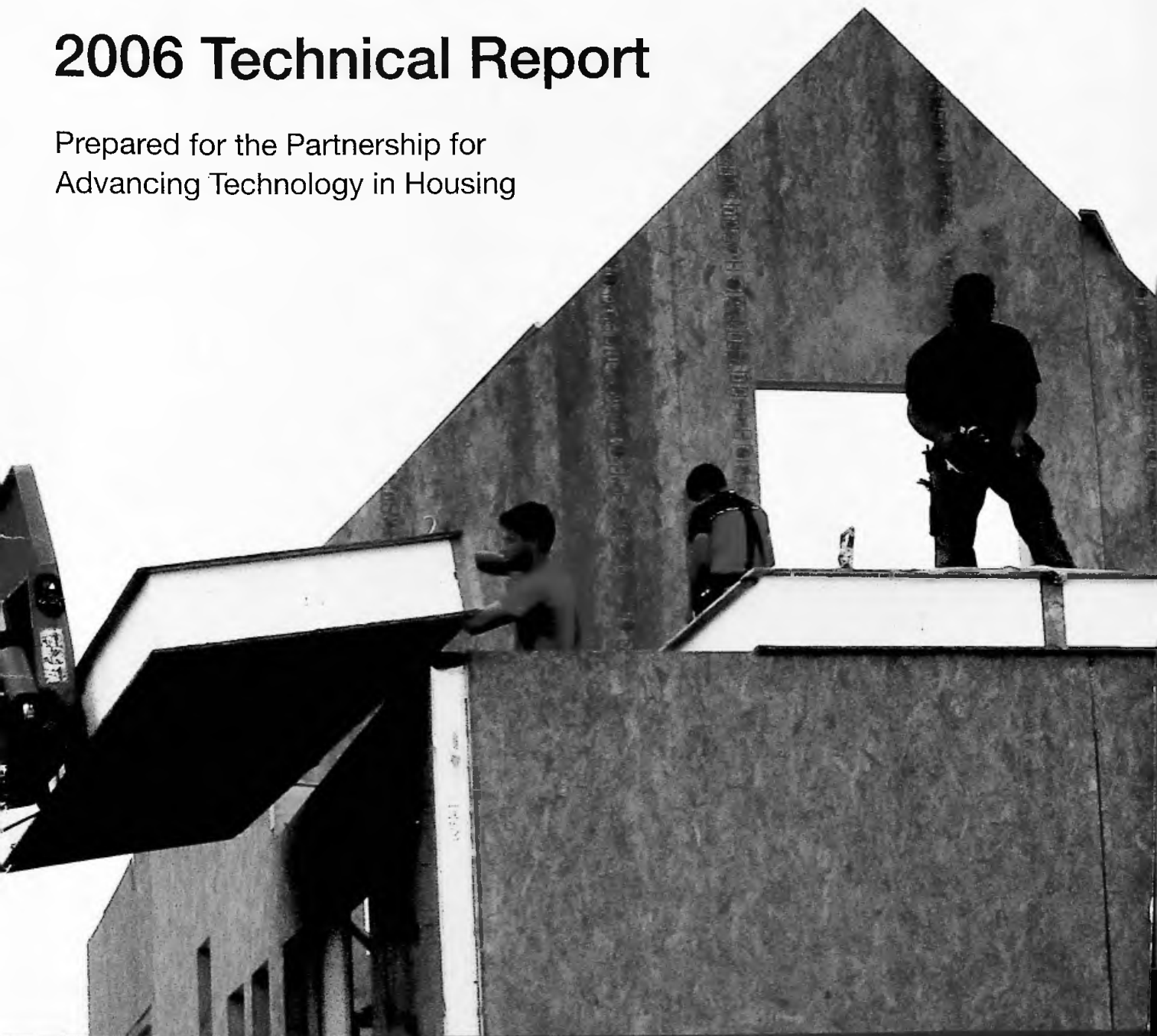


Residential Market Research **FOR INNOVATION**

2006 Technical Report

Prepared for the Partnership for
Advancing Technology in Housing



U.S. Department of Housing and Urban Development
Office of Policy Development and Research

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Residential Market Research for Innovation

2006 Technical Report

Prepared for:
The Partnership for Advancing Technology
in Housing

Prepared by:
McGraw-Hill Construction

August 2007

Introduction

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Carlos Martín, Ph.D.



Harvey M. Bernstein

It is a critical time for the residential construction sector. With single family housing construction having increased dramatically over the past five years and moderate slowdowns expected to keep construction value near 2005 levels, the timing is ideal for the industry to develop and introduce new technologies and innovations.

Efficiency and innovation will help to address some of today's pressures – labor shortages, increasing material costs, pressures from natural disasters, and generally low profit margins. Though in the past, the industry has been slow in its adoption of innovation and new technology development and adoption, these challenges pose opportunities for the industry players to maintain a competitive edge. Yet understanding how to overcome the barriers of new technology development and adoption is important in fostering industry growth.

