and hazard output, solely listing the ingredients and/or hazards present in a product for consumers to read is not necessarily enough information for an informed

purchasing decision or enough incentive to spur manufacturing changes. Manufacturers struggled more with the format and interpretation of that disclosure than the push to disclose information:

We've changed out a couple of ingredients that we wouldn't have changed out had it not been for transparency – or we would have taken our sweet time changing them out. It was difficult and it was expensive and we had to change our formulation. But this is how our product is going to look in these systems if we don't change this out and this is the business we're probably going to lose out on. So on the whole this is a good thing...I'm just saying that it's pretty imperfect right now how we're sussing how healthy a material is.²

The distinction between disclosure and transparency was not clearly made in the proposal for this research, nor in the interview guide. This distinction was very important to manufacturers and therefore pointed out repeatedly. Disclosure was described as *one* enactment of the principles of transparency, but the two terms are not interchangeable. Although full disclosure of product content is sometimes touted as the ultimate transparency, some manufacturers who were unable to participate in the programs this way to due proprietary supply chain claims felt that in the absence of full public disclosure they could still be transparent with their customers about the barriers to doing so. If ingredient and hazard disclosure is the release of product information, transparency is an honest, open dialogue about the nature of that disclosure.

The ability for peer review and conversations of comparison was generally considered a positive result of the transparency movement. While some participants criticized the existence of what they considered incomplete information presented self-disclosure programs (*HPD* and *Declare*), the ability to review and criticize those labels openly appeared to be recognition of the value of public disclosure. Some *Declare* labels have expanded their lists of ingredients over time. Participants postulated that this may have been because of pressure from competitors who pointed out inaccuracies²; it may be also be due to better manufacturer and suppliers education and understanding of the requirements of program and therefore the collection of more accurate and granular information. As programs evolve, manufacturers and their supply chain become more

sophisticated around disclosure. The pressure for accuracy is increasing, as is the ability to release accurate information.

A few participants who struggle with full disclosure emphasized that the word ‘proprietary’ on a label doesn’t mean a manufacturer is necessarily hiding anything. Rather, it often indicates the limits, or perceived limits, of what a manufacturer can disclose about their own product, or what they can learn about their supplier’s products. “We’re giving you as much info as we can. I think that’s still a cloudy area in the whole transparency movement that has to be addressed or understood by people who are looking at an *HPD* and really don’t know what they’re looking at except that they expect to see the Colonel’s 11 herbs and spices.”¹

As for the accuracy of disclosure, while there will certainly have been cases of intentionally omitted or manipulated information to conceal issues with how a product presents, manufacturers felt that at this point the majority of errors in self-disclosure programs should be viewed as errors of *omission*, rather than *commission*¹². It’s clear to manufacturers, and to these program developers, that a lot of self-disclosed labels contain inaccuracies, but this is not necessarily a manipulation and will often be due to lack of accurate information or lack of clear understanding of requirements. Therefore, the aim should be to move towards a future where what is required is clearly defined and clearly understood. At that point, if information is missing, it is no longer just an accident or different interpretation; when we get to that point, inaccuracies become errors of *commission*.

Overall, each participant’s definition and perception of transparency was somewhat different. Interviewee definitions of transparency are shown in Appendix C. The range of definitions in this study, from twelve manufacturers already engaged with these programs, helps to illustrate how difficult it may be to create an industry-wide interpretation and an industry-wide standard for disclosure and transparency.

Each interviewee’s company was attempting to adapt company practices in order to respond to the demand for further material health transparency. However, frustration was clearly expressed at aiming at disparate, and often moving targets. The level and type of

disclosure is different in each material health program, so it is sometimes difficult to know which direction the market is moving in, and whether one is headed in the right direction. At other times, one may feel that they are being pulled in the wrong direction by consumer demand, because consumers may have an incomplete picture of what is needed. The lack of cohesive definition can be difficult for manufacturers trying to grapple with these issues while also balancing a huge number of other priorities and product attributes. Certainly these definitions will continue to shift as the industry continues to adapt, and as manufacturers become more comfortable with the concept of disclosure and assessment.

4.6.2 More Information Than Education

In general, there was a strong perception from all participants that currently there is a huge amount of material content and data being gathered, with little collective understanding of how to interpret or use that information^{1,7,9}. The relative utility of collecting and disseminating that data was much debated by interviewees. The need for more education around material health, transparency and disclosure, however, was referred to in all 12 interviews. Generally, the intended recipients of that education were divided into two subcategories: upstream to supplier, and downstream to consumers and contractors.

4.6.2.1 Supplier Education

The interviewee with probably the most cooperative supply chain pointed out that they were the anomaly in the industry. At this point in time they felt that “the chances of getting information from your supply chain is slim; the chances of getting information that is correct is rarer still”⁵.

This statement points to two perceived barriers to further transparency and disclosure: *quantity* of data disclosed, and the *quality* of that data. Participants felt supplier education would have served to lower both of these barriers. Continued supplier education has the potential for two outcomes. First: to make suppliers more comfortable with the idea of disclosure. The participants in this study are considered leaders in terms of engaging with issues of material health, yet even for them suppliers were often unlikely to disclose at

the level necessary for engaging with many of the programs studied in this research. Participants described some suppliers as nervous that their consumers would switch suppliers or give information to another supplier and cut them out; other suppliers were uncomfortable with giving out their proprietary recipes to anyone⁸. Supply chains that are resistant to disclosure are still the norm⁵, though participants generally agreed that supply chains are becoming increasingly comfortable with the concept of transparency¹. Clearly communicating *what* information is needed, and why the final manufacturer needs it may help suppliers to feel more comfortable with releasing more information.

Second, education may help suppliers to understand the specific data and disclosure requirements, potentially improving the *quality* of the data released. The ease of communication with suppliers and the ability to gather good upstream data was described as crucial to further engagement with programs, and to the success of transparency as a movement. Manufacturers took a range of approaches to obtaining better information. . The staffing and capacity of the manufacturer, and the complexity of the supply chain often affected the amount of control manufacturers felt they had over the quality of data provided by their supply chain. Most were heavily involved in educating their suppliers to the best of their abilities. One participant said they company had thus far actively engaged 400 out of their 1200 suppliers⁴ around issues of transparency and disclosure. Some manufacturers felt they could only do so much and had to trust the suppliers, or their suppliers' suppliers after that. A degree of uncertainty exists inherently in complex, and even in simple, supply chains, which can only be minimized to a certain degree. Other interviewees wanted greater assurance of the accuracy of data, and were going back multiple tiers in their supply chains to gather information. They found that if they merely trained suppliers to ask *their* suppliers for specific information, "it didn't really work because they would ask for the wrong thing and they would come back with huge spreadsheets full of bad information. In the end we found it was a lot smoother if we could do it."⁸ The efficacy of this approach is highly variable between companies and dependent on the size and complexity of supply chains and staffing capacity.

4.6.3 Consumer Education

The need for consumer education around interpretation of transparency and disclosure was the most prevalent of all issues raised in the interviews, regardless of a manufacturer's product types or position in the supply chain.

Participants were grappling with how their company can meet consumer demands to gather and disclose information and be specified for projects, while a) balancing a real, or perceived, need to hold some ingredient or hazard information proprietary, and b) making sure their products were accurately (and of course, favorably) represented. Consumers are generally unlikely to be able to adequately understand and interpret complex ingredient and hazard information. Feeling that one's consumers may be misinterpreting disclosed information regarding product content and safety can be a significant disincentive to disclose in the first place. The areas of consumer education needed as described by interviewees was divided into two categories:

1. Understanding of the attributes and role of each program

Understanding the intention of each program and the type of information it gathers and provides is very important. These three programs, despite the differences among them, are all acceptable compliance paths for material health requirements of green building programs such as for Building Product Disclosure and Optimization Credits within LEEDv4. The reality is that there is often a "check the box" mentality by architects^{3,4,5} who have neither the time nor the expertise to adequately interpret the output of some programs. Compliance with written requirements of green building certification programs is often enough for an architect to specify a product without further research into the product. Participants feared that the differences between the programs would not be appreciated^{3,4,10}; a *Cradle to Cradle* Gold certification might be held up as equivalent to a *Health Product Declaration*, despite the former program being multi-attribute and requiring 'optimization' of the product, and the latter a single-attribute disclosure and communication tool. Each program serves its own purpose, and the importance of multiple avenues of engagement was recognized as important by many interviewees.

However, it remains important that consumers be educated on the role and intention of each program so that demand drives positive change in products.

2. Encouraging more informed product selection through consumer education on interpreting program output

Manufacturers were particularly concerned that consumers be able to interpret the actual output of the program. For the programs studied in this research, the output ranges from an overall product rating level (*Cradle to Cradle*) of bronze to platinum; to an ingredients list with CASRNs listed (*Declare*), to an ingredients list where CASRNs are optional but ingredient hazard ratings are required (*HPD*). Participants whose companies were disclosing information through the *HPD* standard appeared to have the most concerns about incorrect interpretation of their disclosure. Instead of being rewarded for transparency through hazard disclosure, manufacturers were worried that consumers might be scared off by the information disclosed.

This particular concern about disclosure interpretation itself could be manifested in two ways. First, manufacturers felt some uneducated consumers were specifying a product for a project merely based on a product's engagement or compliance with one of the material health programs, regardless of the results of that engagement (output)^{4,8,12}. If *HPDs* were being requested merely as an 'exercise' for manufacturers, or so that architects could "check a box" for a building certification credit, rather than contributing to educated decision-making, "they're useless." *HPDs* screen against a significant number of authoritative hazard lists, but as a standardized communication tool their role is not to ban the use of any chemicals, nor to provide a rating or measure of achievement for material health for a product. Therefore, having them as an equivalent pathway for selecting materials may be problematic as most consumers are unable to adequately interpret an *HPD*. Put another way, two products—one very safely produced with nontoxic materials, and one with a very poor toxicological profile—can both have an *HPD*, and the consumer may not have the time or expertise to know the difference.

Conversely, a consumer may explicitly *avoid* a material based on the hazard ratings of ingredients, without taking into account any product-level chemistry context, or

consideration of the life cycle of the materials. Flooding the consumer market with complex information may actively deter consumers from purchasing products because they cannot adequately interpret that information. For example, many ingredients that present as problematic based solely on hazard ratings, may not actually exhibit these issues in a product if they are bound to other ingredients or are found in a different form. Interviewees shared their own anecdotes of consumer avoiding all products flagged as having carcinogenic ingredients, regardless of the product context or use.

These educational issues can be major deterrents for manufacturers. Barriers to determining what is in one's product, and disclosing that information accurately in one or more programs, are themselves significant. Manufacturers then present that information to consumers in good faith that the public can correctly interpret it. When participants felt their product was, or might be, rejected because of the format and level of information of the standard output, and the level of education required to interpret the output, they expressed reluctance to repeat the process.

4.6.4 Hazard vs. Risk is Important but Controversial

Chapter 2 introduced the terms hazard and risk and made an initial attempt to define them within the context of the current research. Interviews revealed that a) the distinction between hazard and risk is felt to be unclear in the industry and that b) the debate around the use of hazard and/or risk to assess the relative safety of chemicals and products for humans and the environment is *central* to the material health discussion, and one of the *fundamental* disagreements in the building product industry. Participants were divided over their view of the best approach. While none of the participants necessarily disagreed that the use of risk and exposure assessments offered the most accurate representation of a product's risk to end users, their position on the issue of hazard vs. risk *in practice* varied widely. There was also a clear tension between scalability of current material health solutions and the accuracy of those scalable solutions.

4.6.4.1 Restricted Substances Lists

All three of the material health programs studied in this research, and likely the vast majority of programs in existence, incorporate the concept of ingredient hazard as a

measure of product safety to some degree. After inventory of product content is accomplished, program requires some level of screening ingredients against a list, or a set of lists, of “worst-in-class” chemicals. *Declare* and *C2C* require the absence of certain chemicals to publish in the standard; *Declare*’s list is called the Red List, while *C2C* is called a banned list. The *HPD* allows any product to participate, but highlights the ingredient hazards on the standard. The use of ingredient hazard ratings as a determinant of material health signals that some materials are inherently problematic and should be avoided. One of the chemical suppliers interviewed, in particular, took disagreed with this concept, saying “just because something has x or y in it—chemistry is complicated—it doesn’t mean it’s bad, right?...Any chemical, depending on the situation, could be good or bad.”⁹

RSLs were most closely associated with the *Declare* in the interviews. *Declare* does not go beyond screening to require full assessment of ingredients or risk and exposure (although context is taken into account with the use of temporary exceptions allowed for particular applications of ingredients or products) where *Cradle to Cradle* does. In addition, the Red List is the arbiter of whether or not a product can be used in an LBC project.

The simplicity of the Red List approach as a material health tool in and of itself was appreciated by some of the interviewees. RSLs provide clarity for manufacturers and consumers when engaging with issues of material health in their absoluteness; judging products based on the presence or absence of certain materials or chemicals. This method of addressing material health is relatively a) easy to understand b) easy to communicate up the supply chain c) easy to communicate to consumers and d) scalable across product lines and for a whole company. With so many building product attributes to take into account by manufacturers, and by the architects specifying products (Akadiri, Olomolaiye, & Chinyio, 2013; Ogunkah & Yang, 2012), knowing what to avoid can be clearer, cheaper and less time-consuming than a more in-depth, nuanced approach.

The simplicity and scalability of this approach is tempered by its lack of context, which is a greater issue for some manufacturers than others. Despite an expressed desire for

scalability at the supplier level, the outright ban of chemicals was of course, antithetical to the chemical supplier's interests⁹. Beyond just chemical suppliers, the sweeping generalizations required by RSLs are problematic for manufacturers for a number of reasons:

- **Misconception that RSLs capture all the 'bad' chemicals or materials:** lists vary widely, and may not yet include materials that will eventually be considered problematic
- **Discrepancies between different lists:** different governments, material health programs, manufacturers, and even architects are creating their own RSLs. This can mean a product looks 'ok' according to one list, but perhaps not with another, often without understanding the reason for the difference.
- **Red List free doesn't necessarily mean 'good':** merely avoiding a particular set of chemicals does not ensure the environmental and human "safety" of a product
- **Risk of regrettable substitutions:** because lists cannot include every problematic material, new chemicals are being created all the time, and they often do not take into account life cycle or product context, replacing a 'banned' chemical with something *allowable* could ultimately be equally problematic, or even worse
 - For example, Bisphenol A (BPA), an ingredient commonly found in hard plastics was removed by most manufacturers after it was discovered that the chemical is leaching into food and drink and found in human bodies and can have multiple hazardous results. Thought to be preferable, many manufacturers replaced BPA with Bisphenol S (BPS). However, as Figure 4.1 shows, BPS is structurally very similar to BPA and unfortunately has many of the same problematic properties as BPA.

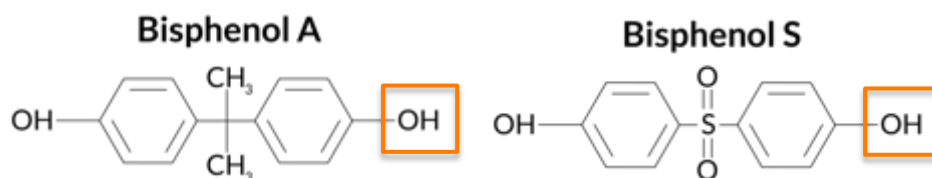


Figure 4.1. BPA and BPS as an example of regrettable substitution.

- Basing lists on the inherent hazards of chemicals often means a lack of context around different stages of the life cycle use of the product, manufacturing process, end-of-life options
- **Ingredient-level chemistry doesn't tell the whole story:** “Chemistry is complicated,”⁹ so assessing a product based on individual ingredients, without accounting for interactions between those ingredients, is perhaps too simplistic.

RSLs can empower manufacturers to make sweeping changes to their products, to their supply chains, and to make clear claims about their products. However, if the above considerations, and others, are not taken into account at the manufacturing level and the consumer is not educated in the broader context of product chemistry, they may not have as positive of an impact as intended, and may even encourage poor choices. RSLs communicate a binary situation in which the absence of a set of “bad” chemicals creates a “safe” product, and assumes the safety of chemicals not present on that list.

List-based approaches to material health may also force manufacturers to consider changes to products that are less than ideal from a health or from a life cycle perspective, in order to comply with program requirements. One interviewee described having overheard conversations where their colleagues considered replacing one chemical with one they *knew* to have a worse toxicological profile, merely because it was not on the RSL. Others described the difficulty of balancing priorities; replacing a Red Listed chemical might result in a product with a shorter life span, thereby resulting in an unintentional increase to life cycle impacts.