As such, the Partnership for Advancing Technology in Housing (PATH) has been working to more fully understand the demographics and behavioral factors that go into technology adoption in homebuilding. Out of that effort, PATH partnered with McGraw-Hill Construction on a year-long project to begin the process of identifying data and research needs in the homebuilding markets. It should be noted that this project was not designed to address all of the industry's innovation needs and opportunities; indeed, PATH has other initiatives in the broader arena of technological change. Rather, the focus was on studying how specific parties in homebuilding gather, assimilate, react and are motivated with respect to market research and 'intelligence' necessary for technological change.

The core of this work came out of the Symposium on Market Data for Housing Innovation (see page 7), created under this project. Industry experts convened to begin to address the challenges to moving new technologies into the market and offer suggestions on research areas and action strategies as well as to address some of the role of various industry players in that process. This report documents those discussions, findings and recommendations.

The outcomes of the Symposium and this project have been exciting – it points to new ways to help builders, manufacturers and others overcome barriers to moving innovation into practice.

Carlos Martín, Ph.D. works in academic and governmental sectors in the areas of technological and social change related to the design and construction industry. Trained as an architect, construction engineer and historian of technology, Dr. Martín studies the cultural and industrial barriers to change – especially those related to affordable housing production. He has degrees in architecture and civil engineering from MIT and Stanford. Carlos returned recently to the US Department of Housing and Urban Development and PATH after serving as an Assistant Professor at Arizona State University.

Harvey M. Bernstein, F.ASCE, oversees McGraw-Hill Construction's Research and Analytics division. He has served as a member of former Secretary of State Colin Powell's Advisory Council. Currently, he is a member of the Princeton University Civil and Environmental Engineering Advisory Council, the Harvard Joint Center on Housing Policy Advisory Board and a visiting professor with the University of Reading's School of Construction Management and Engineering in London, England, where he also serves on their Innovation Construction Research Center Advisory Board. He is a frequent speaker and has written numerous papers covering innovation, productivity, energy conservation and green building. He is co-author of the book *Solving the Innovation Puzzle: Challenges Facing the Design and Construction Industry*.

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Conclusions drawn in this report are based on consensus feedback from Symposium attendees and do not reflect the opinions of the Partnership for Advancing Technology in Housing (PATH), U.S. Department of Housing and Urban Development (HUD), McGraw-Hill Construction, any contributing author or anyone providing support to these organizations. McGraw-Hill Construction's role was to organize, facilitate and record proceedings. This project was funded by HUD (cooperative agreement H-21490CA) and McGraw-Hill Construction.

Executive Summary

“Through collaborative market research studies, the industry will be better equipped to meet the challenge of moving new residential technologies to market.”

The Importance of Market Research in the Residential Sector

Accelerating the adoption of new technology into housing is an ongoing challenge, one that is complex and dynamic.

To overcome that challenge, industry, academic and government experts gathered together at a national symposium (Symposium) to discuss and clarify the R&D and market adoption process, interaction and influences of different industry players and patterns of player behavior.

However, that understanding comes only from sound market research data collection.

Market intelligence allows government and the public sector to successfully influence innovation adoption, and it presents the private sector with an unbiased assessment of the market opportunity and competitive advantage of innovation. Through collaborative market research studies, such as those suggested in this report, the industry – including builders, product manufacturers, homeowners, government and a host of other industry players – will be better equipped to meet that challenge.

Historically, the Federal government has been involved in a wide variety of housing-related activities, including “making homes more affordable to build, safer to live in and less costly to maintain and operate.” Part of these policies has included sponsoring research in housing design, construction and maintenance, and in setting standards for the same. The government has also been concerned with barriers that impede further housing development and homeownership.

Market research assistance – including coordinating shared investments, educating and disseminating information to housing participants and reducing local barriers such as building codes – could help with new product market penetration. Additionally, many builders and homeowners make decisions and purchases with different levels of information. The need for non-commercial, impartial information on innovation and the markets for innovation is critical to overcome these asymmetries.

Critical Market Research Areas

There are five critical areas for market research that would greatly facilitate the adoption of housing technology and innovation. These areas create a roadmap that Symposium participants believe should direct data collection for the next few years.

Critical Research Areas:

- Value and Valuation of Housing Technology and Innovation
- Performance Measures
- Role and Interests of Other Players or Intermediaries
- Information and Knowledge Transfer
- Market Data Collection Methods

Market Research Strategies

There are seven market research strategies identified by the Symposium participants that can be employed to gain understanding in these critical areas.

Research Strategies:

- Conduct Research Studies to Acquire Industry Performance and Market Segmentation Data.
- Create Product and Process Performance Measures.
- Research the Effects of New Technologies on Asset Performance.
- Conduct Market Research Studies to Understand How Intermediaries Drive Innovation.
- Conduct Market Research on Consumers' Characteristics, Decision-Making Process and Motives for Adopting New Technologies.
- Conduct Studies on the Acquisition and Knowledge Transfer of Innovation Information.
- Develop Business Process Best Practices (Including Success and Failure Information) In Homebuilding Product Manufacturing Sector Applications.