In the interviews, the products a manufacturer made were often tied to a company's perspective on RSL approaches. Some manufacturers were much more tied to the ingredients that they use, while others can be more nimble based on consumer demand, making across-the-board ingredient replacements harder or easier. Some manufacturers also had few enough products that they could conduct risk assessments for all of their products, whereas for others, the thought of using a program like Cradle to Cradle for all of their products was laughable due to volume and cost¹². Some manufacturers also found issue in the practice of tying a Red List to a green building standard compliance as

Declare does, feeling that it could encourage manufacturers to lie, or report their ingredients differently, in order to be specified—changing your paperwork is often easier than changing your product^{2,3,4}. However, is not limited to RSLs and *Declare*, and falls more broadly under the issue of self-disclosure and accuracy.

4.6.4.2 Hazard Ratings

As discussed, *HPDs* are primarily designed to be a communication and transparency platform, not necessarily to serve at the architect or consumer level to directly select products. What is more, because the *HPD* allows for significant variation in thresholds and percentages of reporting, “you can’t compare two *HPDs* now”⁷. *HPDs* are nonetheless being requested by architects as a pathway to LEED credits, therefore discussion of their merit as an architectural specification tool is relevant, and important to the manufacturers that are engaging with them.

Out of the three programs studied, the *HPD* is currently the only one that displays hazard ratings for each ingredient disclosed, using the *GreenScreen List Translator*. Even proponents of an ingredient-level hazard based approach to material health expressed wariness about interpretation of the *HPD*. Many felt consumers might select, or avoid, products for what manufacturers would consider to be the wrong reason—an issue discussed earlier in the Education theme. Hazard ratings are more difficult to explain or interpret than RSLs. A few interviewees stressed resistance within their company’s legal departments to the presentation of hazard ratings and the *HPD* hazard summary. “The summary warning is not something our legal team will ever be excited about.”²

Certain ingredients are consistently cited as examples of problems with the pure hazard-based approach to material health. Using the *GreenScreen* methodology, ingredients like Titanium Dioxide, Silica, and Carbon Black, are known carcinogens *in respirable form*. However, the very same ingredients, when bound to other ingredients in a material or product may no longer be problematic. Because the *GreenScreen List Translator* tool looks at ingredient-level hazard, regardless of the product-level context (i.e. physical form, or material or product-level chemistry), these ingredients will be represented on the *HPD* as a potential carcinogen whether or not there is a risk of inhalation for the end user.

For example, silica inhaled in powder form is a carcinogen, but silica once it becomes a glass windowpane is unlikely to be a health hazard. One interviewee described this issue by saying, “Fundamentally...the disconnect is having to appear to be labeling your product as hazardous when the product is not hazardous...”² Without any context almost anything has the potential for harm. “Water will kill you. Water’s toxic if you breathe it in your lungs too much”¹.

There *is* space for manufacturers to add notes and communicate some of this context to the reader on the *HPD*. However, interviewees did not trust that consumers would take the time or possess the knowledge required to adequately interpret the *HPD*, even with the notes. Interviewees felt the distinction between ingredient hazard and risk is not well understood by consumers, and many considered this distinction crucial to future education and to progress in this field.

4.6.4.3 Risk and Exposure

Participants generally agreed that product-level risk and exposure assessments often provide a more accurate evaluation of material health than the list-based hazard approach. “Some of the impacts are more complicated than what Red List can really tackle. There needs to be a human behind those decisions with common sense.”⁶ However, assessment can be expensive, time-consuming and more difficult to scale for some companies with large numbers of products, complex products, or large, complex supply chains.

Participants generally agreed that judgment can not be definitively passed on the relative safety of a product without taking into consideration the relative risk of exposure of individual ingredients, and the chemical reactions between different products. However, some interviewees also felt that risk assessment and toxicology are still imperfect solutions to the issues presented by ingredient and hazard disclosure and should not be regarded as a panacea.

Cradle to Cradle is the only program studied in this research that incorporates full product assessment and risk and exposure. Most participants felt this was the greatest strength of the *Cradle to Cradle* program. Not only is the information gathered and verified by a third party, but that third party also has the knowledge and methodology to

assess not a) product content and b) relative risk and exposure routes. The chemical supplier interviewed also described their preference for internal methodologies that look at risk and exposure and rate chemicals accordingly. The nature of this approach, and of *Cradle to Cradle*'s rating system, allows consumers to compare or rank products more quantitatively than other approaches. However, the lack of standard and assessment transparency makes it difficult for the public to understand or question why a particular product would receive its score.

4.6.5 Lack of Standardization is Stymying Progress

A lack of standardization in the industry was cited as particularly problematic for gathering, interpreting and reporting information on product content and material health. As discussed in Chapter 2, the material health harmonization efforts are working to improve alignment and cross-pollination between different programs and create a baseline of data that feeds all of the systems. However, interviewees in this research pointed repeatedly to a lack of standardization at all points along the continuum of harmonization, from **inventory**, to **screening**, to **assessment**, to **optimization**. Though explicitly mentioned in fewer interviews than issues of education or hazard vs. risk, standardization was central to many of the other issues.

4.6.5.1 Standardizing Content Inventory

One issue in particular is a lack of alignment around reporting levels and thresholds. A list of contents for a piece of carpet tile can be two ingredients, or it can be close to 300, depending on the granularity of data gathering and reporting (J. Connelly, Correspondence, 2016). Figure 4.1 illustrates the impact that disclosure thresholds can make on reported content. Like sieves, increasingly granular thresholds 'catch' more ingredients present at lower levels, resulting in a longer list of ingredients.

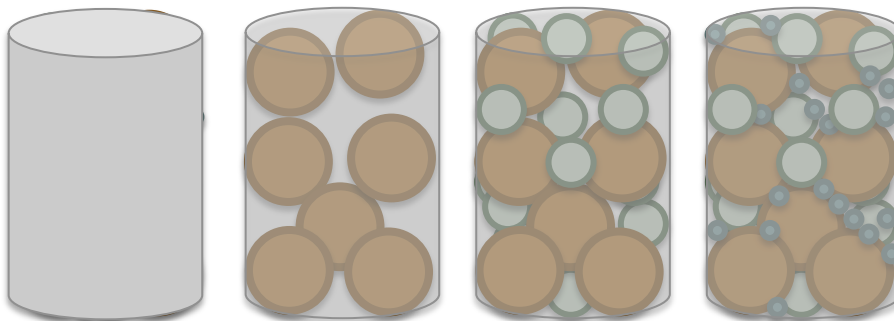


Figure 4.1. Product ingredients detectable at increasingly granular thresholds of disclosure from left to right.

The material health programs studied in the current research have specified thresholds of disclosure requirements, though the *HPD* allows for disclosure at different levels. Less granular disclosure thresholds (i.e. 10,000 ppm) may allow manufacturers to leave off some of the most problematic materials, as these are often present at lower percentages of the final product content (i.e. ingredients in coatings, epoxies, or recycled content impurities). *Declare* requires disclosure of >99% of ingredients in the final product at 100ppm, where *HPD* allows manufacturers the option of disclosing at different thresholds, as well as withholding varying amounts of information, and completing an *HPD* without necessarily having a complete understanding of the content inventory (in this case the must specify that all ingredients have not been characterized and screened). There is not necessarily agreement in the industry of how deeply we should be identifying chemical presence in products, and at what level the utility of further characterization ceases to be useful. Is disclosing recycled materials such as crushed PVC still useful at 10,000ppm, or will it just miss most of the problematic residuals that might be present in a product?¹¹

Accurate disclosure is also highly dependent upon consistent and correctly interpreted communication of requirements within the supply chain. Even if a manufacturer requests a certain level of information, they are often dependent on their suppliers to interpret and provide the level of information they need. Independent testing of products can be done to verify the information provided, but this is costly and cannot be used in all cases^{11,12}.

Accurate and honest reporting by manufacturers was also considered an issue, where some interviewees felt some manufacturers, were “far too comfortable” with inaccuracies that would benefit the appearance of their product.

Interviewees also described facing what is known as the “innovator’s dilemma”. Companies founded on principles of transparency were interested in disclosing their ingredients, but felt that they couldn’t do so without a level playing field. When an ingredients label with complete disclosure of ingredients is held up next to a label with an almost identical product that discloses slightly less information, the fully-disclosed product may a) reveal more proprietary information thus putting them at risk and b) look ‘worse’ in terms of material health.

CAS#s are also an imperfect system of identifying chemicals, and interviewees expressed frustration at times with having to provide “bogus” CAS#s for programs like *Declare* when an appropriate one did not exist. For example, one can obtain a CAS# for a polymer, but the true final composition of that polymer can vary widely depending on the production of that polymer. Polymers themselves can be generally innocuous, however if manufactured in less than ideal circumstances, there may be high levels of residual monomers left in the polymer—and *these* monomers are often of more concern. So the identification of the residual monomers may be more important than just providing a CAS#.

4.6.5.2 Standardizing Screening

The three main programs studied in this research all involve a baseline level of screening ingredients against Restricted Substances Lists to determine presence or absence of certain chemicals—what each program considers the “worst-in-class” classes of materials or chemicals. Screening against lists provides manufacturers with a simple measure of how their product performances in terms of avoidance of certain chemicals and materials in products. However, as determined by the Lowell Center for Sustainable Production (2008), what is on these lists and the reasons for their presence on a list can vary widely from program to program. Restricted Substances Lists used for screening can vary hugely

across programs, across industries, or even just from one manufacturer to another (Lowell Center for Sustainable Production, 2008).

Differences between lists can mean that the same product ingredient is flagged as problematic in one program, but may present no issues in another⁷. Many manufacturers and architects also have their own internal RSLs (Fransson, Brunklaus, & Molander, 2013; Kogg & Thidell, 2010; Lowell Center for Sustainable Production, 2008). “The process may be the same but if you’re not even starting with the same data points, you’re gonna get skewed results,”⁷ therefore interpretation of screening may feel arbitrary at times to some manufacturers.

4.6.5.3 Standardizing Chemical Assessments and Optimization Efforts

Assessment is the next step after screening along the material health continuum described by Heine et al. (2013). *Declare* and *HPD* use inventory and screening, and *Declare* uses a banned list of chemicals. However, neither program goes beyond this to fully assess the hazards present in the product beyond a screening process. Interpretation of results is ultimately left to the customer in those programs, aside from the distinctions made between Declared, LBC Compliant, and Red List Free made by *Declare* (see Chapter 2). Most participants felt that risk analysis was important to understand the context of the product composition, and the life cycle. Even those that approved of the simplicity of the hazard approach to determining material health felt that full assessment of chemicals within a product using the *GreenScreen* or *C2C* methodologies provided a more in-depth understanding of the ingredients. Risk and exposure assessments add context and better prioritization of any issues. For example, if a product contains a restricted chemical such as phenol formaldehyde, which potentially has dangerous emissions, but it meets stringent air quality standards, “then there’s no risk, so what are we talking about?”¹²

Still, some warned that risk analysis was still itself in its infancy and not a replacement for understanding the inherent hazards of product content, nor a panacea for the issues being faced in the industry approach to better products. One interviewee remarked, “risk assessment is so imperfect that I’m not going to default to saying that’s what the issue is.”²

Beyond these issues, a position expressed by some interviewees was the need for an industry-wide initiative where “everyone has to get together to agree on what they will provide—on some level of information,” otherwise “we’re just going to splinter and splinter and splinter until we get everyone back at the table.”⁷ This would require the key players in the industry to come together and agree on a basic threshold. There also remains the question of whether nonprofit-administered standards have the potential to agree on levels and types of information, nor whether selective participation by different manufacturers and different firms in different programs is useful overall. As one participant pointed out:

Holistically- and at a high level I can’t see people agreeing on what they want out of these tools. If only certain manufacturers are participating and design firms that like it for this reason, how does that help everybody? That’s always the challenge, and that’s why everyone continues to spin off and make their own programs.⁷

4.6.6 Prioritization

Participants felt it was important to prioritize what materials we tackle first. Dealing with the most problematic issues, and then working down a list allows for the greatest initial impact. “Let’s get a stake in the ground, a working piece, and continue to add on and strategically look at it...What is the most impact? What are the things I’m most concerned about in the industry and products? What are we concerned about in firms? And working it down from the top down.” Where product coatings are concerned, for example, what is appropriate for space travel may not be the same as what is appropriate for painting an elementary school.

Proactive vs. reactive actions were also emphasized by a few of the participants. One example given by an interviewee dealt with the previously discussed issue of regrettable substitutions. The California Safer Consumer Products Regulation requires manufacturers to conduct alternatives assessments for certain harmful chemical ingredients widely used in products. While a laudable attempt to control for problematic chemical substitutions, the example was held up as a cautionary example of the prohibitive time and money required for this type of assessment. Perhaps instead of requiring alternatives assessments,

more proactive solutions might move the needle further, faster. By that same philosophy, working to locate and expunge all traces of problematic materials in a chair may not be the best use of one's time. None of the interviewees specifically referenced the creation of "good lists" or "green lists" referred to in the research done by the Lowell Center for Sustainable Production (2008). However, interviewee feedback was in line with the findings that some manufacturers are looking to create "positive criteria" for products rather than focusing on avoidance. A number of interviewees referred to the idea of actively searching for better materials rather than only focusing on what to avoid or eliminate from products. "An hour spent tracking down potential [Chromium] VI on a caster is an hour less time finding an solution. I know we need disclosure or transparency but I want to balance it with proactive changes."¹⁰

4.7 Pilot Survey

Once interviews were complete, a survey questionnaire was assembled based on the researcher's knowledge of the field and informed by the interview responses. A pilot survey was first sent to 8 of the interview participants who had expressed a particular interest in the study. This pilot survey was intended to gather initial feedback on the survey in order to gather feedback and determine if there were any issues in the questions prior to releasing the full survey.

There were six responses to the pilot survey. Participants in the pilot survey were prompted to either provide feedback at the end of the survey, or to send feedback separately in an email. Two of the six respondents emailed the researcher separately to provide feedback and elaborate on their responses in the survey.

A number of issues around question clarity were pointed out. In addition, participants pointed out a few questions where the response mechanism (i.e. answer selection method) in the survey was not in line with the question or seemed to be problematic. These questions were revised accordingly prior to distribution of the larger survey. Additionally, the researcher identified a few additional areas of interest, such company position in the supply chain, and supply chain size, and added questions about these to the survey.

4.8 Full Survey Analysis

The full survey was sent to 76 manufacturers in the U.S. building product industry. Manufacturers were identified from a similar population as the interviews. Participants were identified through their association with the various material health evaluation programs focused on in this research.

Complete responses were obtained from 37 manufacturers, though five were ultimately excluded due to having been completed by manufacturers based in other countries. This research was focused on U.S. manufacturers, due to differences in regulations. The 32 analyzed responses represent a response rate of 42.1%. While the response rate was high, the researcher acknowledges that the number of responses is too small for extrapolation from the data gathered. However, the aim of this research was not to predict the perspectives of the entire industry, but to understand the perspectives of leading manufacturers.

Some of the questions in the survey were designed to determine whether a manufacturer's position in the supply chain and their product sector would their perspective on the issues of transparency and disclosure. However, manufacturers rarely fell into neat categories along the supply chain or within an industry. More often, the manufacturer supplied different types of products to different consumers in different sectors. Therefore it was difficult to neatly group the manufacturers and analyze the data along these lines.

Surveys consisted of 29 questions. A further two questions were optional and open-ended. Responses to the survey are described below (the survey questionnaire can be found in Appendix D). The survey was divided into 6 sections:

- Company Background
- Awareness & Use of Material Health Declaration/Evaluation Programs
- Company Approach to Material Health
- Supply Chain Interaction
- Company Perspective on Material Health Information
- Transparency + Regulation

As Likert-type responses were employed often in the survey, descriptive statistics are used where appropriate—such as describing the mode and frequencies (Journal of Extension, 2012).

The following section first describes the sample obtained, and then discusses relevant results from each section of the survey.

4.9 Company Background

The first eight questions gathered background information on both the company and also on the participant's role within the company. When asked first about the company's role within the supply chain, the majority of respondents reported that they sold finished goods, either to other businesses or to consumers (Figure 4.2). Respondents that described their companies as producing chemicals, chemical mixtures or materials were the smallest group (19%). Participants had the option to select more than one answer, as many manufacturers fall into multiple categories, due to either the range of one their products, or because some companies have multiple businesses, some of which are more consumer-facing, and some of which act more as suppliers to other businesses. The purpose was to determine where some of the companies lie in the supply chain, and whether that would influence their perspective on transparency and their perceived barriers to transparency in the industry. Most of the manufacturers fell under multiple categories, which made connections between supply chain position and perspectives on material health transparency more difficult to link.