The Challenge to Creating More Public-Private Sector Research

Collaboration is needed. Manufacturers, builders and homeowners need incentives to bear some of the cost and risk of investing in this type of market research.

The challenge described in this report lies in demonstrating to private sector participants the value participating in these collaborative research projects may have in expediting the introduction of new technologies into the residential marketplace.

“Collaboration is needed. Manufacturers, builders and homeowners need incentives to bear the full cost and risk of investing in this type of market research.”



Setting the Stage

“The lack of knowledge about market drivers for demand of new technologies is creating a barrier to advancing innovation in the housing industry.”

In 1994, the U.S. White House convened various stakeholders to establish a set of "National Construction Goals" recognizing that the residential building industry is one of the largest and most important sectors of the U.S. economy.

According to the U.S. Department of Commerce, the construction industry comprises the second largest contributor to national GDP (over 8%, behind only healthcare) with the residential market comprising more than half of the construction industry as a whole – translating to a market size of \$350 billion.

Therefore, it is critical that the barriers to adoption of new innovations in the residential sector be understood to speed up this diffusion of new technology to the marketplace.

With this challenge in mind, the Partnership for Advancing Technology in Housing (PATH) was launched in 1998. PATH examines the issues and barriers related to technology development in the housing industry and strives for viable cost-effective solutions. It is dedicated to accelerating the development and use of technologies that fundamentally improve the quality, durability, energy efficiency, environmental performance and affordability of housing in the U.S. As a result, study has been done to identify the barriers to the use of these technologies and to outline the supply and demand chain for new innovation.

Despite the importance of the housing industry to the American economy and its products' great market value, there has not been much investment in either innovative residential technologies or market analyses for those innovations compared to other industries. This is especially true of the single-family homes that comprise most of America's housing stock. The importance of this lower level of innovation cannot be underestimated.

Advances in innovative technology are widely regarded as major sources of improvement in the competitive position of firms and industries and

major factors for increased national economic growth and standards of living.

There has been recent work to identify the barriers to innovation, but one of these challenges remains – to identify and then acquire market data and analyses that shed light on behaviors and motives around technology. The lack of sufficient knowledge about market drivers for demand of new technologies is creating a barrier to advancing innovation in the housing industry. Historically, firms have not been proficient in creating or adopting innovations because either the market for an innovative product was not clear or methods to understand market behavior were wanting.

Filling market knowledge and behavior gaps, then, is one method of spurring both innovations in particular and the industry's growth as a whole.

The next critical step is to take the existing and acquired knowledge and identify research data needs and projects that move beyond understanding barriers. Then, the industry will be able to understand the behaviors and motivations and push through these barriers and accelerate the adoption of innovation in homes.

This report is built off the recommendations and discussions from the Symposium on Housing Market Research held in February 2006 (see right). It reviews the problems associated with firms not fully comprehending the behaviors and motivations behind driving through the barriers to fundamental technology innovation and offers some market research solutions to answering some of the most critical market questions. It includes an outline of the most critical areas for research, the advantages to different industry players and a set of proposed research actions.

Symposium on Market Data for Housing Innovation

On February 15, 2006, more than 50 representatives from private industry, government, and academia attended the Symposium on Market Data for Housing Innovation (Symposium), held at the U.S. Department of Energy Headquarters in Washington, D.C. The Symposium's purpose was to vigorously examine the market data gaps related to housing innovation.

This Symposium was not designed to address all of the industry's innovation needs and opportunities; indeed, PATH has other initiatives in the broader arena of technological change. Rather, the focus was on studying how specific parties involved in homebuilding gather, assimilate, react and are motivated with respect to market research and 'intelligence' necessary for fundamental technological change.



The three identified groups around which the discussion took place included 'manufacturers' (above), 'consumers' (homeowners or buyers) (left), and 'builders' (below).

As such, the end goal of the Symposium was to begin the process of identifying data and research needs in homebuilding markets by:

- Defining the primary groups involved in homebuilding technological changes and the market data or research that has described them to date.
- Identifying the gaps/opportunities in market data and research for those groups and their most critical elements.
- Justifying the gaps' importance.
- Determining whether the public or private sector should lead in development of the market data, and outlining the sequence of that development.
- Evaluating the potential impact of the market data, including the policy implications that each market data opportunity entails.

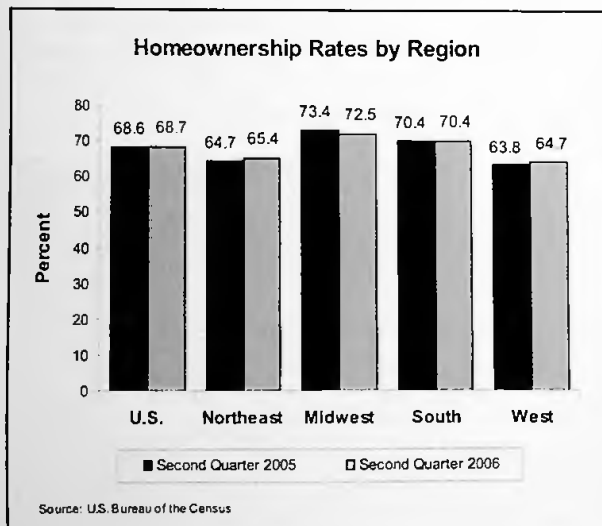
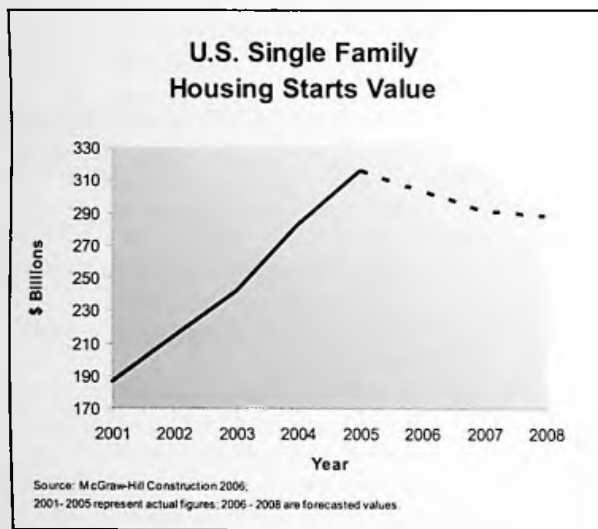


Setting the Stage

Innovation = Economic Growth

Advances in innovative technology improve the competitive position of firms and industries. Technology advances are also major factors for increased national economic growth and standards of living.

In the residential construction industry, evidence has indicated that innovations, in terms of building materials and techniques as well as in marketing and associated services, are not adopted or spread as quickly as they are in some other industries, such as shipbuilding and automotive manufacturing. The residential industry not only suffers from lack of diffusion accelerators (commonly-cited causes: homogeneity, shared 'culture,' strong communications, strong opinion leaders, etc.), but it also suffers from the presence of many additional diffusion barriers.



Diffusion Barriers

Four broad diffusion barriers to innovation exist in the homebuilding industry¹:

- The high level of risk aversion in the homebuilding industry caused by low risk bearing capabilities causes a lower level of willingness by industry players to adopt innovations. For example, size and low profit margins can affect the ability of manufacturers to innovate since their end customers (contractors and sub-contractors) want to avoid the risk of litigation. As a result, they stick with proven products, applications and processes.
- Industry participant preferences can influence which innovations are pursued and adopted. As a result, understanding the preferences of all industry players, including consumers, who may be influencing innovation (despite previous thought that their preferences are represented by builders and contractors).
- Education of industry players in innovative techniques and practices coupled with communication between these players regarding costs and benefits from these new technologies is essential in moving innovation forward.
- Home building is a fragmented industry. As such, diffusion of new technologies becomes even more challenging to implement. However, many of the challenges posed by fragmentation are addressed by understanding how to overcome the other diffusion barriers.

Definitions and Explanation of Key Industry Actors

The term 'Innovation' in this report refers to new products and processes for the residential construction sector. Though the transformation of these products and processes from development to the market is touched on, the focus here is on understanding ways to encourage the demand and development of such innovations.

The research actions proposed on pages 24-31 require participation from four categories of industry players:

- Builders: Includes custom, production and manufactured home builders, as well as remodelers, primarily of single-family detached homes.
- Manufacturers: Includes large, multi-sector manufacturers as well as smaller, homebuilding-focused innovators.
- Intermediaries: Affiliated industry players that influence innovation adoption and includes distributors, suppliers, retailers, realtors, appraisers and media.
- Government: Refers to Federal Agency players.

**Existing Information:
Scant, Disparate, and Not Detailed**

Symposium participants believe that housing researchers are faced with minimal amounts of data and data collection vehicles in their attempts to understand production in general as well as how existing production shapes housing innovation. This lack is particularly acute when examining participant behaviors, motives and perceptions.

There is also currently a lack of information, literature and market data for PATH and others in government and industry to truly understand housing innovation adoption or change. ***This information, though, is critical when trying to change a complex industry that includes a wide mix of players, low profit margins and labor shortages.***

Private Sector Information

The information that does exist is often proprietary in nature and primarily housed within private industry where it is available for sale or difficult to access due to the competitive value it provides to its owner.

Nonprofit industry-related organizations provide complementary, and oftentimes more comprehensive, information and analysis on housing production and practices compared to their public counterparts. Within academia, organizations performing such work include, but are not limited to, Harvard University's Joint Center for Housing Studies and Virginia Polytechnic Institute's Housing Research Center. Trade associations with thorough and ongoing market research include, but are not limited to, the National Association of Home Builders (NAHB), the National Association of Realtors,

Why Should the Private Sector Care About A Public-Private Research Agenda?