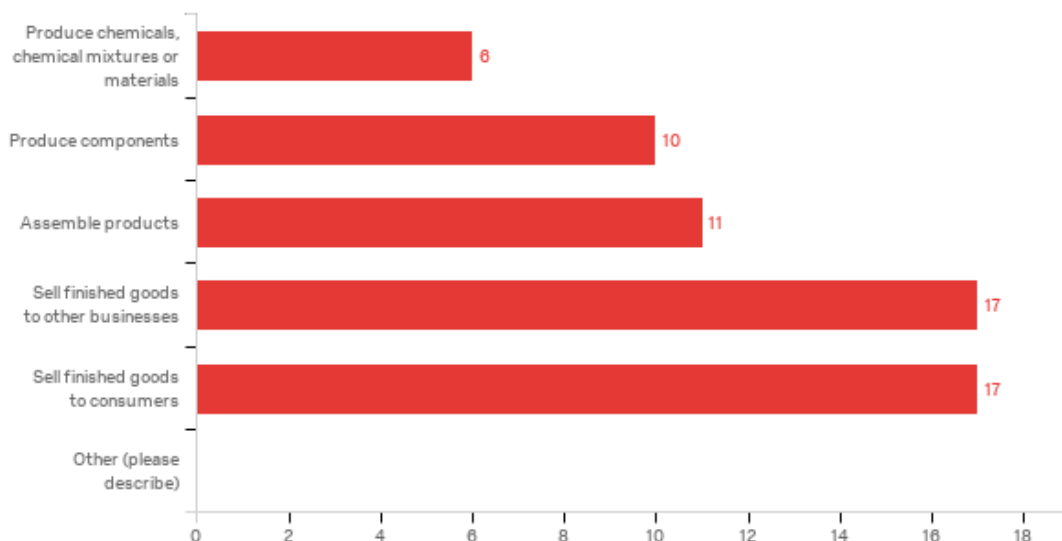


Figure 4.2 Company Role in Supply Chain.

Sample companies also represented a range of product types. The largest category of respondent product type was furniture. Beyond that, wood products, flooring, and insulation were equally represented as the second largest product types. Once again, many of the manufacturers produced products that fell under multiple categories, meaning they may encounter sector-specific issues (formaldehyde in wood, proprietary textile ingredients, recycled content) in multiple sectors.

When asked about the size of the company, 31% of the participant's companies fell in the mid-range of 1,000-5,000 employees. Two companies had more than 10,000 employees. The two largest companies in terms of employees were manufacturers of bathroom fixtures and furniture products.

Survey respondents had a number of different roles at their company. The greatest number of respondents worked on their company's sustainability team. Others were involved in sales, marketing, research and development, and manufacturing, engineering and management. All participants described some degree of interaction with material health evaluation, disclosure or chemicals-related issues at their company.

Of the seven companies that reported having over 5,000 employees in their company, three of the companies reported having less than five employees working on issues of material health. Half of the companies surveyed (16 participants) reported having two or fewer individuals working on these issues of material health and disclosure. Of the nine companies who reported annual revenues of over 1 billion USD, 3 participants had more than 11 employees working on these, and three of these companies had three or fewer employees working on these issues. This indicated that the size and revenue of a company did not necessarily determine the amount of resources being devoted to issues of material health and disclosure. 34% of respondent's companies had domestic supply chains, and 66% reported having global supply chains.

4.9.1 Awareness and Use of Material Health Declaration/Evaluation Programs

Out of the programs studied in this research, most participants had engaged with *Declare* (25), then with the *HPD* (21), and the fewest with *Cradle to Cradle*. Every participant, however, had at least heard of *Cradle to Cradle*, while 1 participant reported being unaware of *Declare*, and 3 were unaware of the *HPD* standard.

Cradle to Cradle was responsible for the fewest number of overall products certifications, while *HPD* was responsible for the most. This makes sense as *HPDs* are a free and open standard, and *Cradle to Cradle* is the most expensive and requires third party engagement. The largest number of respondents also reported *HPDs* as being the most requested standard by consumers, while *Cradle to Cradle* was the least requested. Participants reported the greatest involvement overall in the *HPD* out of the three programs.

4.9.2 Company Approach to Material Health

Participants were asked to rate a number of drivers in terms of their influence on their company's engagement with the voluntary material health programs identified in the study. Overall, out of the factors identified as having "a lot" of influence on their engagement, "Consumer Demand" was identified the greatest number of times, followed closely by "Building Certification Programs" (17) and then by "Company Mission" and Values (16). Overall, participants indicated that "International Regulation" had the least influence on their participation in the programs. However, it is possible that international

regulation may have a large influence on some companies' material health policies and the direction of the green building movement overall without employees being directly aware of this influence. When asked about the impacts of engaging with these programs, an increased knowledge of their product content was selected the most often as a result. Increased confidence by consumers in the company was also identified as being a relative impact of program engagement.

4.9.3 Supply Chain Interaction

Participants were asked about the number of their first tier suppliers, and the number of overall suppliers to learn more about supply chain size and complexity for manufacturers. The number of first tier suppliers for each company ranged from 2 (these participants reported that their company produced wood products and furniture) to 2,500. It stands to reason that the types of issues faced by manufacturers with such different supply chain structures might be quite different. Five respondents reported having thousands, even hundreds of thousands of suppliers in their total supply chain. Gathering ingredient information from a supply chain of thousands is a big undertaking. One respondent answered that their company had too many suppliers to estimate; their company produces a large range from products including plumbing lighting, electrical, wood products, furniture and bathroom fixtures.

When asked what percentage of their entire supply chain they had engaged to collect ingredient and material health information, respondents . The 15 participants who responded that they had engaged 51-100% of their total supply chain, reported having between 2 and 50 first tier suppliers—very low numbers compared to the thousands reported by some of the participants. Manufacturers with much larger supply chains had engaged less of their supply chain.

4.9.4 Company Perspective on Material Health Information

Participants were asked to rate a number of factors from 1-5 (5 being the most important) in terms of how important they were as a barrier to further public disclosure to ingredients. The proprietary secrets of the manufacturer's supply chain were identified as

the largest barrier (13), and supply chain resistance to disclosure followed closely (11). These were trailed by lack of demand for transparency from customers (8), and the manufacturer's own trade secrets/proprietary information.

Most of the respondents reported that their company's Restricted Substances List was created internally, rather than being based only on a regulatory standard or from one material health standard. This is interesting, as it is occurring at the same time that programs are attempting to harmonize and align their lists. If every manufacturer is creating their own RSL, it would be interesting to study whether these efforts serve the industry as a whole, or whether they create the potential for further fragmentation in the industry.

When asked about the utility of different aspects of material health to consumers, from ingredient lists to risk and exposure, product-level risk assessment and the presence or absence of Chemicals of Concern were identified as being the most useful aspect of material health to communicate to consumers. Ingredients, CAS#s and hazard ratings were considered less useful. Product-level risk assessment is only carried out in C2C currently.

4.9.5 Transparency and Regulation

61% of respondents felt that market-driven solutions were more likely than federal regulation to lead to a healthier materials market. This argues for improving the utility of these programs.

When asked to define the term transparency as it pertains to the building product industry, participant definitions varied very widely. Leaving the question open-ended allowed for gathering participant's definitions unbiased. However, providing a few definitions might have helped to better categorize participant's responses. It is clear, however, that interpretations of the term transparency are very different from manufacturer to manufacturer. Even looking at subgroups of data by product type or place in the supply chain, the participants provide very different definitions. Some respondents expressed mistrust of the intentions of disclosure; that releasing information that might be used for a "hidden agenda". Another stressed the difficulty of true accuracy in transparency, calling

transparency “a unicorn” in supply chains with multiple in-feeds, inherent uncertainty and multiple tiers of suppliers.

The full list of participant-given definitions to transparency and material health are given in Appendix E. At one end, respondents defined transparency as “Safety Data Sheets” (OSHA-required information), while at the other end some participants make references to hazard, risk, and the complexity of defining the term at all. Some definitions refer to the whole product life cycle, while others talk just about harm to the end user. This indicates that there are mixed signals in the marketplace, and mixed interpretations of what is expected.

When asked to define ‘material health’ as it pertains to the building material industry, similar responses were given. One respondent wrote “The fact that we’re still asking for definitions says it all,” likely referring to the difficulty of attaining something that is as-of-yet undefined. Some respondents raised the issue of risk versus hazard as a means of assessing product safety. Different definitions focused on different areas of the life cycle. Some definitions were focused solely on human health impacts while others raised the issue of environmental impacts.

4.10 Chapter Summary

This chapter reviewed the responses from both the interview and survey portions of the research. Deviations from the original proposal were discussed. Interviews were analyzed using six overarching themes and their subcategories, and perceived barriers to further engagement with the voluntary material health programs were introduced. For the survey, questions were analyzed using descriptive statistics, using graphics to aid in presentation of the material when necessary. These results and their application in answering the research questions will be discussed in the following chapter.

CHAPTER 5. CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

5.1 Introduction

This chapter synthesizes interview and survey results described in the previous chapter, along with supporting evidence from the review of the literature to draw a number of conclusions about the current research. These conclusions are then discussed within the context of some larger industry issues and compared to existing literature. The limitations of the study are presented, followed by potential applications of these conclusions and ideas for future research.

5.2 Answering the Research Questions

The past few years have been a time of rapid change in the building products industry as green building begins to enter mainstream construction, and what we consider ‘green’ expands beyond energy efficiency. Consumer demand for greater information around the content and health impacts of products has driven the creation of a number of material health evaluation programs. These programs demand standards of material health and disclosure of content information in excess of what is required by federal chemical regulation in the US. In a slow-moving, commodity-based market that has held much information proprietary, voluntary engagement with issues of material health requires significant rewiring of how manufacturers source and track what is in their products, how they disclose what is in their products and what that means for customers, and how they communicate the value of product transparency, disclosure and safety.

The intent of this study was to invite building product manufacturers to talk openly about their perspectives on this movement towards transparency and disclosure around material health. Is the push for more information beneficial or problematic? What are the issues

manufacturers encounter in trying to participate? Where do they see material health efforts headed?

Barriers to gathering and communicating information about products may point to potential areas for improvement in material health programs and avenues for accelerating participation. The hope is that accelerating participation to reach a critical mass will contribute to a more transparent and safer building materials market, and a more informed public.

The three questions guided this research:

1. What are the barriers, both real and perceived for U.S. building product manufacturing companies to engaging with voluntary material health programs?
2. What is the manufacturer evaluation of the three main material health programs? What are the barriers to adoptions? What are the benefits to participation?
3. How do manufacturers define transparency? To what extent do manufacturers feel transparency is a prerequisite to achieving a building product industry that is safe for humans and the environment?

While synthesizing the research findings, these questions were reorganized and simplified to better separate barriers from solutions and improve the clarity of the conclusions. The three questions below are therefore answered in the following sections:

- 1. What do manufacturers perceive as the main barriers to program engagement, and thus to ingredient and hazard disclosure?**
- 2. What solutions will help overcome those barriers and achieve a healthier product marketplace?**
- 3. Are transparency and disclosure crucial to those solutions?**

5.3 Research Question 1: Barriers to Engagement

Interviews and surveys revealed many perceived barriers to further adoption of voluntary material health programs faced by US building product manufacturers. These barriers have been grouped into five overall categories:

1. Lack of **resources** to devote to material health efforts
2. Not enough **standardization** of ingredient definition or thresholds, nor how to **interpret and communicate** data to consumers
3. Insufficient consumer **education**
4. **Proprietary** supply chains make gathering information difficult
5. **Single-attribute** programs may incentivize the wrong choices

5.3.1 Lack of Resources

Many of the companies engaging with issues of material health do not have sufficient resources to scale efforts across product lines. Tracking material health information for even one product, let alone thousands of products, can be difficult. Most manufacturers in the study reported data management issues, due to a) supply chain size, location of suppliers (often supply chains were international) and dynamic nature of supply chains, and b) product complexity and configurability of products (especially surrounding colors and textiles).

Generally, participants reported small staff size responsible for engaging with material health programs. Some of the participants in this study represented their company's entire sustainability team. Often, those participants are engaged with sustainability at both the company level and product level. Just at the product level, the same products are generally pursuing a significant number of certifications surrounding many different attributes. Manufacturers reported difficulty balancing these efforts in terms of time, cost and effort. Without significant demand and return on investment, it can be difficult to prioritize material health when so many other product attributes exist and are important for product aesthetics, performance and price.

5.3.2 Lack of Data Collection, Interpretation + Communication Standardization

Lack of alignment between the three material health programs studied is another barrier to engagement previously identified by Heine et al. (2012) in the program harmonization effort. The lack of consistent definition of how to define and gather content inventory is perhaps the most problematic portion of this. Determining what is considered to be an ingredient is sometimes inconsistent. It can be difficult for manufacturers to know

whether a product should be described as the sum of its input ingredients, or whether the final product is fundamentally different on a chemical level without expensive product testing. Lack of definition and alignment around this issue can make the collection of ingredient and hazard information more difficult and confusing than it need be.

Reporting ingredient information at different thresholds for different programs may also mean manufacturers have to make multiple asks of their suppliers. Overall, this also means that the manufacturers cannot be as confident that reporting of ingredients is consistent across products and different companies.

It is also clear that the collection of data from suppliers is fairly haphazard at this point in time. While some manufacturers have developed systems for data collection, most are still. Also, many participants reported a need to be flexible in their data collection efforts in order to engage suppliers that might otherwise resist disclosure. Receiving information “in 10 different ways from 10 different suppliers”⁷ can make interpretation of supplier information more cumbersome and time-consuming.

Each of the three programs studied in this research presents different types of material health information in a different format to consumers. Program developers should carefully consider what information should be consumer-facing, and which should be reserved for communication within supply chains so as not to provide consumers with information they cannot adequately interpret.

5.3.3 Consumer Education

Lack of consumer education was another significant barrier identified in this research. The production and disclosure of ingredient and hazard information is very important for closing the existing data gap. However, without appropriate levels of information and associated education for consumers, the release of data may not be used as intended. Lack of education for consumers can mean a) better products are ultimately not selected over worse ones, or potentially good products are actually avoided because consumers are scared off by complicated hazard information, and b) lack of demand for program engagement by manufacturers. Education should be centered on the distinction between

hazard and risk, and the roles of the different programs in trying to address material health. Consumer demand is a large driver of manufacturer engagement with these programs and product changes overall. Their education and participation in this process is crucial to reaching a critical mass of adoption.

5.3.4 Proprietary Supply Chains

In a global, mainly commodity-based market, complex supply chains make it difficult to gather specific information and have confidence in the accuracy of that information. Proprietary and trade secret claims in supply chains were a major barrier to program participation and disclosure identified by participants in this research. While *HPDs* and *Declare* labels are most often self-reported, without supplier cooperation manufacturers must either conduct expensive product testing, engage a third party verifier, or make an educated guess about content which some manufacturers are not comfortable with. Often, third party engagement requires a non-disclosure agreement to be signed between the third party and the supplier; therefore the information often cannot be given to the final manufacturer, nor disclosed to the public. This parallels findings by Scruggs and Ortolano (2011) that proprietary claims and information lost in complex supply chains were one of the main challenges facing European consumers in trying to comply with REACH regulations. Figure 5.1 illustrates one example of a complex supply chain.

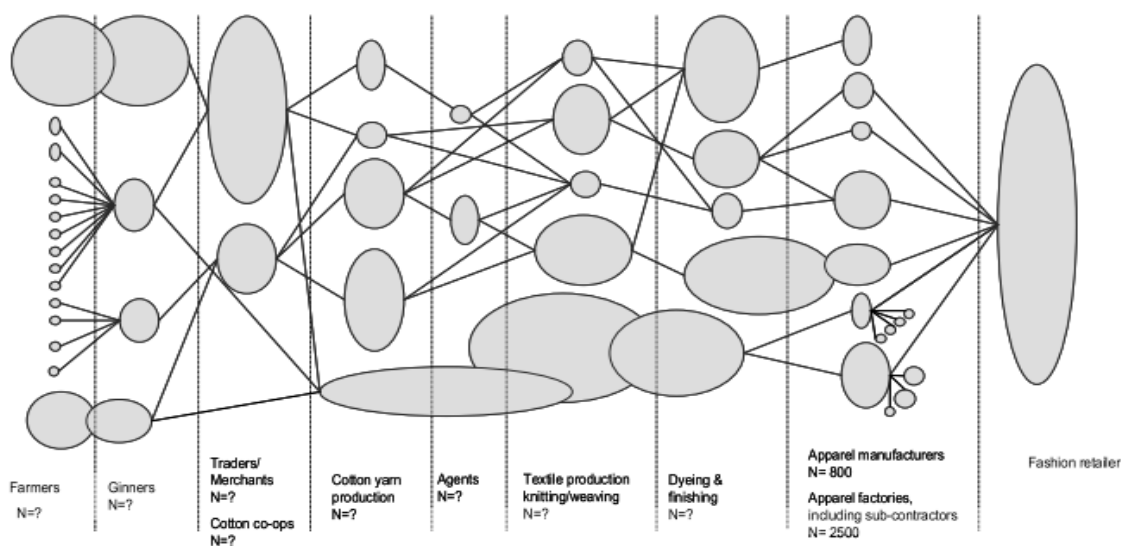


Figure 5.1. Supply chain complexity for a fashion retailer (Kogg & Thidell, 2010).

The manufacturing companies represented by participants in this research are considered leaders in the transparency and material health movement. Overall, consumer-facing manufacturers encounter greater demand for these material health programs, and are likely to be bigger proponents of ingredient and hazard-based disclosure for products. However, those manufacturers are still tied to their supply chain and suppliers often perceive greater risk in participating with these programs. The value of what a chemical supplier produces lies within the formulation of their product, whereas the overall assembly and design of a chair, for example, is what makes it special. Suppliers capable of actually creating chemicals higher up in the supply chain are less likely to want to disclose granular information.

5.3.5 Single-Attribute Tradeoffs

Material health is a crucial component of product sustainability, and therefore of the sustainability of the built environment. However, manufacturers must consider the impacts of product changes and reformulation outside of just material health. Each change to a product can potentially have a cascade of effects around price, life cycle impacts, and durability. Some participants pointed out the danger of too narrow a focus around health and toxicity. As one of the interviewees from this research pointed out:

The health thing is so hot right now and it is so immediate and people are so scared about it. It's so new and so fresh and so scary and we're fixated by it, and I'm not gonna say it's wrong and we should be getting better chemicals. But we have to be careful about, about if we focus on that to the exclusion of everything else what are we going to be sacrificing?²

Cradle to Cradle was the only multi-attribute program studied in this current research.

Even *Cradle to Cradle*, however, does not incorporate life cycle information.

Manufacturers have a huge number of factors to consider in their supply chain. Getting rid of an ingredient may mean price differences; bio-based adhesives may not perform as well as synthetic; replacing an ingredient in a coating may require re-application sooner. Sometimes there is no significant tradeoff, or a product performs just as well without an offensive ingredient, but it is important to consider these issues alongside health and toxicity to make sure that programs are encouraging positive change.

5.4 Research Question 2: Potential Solutions

RQ 2: What solutions will help overcome those barriers and achieve a healthier product marketplace?

The five categories of solutions parallel the barriers outlined in the previous research question:

1. Standardization of Data Collection
2. Interpretation + Communication
3. Education
4. Supplier Engagement
5. Multi-Attribute Thinking

5.4.1 Standardization of Data Collection

Further cross-pollination between the three programs would thus be beneficial for engagement. Increased harmonization of baseline data needs for each program would mean that the manufacturers and programs would be speaking with a common voice to upstream suppliers, potentially increasing the quality and quantity of data and decreasing the time and cost involved in gathering information. Standardization of data collection requirements mean that programs can continue to compete, but data feeds multiple programs, requests are more consistent, streamlined and accurate.

Many of the other barriers identified in this research appear to be connected to this issue of standardization. Further adoption of transparency and material health thus also feel predicated on the establishment of greater standardization and harmonization. Without further standardization, efforts in other areas will be diluted by conflicting methods of data collection, assessment interpretation, needs for education.

Further harmonization of programs and standardization of expectations and interpretation will allow the most efficient use of time and resources and expedite uptake of these principles and progress in the market. Lack of standardization leads to market confusion, reluctance to disclose before competitors, and difficulty in interpreting information presented by these programs. The differences in philosophy underlying the various

programs—what are the most important aspects of material health or disclosure to the program developer—are largely what create these divisions and can be difficult to overcome Kokai (2014). The program developers recognize these differences in their paper on harmonization opportunities, pointing out that while standardization is important, this does not mean that all of the programs necessarily need to merge at this point (Heine et al., 2012). The differences in approach by different programs may serve the market by allowing different points for entry by different manufacturers, and allowing for market differentiation. However, if all of the programs could agree on the standardized collection of data (which is partly the intention of the *HPD*), perhaps the programs could continue to compete based on their interpretation of that content inventory.

Another large barrier is a lack of standardization in how material health information is defined, gathered, communicated and interpreted. The more that the industry can speak in a common voice, the more consistent the demand and response for information will be. Currently, manufacturers are requesting information from their many suppliers, and receiving the requested information many different ways. Their suppliers are being asked for lots of different information to feed different programs using different formats. Flexibility is important to allow suppliers to provide information in a manner that suits them, just as having multiple programs is important for allowing final manufacturers to pursue an avenue that fits their model. However, if programs align enough so that manufacturers request the same common baseline of information from each supplier, the work will become easier for all parties involved. Streamlining the process of gathering information through standardization of requirements, downstream aggregation of content inventory information, and possibly tying material health information to other measurements such as life cycle analysis data may help to decrease redundancy and make material health part of the process rather than an additional cost.

5.4.2 Interpretation + Communication

Wherever possible, material health programs need to communicate to consumers with a common voice to increase recognition of these issues and decrease confusion in the

marketplace. Consumer-facing programs also need to make content presentation and product comparison intuitive so that it is easy to select the most appropriate product.

Also, clear communication from each program about the purpose of each program will also help to improve the use of programs. All three programs studied in this research play a different role. The *HPD* standard as it exists, should not be used by architects or consumers to specify products, as the standard a) does not pass judgment on the relative health or safety of a product and b) is not easily interpretable by architects who often lack the knowledge and time to decipher the document. The *HPD* Standard can, however, serve a crucial role in the collection and communication of standard information used to feed other programs that are designed for interpretation.

Declare is useful as a decision-making tool for architects and allows for clear communication for manufacturers about product content, but there are significant limitations around using a red list screening approach for products. *HPDs* are free to create and *Declare* is low in cost, allowing more manufacturers to engage.

Cradle to Cradle is the most easily interpreted by consumers due to its rating system, is the only program that deeply approaches risk and exposure, and is multi-attribute. It also provides an avenue for manufacturers to engage with material health that are not willing or able to disclose product ingredient and hazard information. However, its lack of transparency in both the standard and the program output, along with the high cost, can be unappealing to many manufacturers, and a deterrent to participation.

The differences in philosophy underlying the various programs are largely what create divisions in interpretation and communication, and can be difficult to overcome (Kokai (2014)). These different approaches, however, may serve the market by allowing different points for entry by different manufacturers, and allowing for market differentiation. If all of the programs could agree on the standardized collection of data (which is partly the intention of the *HPD*), perhaps the programs could continue to compete based on their interpretation of that content inventory.

5.4.3 Consumer Education

Consumers were consistently identified as the greatest driver of change overall. This argues for focusing on education a) within the building industry to change perceptions and foster an industry of building professionals that understand and value the importance of material health alongside more traditional building specifications; and b) for consumers and the general public to grow demand and increase pressure for better products and green chemistry. These principles have to be carried out throughout the entire supply chain down to the contractors, subcontractors and consumers in order to truly be impactful.

Greater education for consumers around the *purpose* of each program, and how to *interpret* the information provided by each program would make the final manufacturers and their suppliers more confident in the benefits of participation and might ease fears about misinterpretation of complicated hazard information in programs like *HPD*. The movement is very much in its infancy, and beyond the leaders in the industry, this education also needs to extend to other manufacturers in the industry.

However, even if some consumers are properly educated about material health, they should not necessarily need to understand how to interpret a list of hazard ratings in an *HPD*. As much as consumer-facing programs can make their output information user-friendly for decision-making, the more it will incentivize better decisions. Fransson (2013) also discussed the need for the provision of appropriate levels of information to the appropriate parties.

5.4.4 Supplier Engagement and Scalability

In a global, mainly commodity-based market, complex supply chains make it difficult to gather specific information and have confidence in the accuracy of that information. Even when manufacturers were able to gather data, some expressed reluctance to publish claims that were hard to confirm without testing every product. Supplier engagement may help here. If final manufacturers can establish basic material health reporting or standard requirements for their suppliers aligned with multiple programs, they may be able to gather better, more accurate data.

More education for suppliers around the purpose and application of the information requested would perhaps also increase their comfort level with disclosure. Ultimately, it will be important to find a common set of requirements that allow suppliers to protect what is truly proprietary information, while giving final manufacturers, and therefore consumers, the information needed to make a determination about a product's relative safety.

Scalability was highlighted as a crucial component of any solution. Another potential solution is to move to a model that collects data beginning upstream with suppliers, and aggregates that information down the supply chain. This would reduce the redundancy of information requests, potentially also reducing the time it takes to make progress and the cost of engagement with programs. Some programs like Material IQ and Proscale have begun to investigate the possibility of this model.

Alignment of how programs interpret risk and exposure from products chemicals will also serve to increase confidence in the output of programs. While differences in the programs do serve the market by offering different levels and methods of engagement, inconsistencies in all of these stages of material health assessment should ultimately decrease in order to speak with a common voice to a larger audience.

Ultimately, this raises further questions. How can suppliers be further engaged? How can these programs be better adapted to engage manufacturers or incentivize them to participate? How do we incentivize supplier engagement? Is it possible with the current systems? How do we create the consistent demand they might need to act?

5.4.5 Multi-Attribute Thinking

Material health is not a siloed issue. Changes made to product chemistry affect other attributes, and may cause tradeoffs in other environmental properties. Multi-attribute thinking, and therefore, multi-attribute programs or databases that aggregate life cycle and material health information, will allow for better decision-making based on the needs of the consumer.

Additionally, there are new programs appearing all the time. *GreenCircle Certified* has a multi-attribute product standard that was mentioned in one interview and the *Living*

Product Challenge is a transparency-based multi-attribute standard, administered by the International Living Future Institute. These programs both take a more holistic approach to material health that offers more for companies that are looking for transparency with a more holistic approach to product sustainability. None of the manufacturers necessarily identified any of the voluntary material health programs they had engaged with as ‘perfect’. Still, each offered them aspects that were important to their company. Some expressed hope that a central, ideal program would arise, while some others felt that resolution around a single program was highly unlikely.

Trying material health information to specifications and life cycle information can potentially better integrate toxicity considerations earlier in the design process. This can also contribute to achieving changes at scale.

5.5 Research Question 3: Transparency and Disclosure

The characterization or definition of transparency is not so simple as the original research question posed. Participants described a significant amount of confusion in the market around the terms disclosure, transparency, material health and sustainability; something that had occurred even in this study. All participants ultimately defined transparency differently, depending on a host of factors. As a whole in the industry, or even in one sector (i.e. carpet), or within a company it would be difficult to obtain a consistent definition of what transparency is.

Transparency was generally recognized by participants to be an important step forward in the building products industry. Though transparency mainly refers to an honest relationship with ones customers, content and hazard transparency is an important piece of the movement. With disclosure and transparency comes a conversation about the status quo, and about where the industry needs to head. Transparency and disclosure can make manufacturers question what is in their products before they even engage with a program. The precise definition of what material health transparency means to the industry is evolving as the industry learns and consumers become further educated.

Transparency is the mechanism by which we begin to define other factors. By creating an open dialogue, and a conversation of comparison, transparency can stimulate change and

education. Alone it is not enough to cause sweeping change, however it is a crucial component of the solution. The transparency movement is still very much in its infancy.

The difference between transparency and disclosure was an important distinction made by participants. Disclosing content does not necessarily mean that one has been transparent. Disclosing all of the ingredients in your product can be a list of three ingredients, or three hundred depending on the disclosure threshold. To be transparent one should communicate the level of disclosure and the reasons.

Transparency has been fundamental in opening up a conversation of a comparison and breaking down old ways of thinking about proprietary information. What is really proprietary? What ingredients are crucial to our product? Even having to consider how one's product *might* look if publicly disclosed may cause a manufacturer to begin questioning what is in their product, and whether it really needs to be there. In some cases a chemical may be necessary for the function of a product, in others it may not be, or a better alternative may exist. Regardless of the answer, this is an important question that industry, and manufacturers, should be asking themselves. As was pointed out in the research "If it's relatively easy, transparency can make it happen even without getting to market."² Transparency is part of the foundation of a safer products market, though it is far from a total solution for achieving better products across the industry in and of itself.

5.6 Discussion

The complexity of addressing material health in a mostly commodity-based market cannot be overstated. Progress can be slow in a country where federal regulation of chemicals is woefully inadequate, and in a market where the material health of products is generally undervalued in favor of price and performance. Businesses are often global in nature, and the structure and length of supply chains can make certainty about product content a difficult, or impossible task.

Despite this, consumer demand, advocacy and green building certification programs are driving the adoption of voluntary material health programs, and hopefully, pushing the market towards taking greater care to understand the impacts of chemicals and materials

in products before distribution in order to avoid issues of human and environmental health.

Though significant progress has been made among early adopting manufacturers, acceleration of material health program adoption beyond these initial leaders is required to impact the market and catalyze real change in the industry. The purpose of this research was to determine how early adopting manufacturers are interpreting the call for transparency and disclosure of product content, in order to inform the future development of these, and other programs. Are the programs being used as intended, what major barriers exist to further progress, and what potential solutions exist to those barriers?

With disclosure and transparency comes a conversation about the status quo, and about where the industry needs to head. Transparency and disclosure can make manufacturers question what is in their products before they even engage with a program. The precise definition of what material health transparency means to the industry is evolving as the industry learns and consumers become further educated.

Transparency does not need to be public disclosure of the formulation of a product, and assurance that it is not may assuage supplier fears. Product-level assessment and risk exposure are important to providing a truer picture of material health—but in addition to ingredient and hazard disclosure. With rising levels of synthetic chemicals found in humans and animals and the environment, open conversations about what is in products we sell, use and dispose of—and what is absent from them—is important.

Clear communication from each program, and from the manufacturers that engage with them about their purposes will also help to decrease confusion in the marketplace. All three programs studied in this research play a different role. The *HPD* standard as it exists, should not be used by architects or consumers to specify products, as the standard a) does not pass judgment on the relative health or safety of a product and b) is not easily interpretable by architects who often lack the knowledge and time to decipher the document. The *HPD* Standard can, however, serve a crucial role in the collection and communication of standard information used to feed other programs that are designed for interpretation. *Declare* is useful as a decision-making tool for architects and allows for

clear communication for manufacturers about product content, but there are clear limitations around using a red list screening approach for products. *HPDs* are free to create and *Declare* is low in cost, allowing more manufacturers to engage. *Cradle to Cradle* is the most easily interpreted by consumers due to its rating system, is the only program that deeply approaches risk and exposure, and is multi-attribute. It also provides an avenue for manufacturers to engage with material health that are not willing or able to disclose product ingredient and hazard information. However, its lack of transparency in both the standard and the program output, along with the high cost, can be unappealing to many manufacturers, and a deterrent to participation.

Overall, consumer-facing manufacturers encounter greater demand for these material health programs, and are bigger proponents of ingredient and hazard-based disclosure for products. The value of what a chemical supplier produces lies within the formulation of their product, whereas the overall assembly and design of a chair, for example, is what makes it special. Suppliers capable of creating chemicals higher up in the supply chain are less likely to want to disclose granular information. Green building certifications are a large driver of material health program engagement, but many manufacturers are engaging despite lacking the demand they might need to defend the amount of time and money it can require. Many feel they need to see the demand and market recognition to justify their efforts, and outside of these early adopting manufacturers, there will likely need to be a better marketable and financial case for engagement. This means that identification of barriers to further engagement and finding large-scale solutions are key for driving broader adoption.

Some major barriers exist to final manufacturer disclosure of product makeup using voluntary material health programs. One of these barriers is a dearth of information from their supply chain. Complex supply chains, and suppliers uncomfortable with disclosing what they consider to be proprietary information, or trade secrets, prevent many manufacturers from being able to participate in programs that require a significant amount of disclosure, like *Declare*. Another major barrier is a lack of education, both for suppliers, and for consumers.

More education for suppliers around the purpose and application of the information requested would perhaps increase their comfort level with disclosing. Greater education for consumers around the *purpose* of each program, and how to *interpret* the information provided by each program would make the final manufacturers and their suppliers more confident in the benefits of participation and might ease fears about misinterpretation of complicated hazard information in programs like *HPD*. The movement is very much in its infancy, and beyond the leaders in the industry, this education also needs to extend to other manufacturers in the industry.

Another large barrier is a lack of standardization in how material health information is defined, gathered, communicated and interpreted. The more that the industry can speak in a common voice, the more consistent the demand and response for information will be. Currently, manufacturers are requesting information from their many suppliers, and receiving the requested information many different ways. Their suppliers are being asked for lots of different information to feed different programs using different formats. Flexibility is important to allow suppliers to provide information in a manner that suits them, just as having multiple programs is important for allowing final manufacturers to pursue an avenue that fits their model. However, if programs align enough so that manufacturers request the same common baseline of information from each supplier, the work will become easier for all parties involved. Even the definition of an ingredient can be unclear at this time.

Another potential solution is to eventually create, or adapt, material health programs that begin collecting data upstream with suppliers, and aggregate that information down the supply chain. This would reduce the redundancy of information requests, potentially also reducing the time it takes to make progress and the cost of engagement with programs. Alignment of how programs interpret risk and exposure from products chemicals will also serve to increase confidence in the output of programs. While differences in the programs do serve the market by offering different levels and methods of engagement, inconsistencies in all of these stages of material health assessment should ultimately decrease in order to speak with a common voice to a larger audience.