All stakeholders:

- Industry-wide data, though hard to justify internally since it is not linked to specific competitive advantage, could help explain how to move innovation into practice.
- Participation enables positive relations with Federal partners and provides an ability to set research questions
- Collaborative efforts leverage the cost of market research dollars.

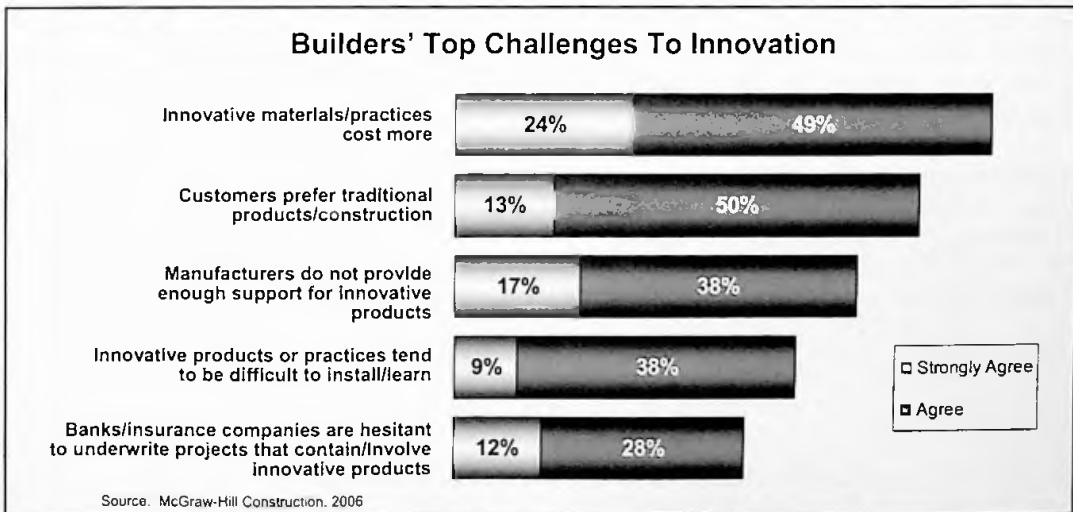
Builder-specific:

- Data on home technology perceptions directly impact sales.

Manufacturer-specific:

- Information on how builders adopt technology provides insights for the development and introduction of new innovations.

and the American Institute of Architects. Lastly, numerous private sector survey instruments and data collection services exist that usually execute the market research for industry, but who offer some level of publicly accessible information. Leading among these are products from McGraw-Hill Construction's Dodge data and analytic information; the NAHB Research Center's Builder Practice and Consumer Surveys; Frost & Sullivan; R.S. Means cost data; housing customer satisfaction studies by J.D. Power and Associates and trade journal surveys in McGraw-Hill Construction, Reed Publishing, Scripps and Hanley-Wood publications (though this is not a comprehensive list).



Setting the Stage

Public Sector Information

There are some significant fundamental data collections and analyses provided by the public sector upon which much of the industry information is generated.

From the ubiquitous U.S. Census – which includes the Census-HUD American Housing Survey (AHS) – to the Residential Energy Consumption Survey (RECS), public data sets and analyses provide much insight into consumer and commercial practices, and thereby spur improved commercial practices and increased consumption. Along with the AHS and RECS, a variety of studies done by Energy Star®, its multiple partners and State or regional utilities and energy offices shed light on home consumers. The Census Bureau's Survey of Construction, Survey of Manufacture, and – jointly with the National Science Foundation (NSF) – the Survey of Industrial Research and Development as well as the NSF's Science and Engineering Statistics all reveal information about the production side (from manufacturers to builders and remodelers).

There are shrinking public resources for fundamental research on housing, let alone for housing innovation.

In addition to broader issues that offer challenges and opportunities for the industry, funding for direct support to innovation research is under pressure. Traditional nongovernmental funding sources for basic and applied research that might be directed toward innovation in home building – philanthropic foundations, university endowments and other nonprofits – have been under financial pressure recently. Much of this is due to the poor performance of equity markets in recent years, where most of the assets of these institutions are invested. Government funding for basic research through agencies such as the National Science Foundation, the National Institute of Health and the National Institute of Mental Health are likewise becoming more restrictive on funding given the recent pressures on federal budgets.

Two data sources that are potentially being scaled back, but are particularly important to understanding the longer-term impact of innovation in home building operations, are the American Housing Survey (AHS) and the Residential Energy Consumption Survey (RECS).

The AHS is conducted biannually at the national level, with studies of major metropolitan areas conducted annually on a rotating basis. It is principally funded by the U.S. Department of Housing and Urban Development (HUD), was initiated over three decades ago and tracks a large panel of homes nationally. With its focus on housing conditions, it is an important and useful database for helping to evaluate the impact of home building innovations on longer-term housing conditions, durability, necessary improvement and repairs, affordability and so forth.

The RECS is a national survey conducted every three years across a panel of homes and funded by the U.S. Energy Information Agency. It focuses on energy consumption, and it is also an important and useful database to track the impact of energy investments and conservation measures on home energy consumption.

Additionally, there are several other government sponsored data efforts that can help with the understanding of the innovation process in homebuilding. The 5-year Construction Census undertaken by the U.S. Census Bureau provides useful information on the structure of the residential sector in terms of the distribution of the size of establishments and the revenue generated per employee, which is a rough estimate of the productivity of these employees. The quarterly survey of expenditures for residential improvements and repairs undertaken by the U.S. Census Bureau tracks home improvement activity to owner-occupied as well as rental housing units, activities that generally are overlooked from their innovation potential.

Finally, monthly data on manufactured housing activity undertaken by the U.S. Census Bureau and HUD tracks activity in this important sector. Given the factory environment for the production of manufactured homes, there are numerous opportunities for innovation in production techniques. Comparable information in modular home production (homes built off-site but shipped to their site without a chassis like manufactured housing) would also be potentially helpful in understanding industry innovation.

Limitations of Existing Data

Despite this somewhat extensive listing, two points should be noted:

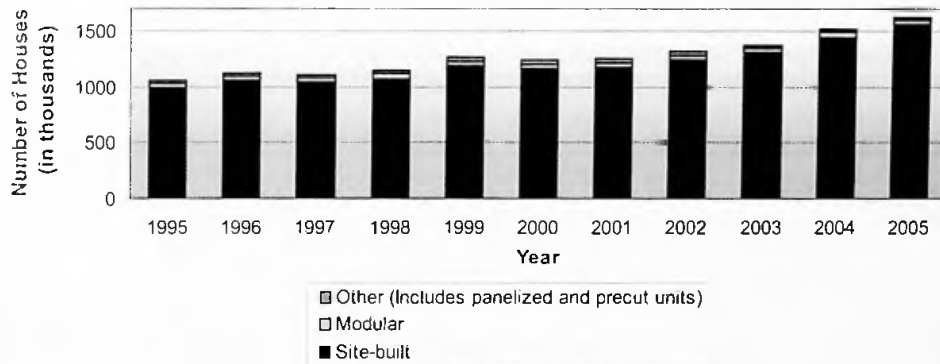
- 1) The level of detail needed to understand obstacles and drivers to innovation adoption is insufficient (particularly when looking at some physical conditions of homes and home production practices).
- 2) Many of these are not ongoing or have decreased resources to perform their work. As such, Symposium participants recommend not only expanding the kinds of data they specified as needed, but also ensuring continuation of core, more generalized data sources.

Advantages to Industry-Focused Data Collection

By focusing efforts on gaining access to market data that is more industry-focused rather than product specific, the public sector can serve a need for the entire industry. Further, it protects proprietary advantage by avoiding product-specific information. As a result, the public sector will find collection and partnerships with private firms easier to navigate.

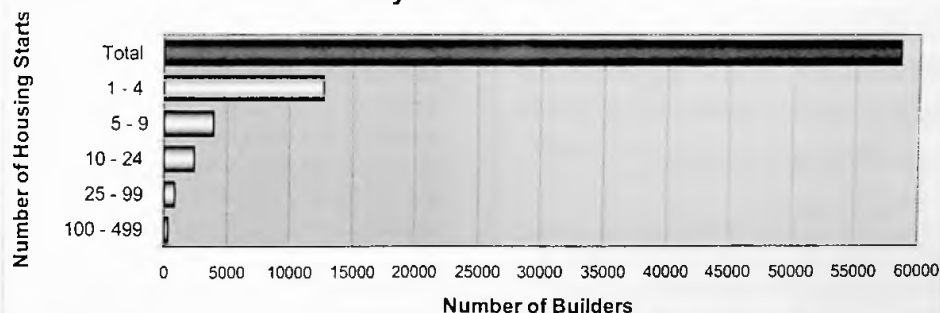
With strategic, increased understanding, there is great opportunity – both economically and competitively – for builders and manufacturers but also socially for home-owners, where new technologies can create more efficient and improved living conditions. The private sector has an opportunity to implement some projects that will not only benefit their bottom line but also will help advance the industry's ability to move innovation more rapidly into practice.

Type of Construction Method of New One-Family Houses Completed



Source: U.S. Census Bureau, Survey of Construction, Characteristics of New Housing: 1992-2005

Number of New Single-Family Houses Built by Each Builder



Source: U.S. Bureau of the Census. The data in this table are based on the 2002 Economic Census. To maintain confidentiality, the Census Bureau suppresses data to protect the identity of any business or individual. The census results in this chart contain sampling and nonsampling errors.

Market Research Areas to Drive

Gaining additional market research information provides insights into the barriers and obstacles facing innovation development and market adoption. Ultimately, the result of increased innovation is increased competitive advantages to individual firms and overall value to the U.S. economy.