All of these improvements will also serve to reward engagement with these programs. Greater harmonization, alignment, and clarity around material health programs will increase demand and will reward the manufacturers who have chosen to engage. Continued movement beyond solely list-based approaches, to full assessments of product content, is important for encouraging better-informed changes. Lastly, material health is not a siloed issue. Changes made to product chemistry affect other attributes, and may cause tradeoffs in other environmental properties. Multi-attribute thinking, and therefore, multi-attribute programs or databases that aggregate life cycle and material health information, will allow for better decision-making based on the needs of the consumer. Most participants felt market-driven solutions were the fastest path to a healthier materials market, both within the interviews and the surveys. None were entirely opposed to increased regulation, though interviewees expressed their skepticism that better regulation was a possibility. Many felt this might allow for a more “level playing field” and increased standardization around disclosure and interpretation. However, even if enough compromise can be found to allow for the passage of better regulation, regulation is more likely to remain a “trailing indicator” of where market direction. Market-driven solutions are the most likely, and most efficient, route to a better market.

5.7 Comparison to Literature

Existing literature looks primarily at flows of chemical, hazard and risk information in consumer product supply chains.

Supply Chain Complexity + Proprietary Information

Supply chain complexity “matrix within a matrix” have been shown here and in the literature to be a significant barrier.

... it is safe to assume that if we should trace all actors of a supply chain for a company that is near the end-consumer in the product chain, we will often end up with a large number of individual companies, even if the range can be considerable, from below ten to, possibly, millions, depending on the size and the nature of the company we take as our starting point. (Kogg & Thiddell, 2010)

This research parallels research by Scruggs and Ortolano (2011) on information barriers to safer products, that proprietary claims and information lost in complex supply chains were one of the main challenges facing European manufacturers in trying to comply with REACH regulations. However, this current research looked more closely at the perspectives of those manufacturers, and underlying reasons for lack of ingredient disclosure. Voluntary material health programs have been a smaller focus of other papers to date, likely as the adoption of these material health programs is relatively new.

As in Scruggs' paper on reducing hazardous chemicals in consumer products (2013), actions by manufacturers are still being done on an individual basis, therefore plenty of 'reinventing of the wheel' is taking place. Lack of a standardized system for data collection may prevent other companies from engaging at this point.

Fransson & Molander (2012) found that information was generally not traveling more than one tier up or down in textile industry supply chains. In the current research, some manufacturers described having to gather information 3 or 4 tiers back in their own supply chains. Red lists were found to be used most commonly in both studies for communication of product content.

Levels of Appropriate Information

Fransson (2013) also looked at consumer paint supply chains and the use of SDSs in communicating hazard information. The communication of appropriate levels of information for each stakeholder was found to be very important where risk is concerned. This current research emphasizes the need for information beyond SDSs and risk information, however it also found that the distribution of appropriate information to different stakeholders is important for decision-making. A rating system for products, that uses a transparent standard may allow consumers the ability to make simple decisions and recognize the safety of a product, while allowing them to research the justification for a rating if they desire additional information.

In their assessment of stakeholder chemical information needs, Kogg and Thiddell (2010) identified two critical tiers of information. Tier 1 information focuses on the chemicals in a product, and which chemicals have the potential to migrate from the product in certain

life cycle phases of the product. This information should be harmonized within an information system. This aligns with findings from this current research that greater harmonization and standardization of information collection will be beneficial. Tier 2 information, the interpretation of this information and instructions for action, aligns with this current research's evaluation that program interpretations of chemical content can continue to compete. Tier 1 collection about ingredients should be harmonized "and...this information should be supplemented with the tier 2 kind of information as tailored support functions to be adjusted and harmonized by and for certain stakeholder groups/sectors sharing similar needs" (p. v).

The emphasis on hazard prevention rather than risk management is also aligned with Rossi (2015) and argues for a programs that address material health further up in supply chains, and aim to eliminate hazard rather than relying too heavily on risk and exposure assessments to show that a product is safe.

The implementation of CiP information systems that enable downstream actors to factor in the content of chemicals (of concern) in their buying decisions will enable policy makers to harness the forces of the market to contribute to put pressure on the upstream chemical industry (Kogg & Thidell, 2010, p. v)

5.8 Limitations

There were a number of limitations in this research, in addition to limitations outlined in the first chapter. Due to the exploratory nature of the study, and the limited number of participants, extrapolation of the results to the larger industry is not possible. In addition, the survey was quite broad in its scope. The research would have benefitted from a narrower focus aimed at quantifying a few of the answers to the research questions. The questionnaire, however, may provide a starting point for future research on manufacturer perspectives.

Samples for both interviews and surveys were not representative of all building product types. Therefore, perspectives from those sectors may have been missed in the results. A larger sample size for surveys would also be useful as a follow-up.

Broad themes were pulled out of the interview results and surveys, and a list of barriers to program adoption and information disclosure was identified. However, ranking of these barriers was not possible. More pointed questions that asked participants to rank a select number of barriers might be useful to determine which issues to tackle first.

Another difficulty was in the ability to compare three programs that function very differently. Future research might group material health programs by their function rather than solely their incorporation into other standards in order to better separate issues of how programs assess material health and how that affects adoption.

History of engagement was also important to the manufacturers. Many reported unfavorable interactions with some of the programs in early pilot phases and were reluctant to engage again, even if some positive changes had been made. It was also generally difficult to separate which results reflect the perspective of the participant and which reflect those of the company as a whole. Personal perspectives, company sector, company mission and a number of other factors mentioned in section 4.6 could have had an influence on survey and interview responses.

5.9 Recommendations for Future Research

The broad nature of this study was useful in a field that has not been written about much in the academic literature. Part of what this study attempts to communicate is the complexity of the situation in order to draw attention to the need for solutions to solve the pressing issue of how we create a healthier materials market. However, the breadth of a study naturally limits the depth with which it can explore particular issues. There would be much utility in exploring more deeply each of the barriers identified by this research.

One possible study could use manufacturers as case studies to assemble a list of best practice methods for overcoming the barriers outlined in this research, and compare these to findings on best practice for chemicals management in consumer products by Scruggs (2013).

A study that focuses on suppliers near the beginning of the supply chain, including raw material and chemical suppliers would provide a useful measure of comparison to final manufacturers. There would also be value in studying individual supply chains in order to examine suppliers at every stage of the supply chain. An interesting study might study a few final manufacturers with complex supply chains in order to determine their specific barriers and how they are overcoming them. The format of transfer of information between different manufacturers, paired with supplier perspectives on transparency and disclosure would be particularly useful to learn more about barriers over multiple tiers of supply chains. Studying supply chains that bridge different industries and therefore may be subject to different regulation both globally and domestically, and different consumer demands and supplier perspectives, would also be interesting.

There would also be use in looking at a few sectors within the building products industry. Ultimately, what works in terms of transparency for a coating manufacturer may not serve the maker of a chair. Another interesting study might compare the approach found within the building products industry to barriers and solutions present in other industries such as the auto, beauty, or food industries. It is easy in many ways to draw parallels between the building products industry and other industries—to point to the auto industry, to look at the push for better ingredients in cosmetics, the organic food movement. However, there are particular complexities present in the building products industry that complicate the issue, not limited to complex life cycles, different building purposes (children's school vs. storage warehouse), differing exposure to interior vs. exterior products, and supply chain complexity.

A review of programs that are beginning the data-gathering process at the top of the supply chain with raw material suppliers and chemical suppliers would allow further insight into how this approach is working, and how realistic it is to expect disclosure of information down the supply chain.

5.10 Chapter Summary

This research was designed using relevant literature and by engaging with key stakeholders in the building product industry. Though the ability to extrapolate the research beyond the sample studied is limited, the research questions set out were answered and industry contact confirms the importance and relevance of this work. Manufacturer perspectives on material health programs and issues of disclosure and transparency were studied in order to determine barriers and solutions to further adoption of programs and thus the release and analysis of further chemical information in the US building products industry. The main barriers and potential solutions to those barriers were discussed. Recommendations for future research with a narrower scope that explores some of the themes identified in this research were presented.

REFERENCES

LIST OF REFERENCES

- Akadiri, P. O., Olomolaiye, P. O., & Chinyio, E. A. (2013). Multi-criteria evaluation model for the selection of sustainable materials for building projects. *Automation in Construction*, 30, 113–125. <http://doi.org/10.1016/j.autcon.2012.10.004>
- Basu, S., & Bidanda, B. (2014). Shortcomings of Eco-labelling of construction and building materials (pp. 151–165). Elsevier. <http://doi.org/10.1533/9780857097729.1.151>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology, 3, 77–101. <http://doi.org/10.1191/1478088706qp063oa>
- Espinoza, O., Buehlmann, U., & Smith, B. (2012). Forest certification and green building standards: overview and use in the U.S. hardwood industry. *Journal of Cleaner Production*, 33, 30–41. <http://doi.org/10.1016/j.jclepro.2012.05.004>
- Fransson, K., Brunklaus, B., & Molander, S. (2013). Flows of Chemical Risk Information in the Consumer Paint Product Chain. *Journal of Industrial Ecology*, 17(2), 310–320. <http://doi.org/10.1111/j.1530-9290.2012.00542.x>
- Fransson, K., & Molander, S. (2012). Handling chemical risk information in international textile supply chains. *Journal of Environmental Planning and Management*, (APRIL), 1–17. <http://doi.org/10.1080/09640568.2012.681032>
- Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *Test*, 8(4), 597–606.
- Heine, L., Kausch, M., Klosterhaus, S., Glass, S., & Lent, T. (2013). Material Health Evaluation Programs Harmonization Opportunities Report, 1–32.

- Hoffman, A. J., & Henn, R. (2008). *Overcoming the Social and Psychological Barriers to Green Building. Organization & Environment* (Vol. 21).
<http://doi.org/10.1177/1086026608326129>
- HPDC. (2015). *Health Product Declaration Open Standard*. Wakefield, MA. Retrieved from http://hpdcollaborative.org/standard-documents/hpdstandard_v1_0_121215.pdf
- ILFI. (2014). *Living Building Challenge 3.0*. Canada.
- Isnin, Z., Ahmad, S. S., & Yahya, Z. (2012). Challenges of the Unknown Building Material Substances for Greener Adaptation Projects. *Procedia - Social and Behavioral Sciences*, 68, 53–62. <http://doi.org/10.1016/j.sbspro.2012.12.206>
- Jackson, T. (2009). *Prosperity without growth: Economics for a finite planet*. London: EarthScan. Retrieved from
http://www.gci.org.uk/Documents/Tim_JACKSON_Prosperty_Without_Growth.pdf
- Kamrin, M. A. (2014). *Regulation, Toxicology and. Encyclopedia of Toxicology* (Third Edit, Vol. 3). Elsevier. <http://doi.org/10.1016/B978-0-12-386454-3.00426-7>
- Koch, L., & Ashford, N. a. (2006). Rethinking the role of information in chemicals policy: Implications for TSCA and REACH. *Journal of Cleaner Production*, 14(1), 31–46. <http://doi.org/10.1016/j.jclepro.2005.06.003>
- Kogg, B., & Thidell, Å. (2010). Chemicals in Products: An overview of systems for providing information regarding chemicals in products and of stakeholder' need for such information, (August).
- Kokai, A. (2014). *The Public Ethics of Green Design Tools in the Building Industry*.
- Lee, Y. S., & Kim, S. (2008). Indoor Environmental Quality in LEED-Certified Buildings in the U . S . , (November), 293–300.
- Long, T., & Johnson, M. (2000). Rigour, reliability and validity in qualitative research. *Clinical Effectiveness in Nursing*, 4, 30–37. <http://doi.org/10.1054/cein.2000.0106>

- Lowell Center for Sustainable Production. (2008). *An Analysis of Corporate Restricted Substance Lists (RSLs) and Their Implications for Green Chemistry and Design for Environment*. *Green Chemistry & Commerce.org*.
- Lowell Center for Sustainable Production. (2009). Gathering Chemical Information and Advancing Safer Chemistry in Complex Supply Chains. *Green Chemistry*, (September).
- Markell, D. (2010). New Directions in Environmental Law : An Overview of TSCA , its History and Key Underlying Assumptions , and its Place in Environmental Regulation. *Washington University Journal of Law and Policy*, 32(January), 333–375. <http://doi.org/10.2139/ssrn.1616674>
- Ogunkah, I., & Yang, J. (2012). *Investigating Factors Affecting Material Selection: The Impacts on Green Vernacular Building Materials in the Design-Decision Making Process*. *Buildings* (Vol. 2). <http://doi.org/10.3390/buildings2010001>
- Pacheco-Torgal, F. (2012). Toxicity of Building Materials. In *Toxicity of building materials* (pp. xv–xvii). Woodhead Publishing Limited. <http://doi.org/10.1016/B978-0-85709-122-2.50019-X>
- Scruggs, C. E. (2013). Reducing hazardous chemicals in consumer products : proactive company strategies. *Journal of Cleaner Production*, 44, 105–114. <http://doi.org/10.1016/j.jclepro.2012.12.005>
- Scruggs, C. E., & Ortolano, L. (2011). Creating safer consumer products : the information challenges companies face. *Environmental Science and Policy*, 14(6), 605–614. <http://doi.org/10.1016/j.envsci.2011.05.010>
- Scruggs, C. E., & Van Buren, H. J. (2014). Why Leading Consumer Product Companies Develop Proactive Chemical Management Strategies. *Business & Society*. <http://doi.org/10.1177/0007650314536393>
- Turner, D. W. (2010). Qualitative Interview Design : A Practical Guide for Novice Investigators. *The Qualitative Report*, 15(3), 754–760. Retrieved from <http://www.nova.edu/ssss/QR/QR15-3/qid.pdf>

- van Teijlingen, E., & Hundley, V. (1998). The importance of pilot studies. *Nursing Standard : Official Newspaper of the Royal College of Nursing*, 16(35), 33–36.
<http://doi.org/10.7748/ns2002.06.16.40.33.c3214>
- Waage, S. A., Geiser, K., Irwin, F., Weissman, A. B., Bertolucci, M. D., Fisk, P., ... McPherson, A. (2005). Fitting together the building blocks for sustainability: a revised model for integrating ecological, social, and financial factors into business decision-making. *Journal of Cleaner Production*, 13(12), 1145–1163.
<http://doi.org/10.1016/j.jclepro.2004.06.003>
- Wilson, M. P., & Schwarzman, M. R. (2009). Toward a new U.S. chemicals policy: Rebuilding the foundation to advance new science, green chemistry, and environmental health. *Environmental Health Perspectives*, 117(8), 1202–1209.
<http://doi.org/10.1289/ehp.0800404>

APPENDICES

Appendix A Interview Guide

MANUFACTURER INTERVIEW GUIDE*Introduction:*

Thank you very much for taking the time to participate in this interview. This research is being conducted as part of my Master's thesis at Purdue University. Your participation is voluntary and you may choose to end the interview at any time.

The purpose of this interview is twofold. First, I would like to learn how the introduction of material health evaluation programs is changing the communication of material hazard information in the building material supply chain. Second, I am interested in how changing standards of material health are impacting relationships between manufacturers and other key stakeholders in both supply and demand chains.

[Your company] has demonstrated awareness of, and experience with evaluation of product material health. I wanted to speak with you to learn more about your experience working with these programs and your company's approach to material health and disclosure.

I will be recording this interview to improve the accuracy of my notetaking. This recording will be used for transcription purposes only. The audio recording will be deleted after transcription, and the notes will be deleted upon completion of this project. Your responses will remain anonymous and no individual or company names will be used in any published results. Please let me know if you would prefer that I not audiotape this interview. The interview should not last longer than 45 minutes - 1 hour.

This project is focused on the *health and toxicological* properties of materials. Therefore, I would like to limit the discussion to your knowledge of Material Health programs, and avoid purely environmental tools like Environmental Product Declarations. "Programs" will refer to the main health evaluation and declaration programs that are commonly used in the industry, such as Health Product Declarations, Cradle to Cradle, and Declare.

Do you have any questions or concerns before we start?

Program Use:

1. Please briefly describe the role of your company in the building supply chain (e.g. supplier of parts, manufacturer of final products, etc.), as well as your role within the company.
 - a) What does your role [mean] with respect to your company's compliance with these programs?
 1. Do you see your role in this process as temporary or do you see it changing more?

- b) Which of these programs has your company pursued for products?
 - 1. Has your company pursued any other health certification/evaluation programs?
 - 2. Why are you pursuing that and not the others?
- 2. Different manufacturing sectors are confronted with different challenges with respect to disclosure and ingredient toxicity. What do you feel are important barriers to the evaluation/certification of products? Are any of those challenges (barriers) sector-specific?

If they have done C2C:

- 3. [Could you describe for me the process of complying with C2C certification?]
 - a) What have been the internal benefits of using a 3rd party assessment program?
 - 1. Do you think the NDAs are necessary to obtain those benefits?
 - b) What were external benefits that you've experienced with your stakeholders?

If they have done HPD and/or Declare

- 4. [How does this process compare to an HPD or Declare label?]
 - a) What have been the internal benefits of self-declaring ingredient information?
 - b) What were external benefits that you've experienced with your stakeholders?
- 5. What have you learned from gathering all of this information [from your supply chain]?
 - a) How does the certification change what you learn?

Internal:

- 6. Has your company developed any additional in-house tools to facilitate gathering, communication or interpretation of chemical information?
 - a) If so, why and what do they do for you?
- 7. What is your impression of the red list/screening approach prevalent in material health evaluation?

Ideal program:

- 8. Could you describe for me what your ideal program *might* be? Multi-attribute, single ingredient chemistry, product-level chemistry, transparency based?

Stakeholder Relationships:

[Supply chain]

- 9. How, if at all, have program requests changed the structure of your supply chain?
 - a) Have they changed your relationship with suppliers? Why or why not?

- b) Are these changes fairly localized to certified/evaluated products or throughout?
 - c) Do you see these changes working themselves into a wider range of products in the future?
10. How would you like to see the flow of information between your company and suppliers improved?
- a) What types of changes to the process of requesting information from your supply chain would allow you to certify more products?

[Architects]

11. How, if at all, has implementation of these programs changed your relationship with architects?
- a) How do you see this relationship continuing to evolve in the future?
12. What type of data do you find is most valued by architects? What do you think is most useful to them? What do you think they need to inform their decision-making?
13. How do you use HPDs? Internal document? External?
14. How about with Consumers?

[competitors]

15. Lastly, I'm interested in how program requests have changed your relationship with your competitors?
- a) Have these programs promoted information sharing between you and your competitors?
 - b) Is increased information/data sharing a reality in your sector? Across sectors?

Transparency:

16. What does transparency mean to your company?
17. Is transparency necessary for a healthier materials market?

Other:

18. Is there anything else you would like to discuss or mention beyond what we have spoken about?
19. Who else should I talk to?

Appendix B Participant-Given Transparency Definitions

1	<p>“[Recognizing] man’s simple nature to not change anything, to not upset the apple cart, there does need to be some transparency. I don’t think it needs to be the be-all-end-all. It can destroy trade secrecy. It can destroy originality in some senses. But I think there needs to be some to an extent. I don’t know what that extent should be. The ultimate safety of your users should come into play but I don’t know whether it should be the guard of whether something goes to market or not. If you have a cd that says “explicit language” – buy it at your own risk. Same with products. I think that’s beneficial.”</p>
2	<p>“Now there is a race to the top- I want to be the “transparentest”...That is generally a good thing. I believe transparency is the foundation. How we then do the assessments for what has been disclosed...is now even more in its infancy than standardizing what transparency means... but that is undoubtedly a good thing.”</p> <p>“If it’s relatively easy, transparency can make it happen even without getting to market. The more difficult stuff will probably take more pressure.”</p>
3	<p>“So I think that’s where looking solely at transparency – it’s a great start but there needs to be more, it needs to be stronger, there has to be that continuous improvement.”</p> <p>“I don’t buy into that if you put it out for everyone to see, you will clean it up, because that’s not what we see in the marketplace. We’ve seen people put out an HPD and people say “Thank you” and they check the box.</p>
4	<p>“I would kind of answer ‘No.’”</p> <p>“Having said all that though, I think if there is a level playing field for transparency, I think it could potentially move the market because competitors in different industries would be looking at each other’s disclosures and potentially figuring out where the common issues are or where someone else has made improvements. But that also presents problems of, what’s the benefit of innovating if everyone can just take your idea, so you get some of that issue too, there are some interesting opportunities, I just don’t know if its there yet.”</p>
5	<p>“You can’t <i>really</i> be transparent without being really honest and thorough. I know that there are a lot of organizations that would view- ‘oh there’s not XYZ in it’ as being transparent. But I think we really need to move towards a model that is, being completely transparent before we are really able to make significant changes in what we’re using. We need to have some pressure. I need to be able to put pressure on my suppliers ...as long as there is a way to hide behind not being fully transparent, I don’t think that can happen. I think we’re a long ways out before all manufacturers embrace transparency. But I hope that the market will reward the folks that do.”</p>
6	<p>“Yes, yes. I would definitely say yes. Because it brings- it gets people thinking about what they’re putting in their products and what they want the public to see about what’s in their product. And it drives people to making better choices, and everyone is always looking for those better options...but I think just putting it out there makes people think it over twice.</p> <p>I think the other thing that it does is- it drives a harder conversation of getting that information from <i>our</i> supply chain. So while we’re being asked to be transparent, we need to be <i>sure</i> that we are telling people the right information. And if we don’t know what’s in our products, we can’t do that. So it forces us to tighten up our information-gathering practices from our supply chain, which, as I’m sure you’re aware by now, is not easy. It’s really difficult to do.”</p>
7	<p>“The first thing that came to my mind was the HPD vs. C2C. I can tell you everything, all the materials down to 1% or less as a threshold (which is where all the difference makes in that special sauce that makes the differentiation in the product). And that’s fine, we don’t want to give trade secrets. Is that <i>better</i> than giving it to C2C and they put it in their black box and magic machine and it turns out gold, platinum, bronze certification? I don’t know.”</p>

8	<p>“Transparency on its own doesn’t do anything.”</p> <p>“So yes, it’s very important, but I’m afraid that that’s only one piece of it that is important. The rest of it is making sure people understand it.”</p>
9	<p>“If the market wants transparency and we as manufacturers want to sell into that market, we need to work something out. That being said, we’re not just gonna do what all the NGOs and what one faction of the world wants. We’re going to do what is scalable and what the industry at large can do.”</p> <p>“I think transparency in a vacuum, it’s a starting point because you have to have it to do some of the other things in some regard, but there’s also different ways to deliver that. You have to consider things Intellectual Property and who are you telling these things to and why do they need to know and it’s obviously a very complicated subject.”</p>
10	<p>“I think I had a better- maybe a more confident answer- maybe 2 years ago. Now I feel like, I don’t know anymore where the industry is gonna go.”</p> <p>“I know we need disclosure or transparency but I want to balance it with productive changes.”</p>
11	<p>“So I’m a full blown proponent. We’re exposing ourselves to stuff and the government’s not going to say it. So I want to know everything and I want to disclose everything and I want things to be as healthy as they can possibly be.”</p> <p>“as people have started to become more aware of these things through disclosure of ingredients and the health impacts of them, it changed the market significantly and this is gonna be no different. “</p>
12	<p>“I want to be transparent; I think it’s great. But as we discussed, in practice that is a very difficult thing to do. And I’m not sure that companies are willing, or have the ability, to be transparent. It depends on the company, right? But it’s just very difficult, and it’s going to take a long, long time to get there. I think the writing’s on the wall. We need to be transparent; we need to know what’s in our products.”</p>

Appendix C Interview Summaries

INTERVIEW 1

Growing interest in material health/transparency

Growing attention to material health from customers
 Transparency as differentiator for companies
 Growing demand for chemical information from consumers

Need for Education

Need for education around transparency
 Industry learning curve (lead wasn't put in there to harm people)
 Purpose to 'nasty' chemicals
 Buy at your own risk, if knowledge of contents and risks
 Importance of decisions/education being carried down the chain (to contractors- otherwise, a lot of work for nothing)

Level of Transparency

Difference between transparency and revealing the product formulation
 Drawing the line in how much transparency is reasonable
 Transparency + conversation of comparison
 Limits of transparency

Program Pros + Cons

HPD provides a clearinghouse of materials and transparency
 High cost of programs/testing can be a deterrent

Qualifying Hazard, Risk

Qualification of hazard
 Hazard vs. risk
 Practicality: anything, any substance can kill you in the right circumstances
 Context (encapsulated materials, bound materials, circumstances) affect risk

Communicating Product Information

Hazard warnings can scare off consumers for the wrong reasons

Approach to Making Products

Perception that you can make green products without expensive certifications

Barriers to Obtaining Information

Proprietary Information

Difficulty of gathering information higher in supply chain

Trade secrets up supply chain

Further up supply chain there is more to set a material apart (PI)

Communication Gaps/Errors

Not using threshold in requests from suppliers (accuracy of info?)

3rd party verification importance

3rd party verification helps manufacturer confidence in information
 Work with verifier to understand proprietary information

INTERVIEW 2

Importance of Transparency

Transparency can have delayed positive impacts, by making the manufacturer think about what they are giving to their customers

Transparency can change the market by itself if it's easy

Difficult changes will take more than transparency

Seeing a race to the top to be the "transparentest"

Transparency is the foundation of material health

Transparency-based tools alignment with company philosophy (setting an example)

Ingredients level approach to transparency is important

Partial disclosure is better than nothing

Programs may be smokescreens, but pressures manufacturers to do more in future

Despite lack of publishing, stresses early involvement in programs/pilots

Industry shared supply chains mean proprietary ingredients often aren't secret

Language of Transparency

Need to develop the *language* of transparency

We should rate *how* transparent you are before we rate hazard

Disclosure vs. Real Transparency

Manufacturers know better in some situations- i.e. when a CAS# is misrepresenting an ingredient

Hard to drive change if changing paperwork is done over changing a product

Ingredient/Product Assessment is in its infancy

How we assess what is disclosed more in infancy than standardization of transparency definition

Problems with Existing Standards

Desire for transparency of standards

Importance of transparency-based standard

Difficulty of working with NGOs for long periods of time

Compliant or noncompliant Red List approach encourages lying

Tying transparency program to a green building standard encourages manufacturers to lie

Potential issues of binary status (in or out) with material health

Many manufacturers are too comfortable lying, even just a little bit

Overall frustration with how programs are unfolding

If you have to label all products as hazardous, can't find the ones that aren't

Cost as barrier to program participation

We are building on imperfect systems like CAS#

Desire for transparency around Red List formation

Program output/Labeling

Having to label your product as hazardous when it is not

Hazard vs. Risk

Risk assessment is imperfect, not a panacea for hazard approach

Hazard systems describe their products as toxic, which they disagree with

EPDs help to feed HPD information (ingredient information)

Need for regulation

Chemical regulation is failed and broken

Electronic waste as example of where regulation would have been better than state rules

Industry groups hang on program issues (titanium dioxide, silica, etc)

Political advocates want to throw out programs because a few parts don't work

Mishmash of NGOs and corporate buyers and statement requirements, hugely complicated

Predicts people will be begging for regulation to simplify

Need to balance priorities

Perfect chemistry as barrier to recycling (competing/tradeoffs of sustainability)

Immediacy and fear around health topic, but need to take a more holistic approach to products

Verification

3rd party verification needs a standard

INTERVIEW 3

Transparency alone is not enough

Pure transparency standards do not go far enough
Transparency is not enough to catalyze change
Pure transparency standards externalize selection of safer products to customers
Architects don't have time or expertise to understand HPDs
Standards should be transformative and require change
3rd party disclosure is very important for better understanding of product
C2C is expensive but worth it for what it offers
Sustainability is not single-attribute
Material health alone as a cause is insufficient
It will be a long time before suppliers are begging to disclose

Proprietary Information

Not all supply chains are ready to disclose
3rd party verification allows for more granular information
Full formulations held tight by suppliers

Evaluation of Standards/Programs

Free and open standards allow for greater involvement by broader set of manufacturers
Products are being selected because of HPD purely to check the box
Consumers may have a preference for one program over another

Need for education around standards

Lots of education at conferences going on to help architects understand standards

Changing Industry / Commerce drives change

Ingredient/health considerations are here to stay
Opponents to industry change are trade groups, not customers
Manufacturers should listen to their customers, this will drive change
Certifications aren't changing the market, the market created the certifications
Demand creates transformation
Commerce drives change (Exchange dollars for better products, manufacturers listen)
They have made some supply chain changes

Industry Efforts

Example of manufacturers working in groups to push down supply chains
Aggregated power- work together to make change

INTERVIEW 4

Supply Chain Education

Working with suppliers up to 6 tiers deep in supply chain
Lots of education efforts
Engaged 400 of 1200 suppliers

Approach to Safer Products

Proactive approach to product design
Avoiding materials they don't want through their engineers
Internal 'priority materials of concern' list

Proprietary Information in Supply Chain

Suppliers hold information proprietary
 Proprietary supply chains can prevent participation in programs
 Disclosure-based programs vs. assessment-based programs
 Company has historically focused on assessment
 Suppliers can increase or decrease up supply chain

Difficulty Gathering Information from Supply Chain

Share supply chains with residential furniture and auto industry
 If they ask for something different than bigger industries, will be dismissed
 NDAs put in place by suppliers
 Suppliers don't want another account (HPD builder, anything)
 Need to be flexible with suppliers in order to successfully gather data
 NDAs can still point to hotspots of material issues
 Supplier reluctance to share information depends on situation

Importance of 3rd party certification

Want your certification to mean something to the market (C2C does)
 3rd party certification = stamp of approval outside their company

Difficulty of Replacing Problematic Materials

Replacing problematic materials (3 methods)
 Developing new materials can be really challenging

Need for Consumer Education Check the box mentality

Inability of architects to interpret HPD
 Architects using HPDs to check a box

Need for Standardization of Disclosure (/Innovator's Dilemma)

Level playing field for transparency could move the market
 Does a level playing field destroy innovation?
 Transparency vs. disclosure
 Innovator's dilemma- don't want to be first
 Disgusted by lack of ingredient representation on some labels
 Until they can disclose fully, don't want to disclose at high level
 Conservative companies don't want to make claims they can't back up

What kind of transparency serves us? Format of disclosure

Can we really interpret food labels? (even PhD in inorganic chemistry)
 Hazard vs. risk issues
 Nutrition information vs. ingredients (high carb, etc)

Need for Standardization of Interpretation (not just education)

Interpretation of disclosure/transparency is not constant
 Everyone is interpreting full ingredient disclosure differently
 The manufacturer that is the most transparent has the worst looking product

Importance of Proprietary Information

Reverse-engineering to determine what is in products

Hazard vs. Risk

Importance of Easy Product Line Certification (scalability among products)

Many different groups have their own RSLs
 C2C allows for easier product line certification (allows for exclusions)
 Brand recognition can be the most important (i.e. Patagonia vs. Nike)

INTERVIEW 5**Getting good information from your supply chain is generally very difficult**

Vast majority of experiences getting information from supply chain are difficult
 Knowing the supply chain and working directly with them helps
 Chances of getting information is slim
 Chances of getting *correct* information is rarer
 Tons of room for improvement in flow of information in supply chains
 Supplier lack of understanding around what to disclose
 Supplier lack of care in accuracy
 HPD is an avenue for better communication

Barriers to Disclosure

Getting good information from your supply chain
 Multiple suppliers for same components
 All products are custom, still making disclosure difficult despite product simplicity
 Recycled content is a big issue- how to report it
 Chaos, confusion, and burden of data management for companies with many suppliers and SKUs
 As long as you can hide behind not being fully transparent, there will be no pressure to change
 Will always be leaders and laggards in all areas (including material health)

Disclosure is very important

Disclosure is incredibly importance (outlier)
 Attention to material health is an important part of the evolution of the industry
 Need to “clean ourselves up a bit”
 As long as you can hide behind not being fully transparent, there will be no pressure to change

More regulation is welcome, but market-driven solutions will be faster**Lack of Risk vs. Exposure Acknowledgement in some standards is a problem**

Understands concerns about risk v. exposure
 Not enough weight given to production and disposal in risk assessment

Motivation for Disclosure

Believes transparency is still the best
 The fact that you’re willing to disclose should signal you are doing the right thing
 Going after certifications/standards even without real demand for them
 Helps company to communicate their commitment to sustainability
 Hopefully the market will reward those who embrace transparency

Different Program Attributes Allow for Greater Overall Participation

HPD allows you to list hazards without CAS, allowing for protection of IP
 Cost as deterrent for C2C, other areas to spend money in
 Cheap and free standards level the playing field so smaller companies can’t get shut out
 C2C is the easiest to use, so as a user that would be preferable

Not as much demand for HPDs/labels yet

Manufacturer spending more time explaining what an HPD is than being asked for them
 Expectation that demand for HPDs will rise

Education is a big, important task

Manufacturer spending more time explaining what an HPD is than being asked for them
 Expectation that demand for HPDs will rise
 Appears HPDs are being collected just to “check a box” for compliance
 People don’t know what to do with HPDs yet
 There is a lot of education to do in the marketplace
 Labels can get very confusing, and greenwashing happens
 Comes down to a need for education around what is being specified

Industry is starting to pay more attention to what they put in things (and it's time)

Internal conversation is expanding for manufacturers – from energy to chemical related issues
They haven't yet targeted their chemicals, but many they'd like to get rid of