In order to focus efforts in the most critical areas, experts (see page 5) propose directing market research over the next five years around five areas:

- Value and Valuation of Housing Technology and Innovation
- Performance Measures
- Research on Role and Interests of Other Players or Intermediaries
- Information and Knowledge Transfer
- Market Data Collection Methods

Work in these five areas will have the greatest impact in gathering this important information. Below (pages 12-19) are descriptions of these research areas, followed (pages 20-23) by the value of research in these areas to key stakeholders: builders, manufacturers, intermediaries and government (see page 8 for definitions of these groups).

Importance of Research to Public

The government has a unique role with regards to market intelligence – it is both a user of data and analysis for policy formulation as well as a generator of data and analysis either through funding, coordinating and/or executing that market research work. Because of these multiple activities, it is critical to revisit the context within which housing statistics in general – and housing technology and industrial practice statistics in particular – are generated.

All five target initiative areas outlined in this section require necessary public interventions due to the competitive nature of private sector research results, which are not always available in the public domain.

Despite housing's importance in individual lives and family outcomes, it is a social phenomenon. More than almost any other industry, it deserves efficient public interventions that neither change regulations nor require ongoing public funds. Funding of preliminary market intelligence is one such intervention.

Market Research Area: Value and Valuation of Housing Technology and Innovation

Understanding the perceived value of housing technology and innovation is necessary to overcome existing barriers to innovation. Specifically, Symposium participants identified three types of perceived value to investigate:

- Consumer valuation
- Builder interpretation of value to projects
- Builder perception on consumer valuation

The various industry players will use data on one or all of these according to varying degrees of importance.

Why This Research Area Is Important

The home building industry and consumers are reluctant to embrace innovation due to the little objective public information documenting the full benefits of an innovation. Little is known about how well construction products or processes perform over the life cycle of a

home. While the first cost of an innovation often can be estimated, the final cost of an innovation – to help determine its full benefit – often is missing. One reason for the success of the government's Energy Star® program is that it gives consumers clear information on the ongoing energy consumption of products.

Builders and homeowners make decisions and purchases based on different levels of information available to them. The more market research that is available in the public domain, the easier it is for firms to weigh the risks and rewards of investing in innovation. Lack of this information adds risk to the decision and generally leads to more conservative, time-tested results.

As a result, the information gained from housing valuations would directly benefit all firms.

Public Value

The public value of research directed toward technology valuation stems directly from public interest in improving the condition of American housing (through incentives rather than regulation, to the greatest extent possible) and from decreasing the costs of housing in order to increase actual home ownership.

Knowing whether changes in production and products can alter the cost structure and, in turn, demonstrate improvements in the quality and/or increases in the quantity of homes is critical to all of the governmental programs that have either of these as a goal. Moreover, the simple measurement of that valuation is critical for creating industrial incentives – thereby spurring further cost considerations without additional public resources.

Current Data Information

Databases, particularly longitudinal data bases, that provide information on housing quality and characteristics, energy consumption and efficiency and modifications to the housing stock that affect their performance and cost of operation are critical resources for the development of these performance metrics. Some publicly-funded databases, such as the AHS and NCHS, are rich and reliable. However, industry data sources also are available that have not been fully used to evaluate the longer-term impact of home building innovations and have the potential to supplement government efforts.

Data Needed from Manufacturers

Data from the manufacturers' perspective are needed, though not demographic in nature. Rather, manufacturers' willingness to share some data on their products and the processes involved in the manufacturing of those products would help overcome industry barriers.

Those manufacturers that are successful in demonstrating the data on how homes with new technologies perform and lead to increased home values will have an easier business case for innovation.

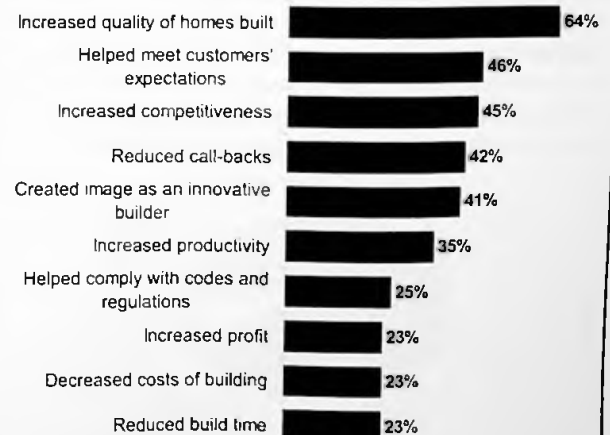
Potential Actions

Developing an effective monitoring system for assessing the impact of innovations is a three-step process:

- 1) Review of publicly available data sources systematically to identify data items that can help to assess the long-term impact of innovation in home building.
- 2) Identify and review of private data sources that can supplement public data sources in this effort. Because private sector historical data may be perceived as having less value than recently collected data, providers may be willing to put it in the domain at a more modest price. The willingness and costs of accessing private sector historical data sources needs to be assessed to combine with public domain data.
- 3) Identify the gaps in required information and create a strategy for filling these gaps. Adding a few data items to existing surveys often can fill an existing data need. In other cases, a new data collection effort will need to be considered.