INTERVIEW 6**Different businesses in companies have different regulatory and customer requirements**

Some companies have consumer-facing businesses, but also ones that don't face customers
Each business owned by a company may have a different regulatory climate
Different businesses owned by a company may have different consumer need
So company may have many different industries, needs, wants to juggle

Ubiquity of Chemicals

Everything is coated with something

Drivers of Change

Building products driven by green building standards
Residential interiors driven by purchasing by Loewe's, etc

Type of Disclosure – input ingredients vs. cured product

Disclosure of wet applied vs. baked on coatings
Input materials vs. final product disclosure

Red List Benefits

Red Lists and HPD are driving internal conversations about avoiding CoC
Red List approach is actionable and scalable

Red List Issues

Intellectual property is important – particularly for formulations
Fear of expanding Red Lists
Is disclosure feeding new restricted substances lists
RL can result in regrettable substitutions- overhead conversation about substituting worse chemical

Communication with Suppliers

Communication with their suppliers is often through a letter or email confirming RL free
Want to compile their own internal CAS#, beyond RL for all chemicals they are concerned with
Likes the idea of reportable lists – tell us if it's in there, we will still buy it, better than just absence

Supply Chain Structure/Variability

Company isn't tied to suppliers, based on price
Highly variable, large supply chain.
Size/variability of supply chain makes it difficult to confirm material content
Pitfalls of price-based approach.
Have begun to consolidate supply chain to have better purchasing control
Want to hold suppliers accountable for formulations and preference to transparency
Want more trust in supply chain
Need more supplier education

Disclosure Information/Format

Non-toxicologists have a hard time understanding disclosure requirements and output
Difficult to determine how you measure up in an HPD

Data Gathering/Management

Plan is to annually updated internal CAS list, and contact manufacturers minimum of every 3 years to update disclosure (cycle of standards)
Hazard vs. risk criticism of HPD

Scalability of solutions

California safer consumer products regulation- alternatives assessment- was expensive and slow

Tradeoffs in impacts- Life Cycle vs. Material Health

Tradeoffs- life cycle impacts vs. material health
Need to have human decisions to weigh tradeoffs

Consumers drive manufacturing changes

Manufacturers driven by what consumers want.
Voluntary programs help employees push material health and transparency internally

Why Transparency Matters

Transparency is necessary because it gets people thinking about what they put in products and what the public sees

Regulation is slower than market solutions

Regulations are trailing indicators for Chemicals of Concern
NGO-driven programs and state regulations, purchasing campaigns are leading indicators
Need more conversations between trade organizations and NGOs.
By the time a chemical is regulated it's off of their plate, they deal with proactive
Will they or won't they stock us is much quicker than regulation
Transparency programs drive a harder conversation of getting *good* information from the supply chain.

Transparency in its infancy

There is a long way to go with transparency
More people are on board with transparency
Green labeling will balloon for a while

Difficulty of Multiple industries working on these issues, different asks

Programs are starting to work together in building industry, but that's only one industry.

INTERVIEW 7**Transparency is in its infancy**

Cannot compare 2 HPDs
Only recently enough HPDs to comply with LEED credit

Engaging in lots of education, need for much more

Interviewee's company focus still largely on LCA impact
Material health not yet primary concern
Lots of internal education – customer service, marketing, corporate, global initiatives
Lots of external education – panels, white papers, speaking, trade shows, nonprofit involvement
Importance of educating the market – so they can digest the information they are given.
If we collect all this data, and no one can digest it and understand it, why is it valuable?
Chicken and egg data situation- trying to learn everything even when you don't know how to read

Disclosure output/format

Issue with having to disclose hazards for ingredients that we know are not problematic
Do we disclose without criteria *or* put through black box and get a rating people can use?
Company actions based on customer requests

Tradeoffs in producing products

Fundamental lack of understanding in market around exposure vs. risk. Vs. performance. Vs. value
Life Cycle Tradeoffs: bad chemical effectiveness and product performance

Unrealistic to remove all synthetic chemicals at this point

Can't say that all chemicals should come out of products
 95% of all building products come from petroleum. Everything is made from oil right now.
 One day we will get to renewable, organic materials, but we need to be realistic

Exposure and risk for exterior products, encapsulated materials

Base ingredients vs. final product may be 100% different
 GreenScreen is single chemistry analysis
 Encapsulated products may remain encapsulated, can even reuse products

Complicated, global supply chains

Supply chains are massively complicated – 3 tiers back there are “literally thousands and thousands of suppliers that can product those chemicals and raw materials”
 Can't go back more than 1 or 2 tiers because suppliers have relationships with their *own* suppliers
 Spiderweb of networks
 Working on optimizing and collaborating with suppliers
 Some suppliers are living in the dark age
 Some suppliers are being asked the same questions from all angles and the “writing's on the wall”
 Better relationships with big suppliers with brand names.

Diminishing Influence Up Supply Chains

Billion dollar industry is a drop in the bucket compared to other industries their suppliers supply
 The whole industry needs to make the same ask to have more power
 Need main players in the industry to buy into this, to have enough power

Lack of Reliability/Variability in Supply Chain

Ordering a batch of materials from a company 3 months apart, could be entirely different material source (not like ordering pens from staples)
 Price and volume has a monumental effect- makes it difficult to prioritize only material health
 HPD and EPD help with internal understanding

Tracking Information

Lack of standardization makes data difficult to track and interpret
 Getting information 10 different ways from 10 different people
 If you don't start with the same data points (standardization) you will get totally different end

Red List benefits

Red Lists put a stake in the ground, allow us to establish something
 Lots of progress made in past 5 years but a long way to go.

Red Lists

All of these different lists will give you different outcomes
 REACH is doing a good job in Europe, but not used here
 Collectively, things are moving in the right direction
 Red lists were a good start, lots of room for evolution

Need for Holistic Approach/Prioritization

Need to look at *project* – not ingredient, product, assembly. Holistic
 Different projects (hospital, school, data center, warehouse) – wouldn't treat these the same
 Do we need the building to last for 100 years, or be safe to eat?
 Building owners are crucial in requesting health and environmental aspects
 No longer a commodity-priced market – this is a differentiator between products
 Prioritization: silica is not an issue. What we sit on and touch is bigger. Tackle most impactful first

Disclosure Interpretation/Need for Customer Education

How HPDs are being used is a really big unknown.
 Some HPDs being passed directly to client, not being used for analysis
 Fear of liability in disclosure

Need for Standardization

Need standards for data collection and interpretation: we're just going to splinter and splinter and splinter until we get everyone back at the table

Splintering Efforts

Interest in cutting out the middle-man (nonprofits)

Nonprofit and for-profit working together- totally conflicting ideals at their core, doesn't work

Have to have collaboration between architects and manufacturers. Declaring war doesn't work

Cost as barrier to entry for some programsINTERVIEW 8**Need for more internal support**

Hired a chemical engineer to help with HPDs

Gathering Info from Supply Chain

Rare to find small suppliers a few tiers deep; small supplier wouldn't be able to formulate chemistry

3,4 suppliers deep and we're talking to BASF about a particular washer in a particular product

BASF dwarfs our entire industry, they couldn't care less if we pull our business they wouldn't notice

Textiles and colorant suppliers might not even disclose with an NDA

"Secret Sauce" much more in textile, colorant industries, wood laminate

Need for Supply Chain education

Suppliers ask their suppliers the wrong questions, so need to be trained, or need to ask directly

A lot of work goes into making sure everyone is comfortable with HPD process.

They have to work with the supply chain because suppliers were asking for the wrong thing

Huge spreadsheets sent back full of bad information, like the Pantone color

Easier for them to go back 4 tiers than to wait for the information

As you move back in the supply chain, portion of supplier's business you account for decreases dramatically

Suppliers still uncomfortable with what they're being asked for

Need for Consumer Education

Hopes we get there because it's a lot of work, and you want to see the payoff when people understand and can use them to make decisions.

Architects saying "I just look to see if there are carcinogens in the HPD. If there are, I don't buy it"

Disclosure Format/Output

Can't disclose CAS# with NDAs, but hazards are more useful anyway

Architects getting HPDs getting them because they are required, not looking at them

Didn't publish in version 1 of HPD because it looked so bad

C2C cost barrier but cost also felt arbitrary

Heavily involved in Level

Risk vs. Hazard

Planning on having HPDs for all products

Some manufacturers want to use risk to justify use of chemicals, not as bad, maybe a truer picture

RL is simple and people can do it, but it's limited in how meaningful it can be

Context matters so much

10 products all with carcinogens are *not necessarily equal*. How can you know?

HPD has taught them a lot internally.

Unless you ask, how are you going to know?

Perspective on Transparency/Disclosure

"Transparency on its own doesn't do anything"

There is too much information

Wants transparency standards to be better, more widely adopted, easier to understand.
Have to get really granular in disclosure for it to mean anything

Difficulties Changing Ingredients

Finding a chemical of concern in a part is the worst part of any month.
Changing ingredient, component, etc is really hard. Have to match visually.
Have been trying to find Phenol formaldehyde replacement for 7 years. 40k later, still no solution.

Data Management

Data management – want to have sustainability information tie directly into product information
When an engineer chooses a product they will choose from disclosed list of materials
Closing the feedback loop

INTERVIEW 9

Need for Scalable Solutions One of the most important issues for chemical company

“We’re not just gonna do what all the NGOs and one faction of the world wants. We’re going to do what is scalable and what the industry at large can do.
‘boutique solutions’ are a waste of time”
Have to be able to do it across industries.
Chemical companies very heavily involved in almost everyone’s supply chain **ACROSS INDUSTRIES**
Having a way to report chemistry in so many specific industry applications would be ideal, and it actually would make things cheaper. Addresses question of ‘why do my green products cost more?’
Amount of work/information- for a large company and cost of compliance can be huge
“Build a system that suppliers can play in...and then the industry can adopt it.”

Comparing Products

Importance of comparability and scalability
Need for ability to make comparative decisions.
They can compare their own products with testing within the company
Internal programs and ratings

What do consumers need to know?

“Some of the tools are too simple because I don’t know what to do with that information.
“I work for a chemical company and I can’t interpret an HPD.”
“What everybody really wants to know is: is this thing bad for me?”

Red List Pros and Cons

Precautionary principle vs. risk and exposure.
Not everyone buys into the precautionary principle, so it’s ridiculous to make everyone do it
If people want to know hazards that’s great, as long as they have meaningful information

Chemistry is complicated/Chemicals serve a purpose

“Just because something has x or y in it—chemistry is complicated—it doesn’t mean it’s bad, right?”
Chemistry is universal. It doesn’t care what it ends up in.
“Any chemical, depending on the situation, could be good or bad.”
“I’m not a scientist, but they put it in there for a reason”
Chemicals make the stuff do what it does

Transparency in its infancy/Increasing Demand for Information

Got involved early with nonprofits and programs due to connections with green building
“The people asking for materials information 3 years ago was a ‘rounding error’” (tiny percent)
This issue isn’t going away.
Transparency in a vacuum is a starting point, but there are different ways to deliver that.

Level/Type of Disclosure

Fear of reverse-engineering “It’s a very real thing” – but if jumbled in components, that’s ok
 None of the options for providing that transparency right now are great
 “There is zero incentive”- to disclose in HPD because of time lag; getting replaced on a job 3 years out
 Google’s proprietary algorithms vs. chemical company proprietary information
 More at stake on IP side for chemical company than the cool looking chair company
 More information disclosed is inevitable- but “to what extent? How far? How fast?”
 Solution has to consider IP and more than the Precautionary Principle (risk); can’t cost a ton
 Why tell people what’s in your product if they don’t even know what to do with it?
 Waiting to see the dust settle, see what the market picks.

Representation of Products in HPDs

Air barrier interviewee would be comfortable “Lit up like a Christmas tree” in HPD from 10th of a percent of ammonia for a pH buffer
 The hazard-based approach will only scare you off from using a really good product, crux of issue

Hazard Assessment without Risk is inaccurate

Red List “sin list” – having a list generated by an architecture firm is “crazy”
 Fundamentally don’t believe in red lists.
 Rigorous internal toxicology assessments. “inferior” assessments done externally.
 All about application and exposure

Where do we put the bad chemicals

Traffic cone vs. baby toy: everything has to go somewhere. Where is the best place to put them?
 Crack a petroleum barrier, 7 blocks of chemistry are inevitable. We can’t ship it off on a rocket
 We have to figure out where to put the rest of the things. Like traffic cones.

Business Drives Decisions

“We don’t necessarily care” what they make. I want to be in business
 When we find chemicals or products we don’t like “Guess who’s gonna make the next thing too?”
 Retail “carries a much bigger stick” than green building community
 Green products exists sometimes but they’re expensive so no one buys it, and cheap option is bought by everyone (i.e. phthalates)
 Company weighs the request customer-by-customer, business-by-business
 May prefer to give info to manufacturer- manufacturer is spending money with you. 3rd party is not.

Regulation Provides a Level Playing Field

NGOs want perfection from regulation. No compromise
 REACH: “establishes a level playing field. No one loves regulation. Universal system.” US is wild west
 If in 10 years, we have a solution people are halfway pleased with, it will be a shock.
 Sees potential for regulation “we support TSCA reform. I see it happening more in codes. You can have a universal system—REACH isn’t a transparency system but it feeds it.”

Need to work on communication

Company is not great at communication.

INTERVIEW 10

Supply Chain Issues

Many furniture manufacturers don’t even build their product at all – more like distribution
 Somewhat vertically integrated. Supply chain- 70 main suppliers.

Program Perspectives

Have done C2C, then BIFMA, then HPDs last 4-5 years, but haven’t published HPDs
 C2C was a “black box”. Owned by MBDC, lots of \$, you don’t own the information so you can’t take it with you
 C2C: chemistry thoroughness; gives framework for reporting chemistry, multi-attribute, protects IP, well packaged, market driver.

Level- furniture industry standard, flat price structure.
 LEVEL only tells you what's *not* in there, not what is: avoid heavy hitters, but not transparent
 HPD might be overly detailed, C2C perhaps not enough

Barriers to Gathering Information

IP is an issue- legal teams don't like that (BASFs won't let you to see IP often)
 Competitors have same supply chains but it's *still* really difficult to ask for that same information
 You may deal with different salesperson from the supplier, perhaps
 Gathering information at more macro-level still
 Getting information requires a lot of follow-up, a lot of education
 Have tried to work with competitors to have the same data gathering template, but not so easy.
 Difficulty in colors and finishes

Need for consumer education

Disclosure misunderstanding: people don't understand what they're reading
 Some people "simply want us to go through the exercise", which is good, but do I want to publish?
 Reluctance to publish HPD on website, even though on a case-by-case basis willing to show it

Perspective on Transparency/Disclosure

Not yet pushing for full disclosure. Scale of 1-10, they're a 5
 "Right now there's not as much demand as people think.
 Demand for certifications/transparency among the thought leaders, but the people who are specifying for a project aren't necessarily sticking to that requirement."
 HPDs and legal issues: 'medical liability'

Approach to Specifying Better Materials

Have an internal banned list
 Often have to help supplier work with their suppliers (going to tier 2, 3)
 Have gathered information for about 20% of their products
 Civil chemical engineer and toxicologist on staff.
 But sometimes, the PhDs in chemistry are being used wrong, only to badger supply chain

Data Uncertainty

Common assessor for two furniture companies- found out inconsistencies from the supply chain.
 You are relying on someone's word in many cases. Even if they sign something, can't be 100% sure. Not being sure scares me. I don't think there's a solution unless you get into testing everything.

Where is the Industry Headed

Sees us moving toward database that allows you to compare product performance and attributes.
 "I think I had a better—maybe a more confident answer— maybe 2 years ago. Now I feel like I Don't know anymore where the industry is gonna go."
 Haven't necessarily changed suppliers, but have gotten rid of some ingredient (a lot of PVC)
 Now being more proactive about what to avoid- not just cause of transparency, but overall awareness. Big clients help drive.
 Not a massive correlation between consumer interaction and this work, but positive for sure
 RSLs most practical solution. "Suppliers will go after that so much quicker nad so much better with better information."
 Regrettable substitution is a problem, but it's the most user-friendly.
 They ask- if something is formaldehyde free, what are they using as a substitute?

Proactive vs. Reactive Materials Selection

Perhaps should focus less on finding pththalates and more on finding the best available ingredients
 An hour spent tracking down potential chrome VI in a caster- is an hour less time finding a solution.
 "I know we need disclosure or transparency but I want to balance it with productive changes."

Data Management/Dynamic Supply Chains

Biggest barrier: very dynamic supply chain
 Low cost in their chain could mean Tennessee, or China, but when we switch, we restart the clock.
 Can control some issues with your specifications, but it's difficult.

Sheer number of products and materials – lots of data. Tons of product variations
 Generally stick with the same supplier. Change when they have to.
 That's part of doing business, and why the cost of a chair has stayed relatively flat cost over the past number of years.
 "We're a fashion industry" – changing colors. Could be tracking materials forever.