Supplemental information may be needed to develop these performance metrics, such as having product manufacturers document the performance of a product over its life cycle or having an outside testing and documentation agent assemble the information over the life cycle of the home, in effect creating sort of a "Consumer Reports" for the home building industry. Government agencies may need to provide incentives for this effort.

Percentage of Sampled Production Home Builders that Rank Specific Technology Benefits as "High" Over the Last Five Years



Source: Koebel and Cawell, "Characteristics of Innovative Production Home Builders," PATH 2008

Market Research Areas to Drive

Market Research Area: Performance Measures

Not only is there no comparable information about technologies' performance, but there also is no uniform benchmark or standard practice for how home builders adopt technologies or how manufacturers innovate.

Why This Research Area Is Important

Specifically, the creation of an industry performance measure can outline the advantages and added value of innovation to builders' and manufacturers' bottom lines. Though there are a number of challenges involved, establishment of new measures will help make the business case for new technology development and the advantages transparent to the market. As a result, more industry players will be able to justify expenditures for new innovation research and development.

By establishing performance metrics, the homebuilding industry would be able to set a standard and create a level playing field – the result being information relevant across stakeholder groups.

Public Value

Probably no greater problem exists in trying to understand how innovation has affected residential construction than the near impossibility to measure definitively the impact of these innovations on industry performance.

To date, the industry has not been able to create performance metrics. This is likely due to two causes. The first is that there are no incentives for any one firm to take on such metrics and, as such, public intervention is required to provide for the common good. The second is the fact that extreme competition in the industry prohibits virtually all collaborations, particularly with regard to manufacturers' operations (though deterrents to proprietary exchange appear to be minimal). A neutral, non-regulatory third party, such as public research and incentive programs, fill these gaps nicely.

While the public interest is served both by spurring market intelligence that might increase industrial R&D and by evaluating other governmental programs, the need for government to produce such investigations also stems from its role as a common arbiter. Reliable, unbiased and easily available information on home performance and industry productivity can only be provided by the public sector, though with significant industrial assistance.

Current Data Information

Conflicting estimates exist on the direction of trends in productivity in the construction sector, particularly given that the Bureau of Labor Statistics does not compute productivity in this large and important sector of the economy. Productivity measures the relationship between labor inputs and output, and in the case of construction, both sides of this computation presents challenges. However, the lack of precise measurement certainly inhibits innovation, since it is nearly impossible to assess the overall impact of innovation without knowing how productivity is changing.

A commonly held perception is that productivity gains in construction have been low (or nonexistent) over the past several decades. Serious efforts to measure productivity trends in construction have not generated a consensus. (See for example Allmon, et al., 2000, and Teicholz, 2001.²) The lack of a consensus of productivity in the industry almost certainly colors the perceptions of innovation in home building. Construction productivity studies have proven problematic in part because they have used aggregate data that often contains serious measurement flaws. An example is the measured amount of home improvement activity in the U.S. Two government surveys – the quarterly survey of residential improvements and repairs and the biennial American Housing Survey – generate estimates of homeowner improvement activity that were recently estimated by the U.S. Census Bureau to be about \$40 billion or 48% different. While some of the difference was due to varying definitions, much of it could not be explained (Rappaport and Cole, 2003³). The magnitude of these differences in output makes any effort to measure home improvement productivity suspect.

Data Needed from Industry Players

Intermediary Data: Needed by Manufacturers

Among intermediaries, data are needed on what kind of technologies suppliers and retailers are buying and the value added at each delivery stage. Without the full understanding of these affiliated players (or intermediaries), understanding of innovation adoption will be incomplete. Understanding the role intermediaries play along the delivery cycle is important in creating a complete picture of the performance measures manufacturers require to convey superior performance and advantages of their technologies.

Consumer Data: Needed By All Industry Players

Understanding consumers' decision-making processes and characteristics will help builders, manufacturers, distributors, retailers and other intermediaries gain market advantage and improve their customer satisfaction.

Builder Data: Needed by Intermediaries, Manufacturers and Builders

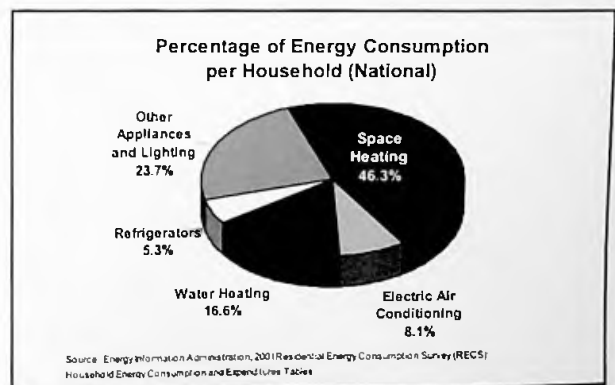