Barriers to Better Products

In some situations there isn't a better ingredient option

INTERVIEW 11

Educating Consumers

Communicating with market, with architects, trying to understand where they are
 Lots of education created for their customers about importance of transparency, programs
 Education is really important.

More Information than Understanding

"We are in an infant stage there. Caught in between what we think we know and what's really so"

Multiple Businesses in different regulatory environments

Building products market division is far ahead of the other divisions in terms of env. sustainability

Where is the Industry Headed

Harmonization between programs very positive.
 "I don't think anything has emerged yet that is going to be the thing."
 Architects looking for 1 cert. program (i.e. GCC)- so they can side by side compare all attributes.
 Living Product Challenge and Green Circle Certified are frontrunners for him.
 Predicts company like Google will make publicly available platform where you can quickly populate all products for a project.
 Hard to completely change a company based on certain product, so we need time.

Internal Learning

Inputs vs. final product: "is it's about what's in the finished product, and not the chemistry and reaction that goes into it" (reporting confusion)
 What is in your product vs. what you thought was in there
 Started on Transparency platforms (HPD, Declare) about 2 years ago.
 Self-taught about these issues.
 Declare, LCAs, HPDs, EPDs, google and portico, etc has worked with all
 Carpet has industry NSF140 internal certification.

Barriers to getting information from Supply Chain

Some chemicals don't have CAS#; registered with EPA as trade secret. Won't even disclose with NDA.
 "We want to know everything. And that's what we're up against right now"
 Can't get all of the information yet from suppliers
 Somewhat vertically integrated.

Scalability/Data Management

Dealing with how to collect data and manage in comprehensive chemical database.

Risk v. Hazard

How do you deal with risk vs. hazard?
 Without risk analysis, most products wouldn't meet LEED V4 criteria of not having any BM 1s

Internal Position

Won't be sorted in a short period of time, in terms of figuring this stuff out as a company.
 As you become more transparent, more incentive to eliminate certain ingredients
 Conservative company, not going to jump on the bandwagon right away

Representation of Products in Standards

Manufacturers very hesitant to put HPDs out because of how your product is represented.
 “No one wants to be the first to put something out that makes your product look like a carcinogen.”
 Haven’t publicly published HPDs. They have Declare labels. More to learn, but they are accurate.

Need to Balance Priorities

Consultants are the way to go right now “we have a lot of irons in the fire”
 Hard to figure out what to focus on
 Feels good to test a product to know there are no residuals, but testing costs a lot
 Lots of PhDs on staff, but often have to decide whether they want to work internally or externally
 It’s not scalable to research every product, every ingredient.

Need for Industries to Address Health Concerns

Wants to get ahead of cancer rates and prevent, rather than just treating
 “I’m probably different than most. I want to disclose everything”
 I want to know what me and my kids, and their kids, are being exposed to.
 Cancer rates are going up, so we need to start preventing, not just get better at treating it
 Manufacturer as customer perspective.
 “There’s nothing I’m more passionate about than this subject”
 HBN did a study and recycled content can be really problematic
 Within the same business, not every division is the same. One specifically makes proprietary chem.

Transparency is Important

Transparency makes a difference
 People in companies make decisions because of transparency because they realize they have to disclose what’s in the product and it’s not going away.
 We have seen this change in food; who heard of gluten free a few years ago? Will change the market.
 Level of disclosure: 10,000 ppm, 1,000 ppm, 100pp - what’s useful?... 10,000 is not
 You can’t get to 1ppm, but as we learn more, if 100ppm is no where we need to be, then head there

Red List Approach

Some materials have issues throughout the lifecycle. Don’t want workers or customers exposed.
 But you can’t say all PVC is bad if it’s just the plasticizer that is bad. Has to be science behind it.
 Red Lists can work, if the science is right, *and* if exposure standpoint makes sense.

Disclosure Format

Ok with disclosing the cooked cake, not the cake recipe.

Need for a level playing field

Didn’t want to be the first with HPDs. Have seen them manipulated, and don’t want to play games

INTERVIEW 12**Gathering Good Data from your Supply Chain**

Huge amount of suppliers globally
 Sustainability data management: how do you query and get consistent answers?
 Where it’s made, how it’s made, what’s in it- very hard to get consistent information
 Company is less and less vertically integrated all the time; very global supply chain
 Even for a company of that size, sustainability department of 1 person
 Goal of institutionalizing LCA and material ingredient reporting into the process
 If you don’t streamline the process you will need 20 people to do the job
 If suppliers would just provide HPDs, manufacturers could feed those into their products
 Aggregating information down the supply chain would be preferable

Disclosure is like peeling an onion

Material ingredient reporting and supply chain work is “peeling layers of an onion”
 Better you get at retrieving information and more rigorous you are, the worse the product may look

Worst HPDs or Declare labels (least rigorous) may look the best
Twinkie = cake + frosting on the surface, but really 110 ingredients once you look deeper

Importance of Disclosure

Everyone needs to be engaged and lay their cards on the table.
“The writings on the wall. We need to be transparent. We need to know what’s in our products.”
“I want to be transparent. I think it’s great. But...in practice that is a very difficult to do.”
HPDs are a gateway- you might not publish/report, but it’s a way in

Educating Customers

Consumer end- Distributor needs to understand HPDs or else all this work was for nothing.
They have a green distributor department.
Make it easy for the architects to figure out your product.
Loves to talk to architects- that’s how they learn from their customers.
If architects don’t understand how to read HPDs or Declare labels, how will they know that cake + frosting is maybe not accurate, or that the label *with* the ‘additive’ is just more complete
Lots of confusion around what people are asking for.
Must know systems better than project teams requesting them

Educating the Supply Chain

Need to educate first tier suppliers; those suppliers need to educate their suppliers.
Need to just make it part of The Ask.
Social impact is ahead of this- an error of commission
Health is still an error of omission. Need to make it an error of commission.
Gathering information on SDS down to CAS #s
Working on educating supply chain, market
Haven’t had many issues with NDAs in supply chains

Internal Approach to Materials

Already had a red list of common things in their industry, but expanded with programs
Company is not married to its ingredients; customer drives the product
Engineers + suppliers were directed to remove the unwanted ingredients
Company is not where interviewee wants them to be yet, but working on it
Transparency ability depends on the company, will take awhile to get there

Data Management Issues

“Metal” or “plastic” are not acceptable answers from the supply chain. Weight drives reporting
All of these considerations must be done without impacting price
Have to balance need for material information and RL exclusion with supplier relationship
Have to believe your suppliers to a degree- you do a spot check, desk audit
Has started to see substitutions happen and get better information
How do you capture everything, all the information, though?

Barriers to getting good data from Supply Chain

Some testing of products to see how accurate reporting is, but testing is expensive
Have to take information at face value at some point. Can’t audit everyone, can’t test everything
Dynamity - 1 part from 4 suppliers. Can’t tell you which day you buy part from which suppliers.

We can only go so deep on disclosure

Can’t report lower than Global Homogenous Materials. Can’t go beneath stainless steel
If we go too deep in materials, too big of a conversation.
I can’t impact what’s in my recycled steel

Need to Balance Attributes of Products

They have other things to watch as well: recycled content, buy America, regionality, etc

Simplicity of Hazard Approach + Red List

Hazard vs. Risk: I like the hazard approach because I can know what to avoid. Clean approach.
Red List is more scalable, so it’s preferable. “Amen. Hallelujah. I got it”

Red List vs. actual risk

Need to prioritize efforts

But if it's phenol formaldehyde and it's CDPH-compliant so no risk, what are we talking about?

Need to focus on highest-level risks.

Not focusing on how to avoid regrettable substitutions- just going on current and future regulation

Getting HPD requests for tiny components- have to prioritize based on cost and importance

Recycled content: "there's probably zero risk for what's in there"

Changes happening in industry

Things have changed hugely in 3 years in the industry

Food analogy- things will change like they did for food industry.

Pharma: each batch is highly traceable. Not necessary for door bumpers, but still, for some maybe

Starting to be more pathways for which direction you want to go to (HPD data, turn into Declare label, put in Google portico, etc.)

Program Output

Some responsibility for communicating on formats lies with the manufacturer- HPD comment space

No space to talk about risk/context on Declare label; "yes it's Red List, but it's an exterior product"

C2C is more simplistic. But the manufacturer is paying for the certification that org. is providing.

If had 6 products, would do C2C "just be done and get some magic certification" but too many SKUs

But the manufacturer doesn't want to be a toxicologist. Want to trust C2C gold etc.

Appendix D Survey Questionnaire

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Material Health Evaluation - Thesis Survey AM

INFORMED CONSENT

i.

Informed Consent Form Introduction

This study attempts to collect information about the integration of voluntary material health evaluation programs into manufacturing companies in the U.S. building products industry.

Procedures

This questionnaire consists of 26 questions and should take approximately 10 minutes or less to complete. Questions are designed to determine relative familiarity with these programs as well as your company's perspective on material health reporting.

Confidentiality

All data obtained from participants will be kept confidential and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). *No participant names or company names are collected* as part of the survey. All questionnaires will be concealed, and no one other than the primary investigator listed below will have access to them. The data collected will be stored in the HIPAA-compliant, Qualtrics-secure database until it has been deleted by the primary investigator.

Compensation

There is no direct compensation.

Participation

Participation in this research study is completely voluntary. You have the right to withdraw at anytime or refuse to participate.

Questions about the Research

If you have questions regarding this study, you may contact Dr. Michael Dyrenfurth, at 765-496-6160, mdyrenfu@purdue.edu or Alexandra Muller, 516-220-0292, muller2@purdue.edu.

Questions about your Rights as Research Participants

If you have questions you do not feel comfortable asking the researcher, you may contact Purdue's Institutional Review Board at 765-494-5942, irb-questions@purdue.edu.

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ii.

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

 Yes No

COMPANY BACKGROUND

Q1. Which best describes your company's role in the supply chain? (Select all that apply)

 Produce chemical substances, mixtures of chemicals or materials Produce components Assemble products Sell finished goods to other businesses Sell finished goods to consumers Other (please describe)

Q2. What types of products does your company manufacture? Select all that apply:

 Appliances Bathroom fixtures Ceilings / Acoustics Chemicals Coatings Concrete Doors Electrical Elevators Flooring Furniture Hardware HVAC Insulation Lighting Masonry Paint Plumbing Railings Roofing Shading Walls Windows Wood products Other (please describe):

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Q3. How many employees are there in your company?

- 1 - 49 employees
- 50 - 249 employees
- 250 - 1,000 employees
- 1,000 - 5,000 employees
- 5,000 - 10,000 employees
- More than 10,000 employees

Q4. What is your company's annual revenue? (in USD)

- Less than 1 million
- 1 million to less than 10 million
- 10 million to less than 25 million
- 25 million to less than 100 million
- 100 million to less than 250 million
- 250 million to less than 1 billion
- More than 1 billion

Q5. How would you describe your team at your company:

- Sustainability
- Legal
- Compliance
- Design
- Sales
- Marketing
- Research & Development
- Chemical Policy
- Other (please enter below):

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Q6. What is your role in that group?

- VP
 Director
 Manager
 Engineer
 Other (please describe):

Q7. If you interact with material health evaluation, disclosure or chemicals-related issues at your company, please briefly describe your role:

- Describe:

- I do not interact with issues of material health evaluation or certification at my company.

Q8. Including yourself, how many employees work directly on issues of material health and material health program compliance at your company?

- 0
 1
 2
 3
 4-5
 6-10
 11+

AWARENESS & USE OF MATERIAL HEALTH DECLARATION / EVALUATION PROGRAMS

Q9. Please indicate your familiarity with the following material health declaration and evaluation programs/standards:

	Never heard of it	Heard of it, but minimal knowledge	Familiar with the standard but haven't used it	I have engaged with the program

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Declare	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cradle to Cradle Certified Product Standard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Health Product Declaration (HPD)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BIFMA Level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
GreenScreen for Safer Chemicals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q10. How many products in your company have been disclosed/evaluated by each of the following programs?

	0	1-4	5-9	10+	Not sure
Declare	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cradle to Cradle Certified Product Standard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Health Product Declaration (HPD)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BIFMA Level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q11.

Please rearrange the following programs or standards to reflect the relative number of requests your company gets for each (1 being the most requested, 4 being the least requested)

Declare label	_____
Health Product Declaration	_____
Cradle to Cradle certification	_____
BIFMA Level certification	_____

COMPANY APPROACH TO MATERIAL HEALTH

Q12. How greatly do the following factors influence your engagement with issues of material health and material health programs?

	Not at all	A little	Somewhat	A lot
Consumer demand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Building Certification Programs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Anticipated Future regulation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International regulation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Company mission + values	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q13.

Responding to requests for material health evaluation/declaration has:

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	N/A
Increased internal understanding of our products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased consumer confidence in our company	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Significantly changed our relationships with suppliers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Altered our relationships with architecture firms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Changed our relationship with competitors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved our competitiveness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SUPPLY CHAIN INTERACTION

Q14. Approximately how many first tier suppliers are in your supply chain?

Q15. How many suppliers would you estimate there are in your entire supply chain?

Q16. Is your supply chain

- Domestic
-

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Global

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Q17. What percentage of your supply chain have you engaged to collect ingredient and health information?

- 1-10%
- 11-25%
- 26-50%
- 51-100%
- Not sure

Q18. How does your company communicate material health requirements to your suppliers? (Check all that apply)

- Use of a Restricted Substances List (RSL) to screen suppliers
- Requesting that suppliers complete an HPD for product components
- Requesting SDSs from suppliers
- Use of a 3rd party to collect chemical information
- Using an internal data collection process
- Other:

Q19. Was your company's Restricted Substances List (RSL) (Select all that apply):

- Created internally
- Based on regulatory standards (please list below)
- Pulled from a particular material health standard (please list below)
- Other

Q20. Which of the following measures has your company used to verify the chemical content of a product?

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- Letter from a supplier
 3rd party engagement of the supply chain
 Laboratory testing of product content
 None
 I'm not sure

Q21. Which of the following tools has your company used to avoid regrettable substitutions?

- Restricted Substances Lists
 Internal database of vetted chemicals
 Conducting a GreenScreen assessment
 Using the GreenScreen List Translator and/or Pharos Chemical and Material Library
 Hiring a 3rd party consultant to assess new options

COMPANY PERSPECTIVE ON MATERIAL HEALTH INFORMATION

Q22. In your opinion, how useful is it *to consumers* for manufacturers to communicate each of the following aspects of material health?

	Very Useless	Useless	Somewhat Useless	Somewhat Useful	Useful	Very Useful
Presence or absence of Chemicals of Concern	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Full list of product ingredients and CAS #s	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ingredient hazard rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Product-level risk assessment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q23. Please assess the following attributes of a voluntary material health evaluation program in terms of their *relative importance to your company* (1 being least important, 5 being most important)

	Least Important				Most important
	1	2	3	4	5
Requiring public disclosure of ingredients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hazard assessment of ingredients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Risk assessment of product	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Program/Standard transparency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Self-disclosure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3rd party certification	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q24. Engagement with material health evaluation programs/standards has:

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Increased internal understanding of our products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased our supply chain engagement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Led to changes in our supply chain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Led to changes in our product chemistry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased consumer confidence in our company	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Acted as a platform for our company to differentiate itself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Led to increased revenue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q25. Please assess the following programs in terms of their:

	Ability to communicate with the A+D Community			Potential as a decision-making tool for A+D Professionals			Ability to confer a market advantage		
	Ineffective	Somewhat effective	Very effective	Ineffective	Somewhat effective	Very effective	Ineffective	Somewhat effective	Very effective
Declare	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cradle to Cradle	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
GreenScreen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Health Product Declaration (HPD)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BIFMA Level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q26. How relevant are each of following barriers to further public disclosure of your company's product ingredients? (1 being the least relevant, 5 being the most relevant)

Least relevant

Most relevant

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	1	2	3	4	5
Company inertia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dynamic or fluid nature of supply chain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Supply chain resistance to ingredient disclosure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of demand for transparency from consumers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Need for greater internal education to interpreting information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Need for supplier education around material health disclosure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Difficulty in gathering and managing large amounts of information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of obvious leading disclosure/evaluation program in market, market confusion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My company's trade secrets/proprietary information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Supply chain's trade secrets/proprietary information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time and expense of determining product content	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The market is too competitive for us to reveal further information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
More information makes products appear more dangerous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (Please describe) <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

TRANSPARENCY + REGULATION

Q27. Which do you feel is more likely to lead to a healthier materials market?

- Market-driven solutions
- Federal regulation
- I don't know

Q28. Please define 'transparency' as it pertains to the building material industry:

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Q29. Please define 'material health' as it pertains to the building material industry

Qa. Optional: please enter any additional thoughts/comments on the topic of material health and disclosure in manufacturing: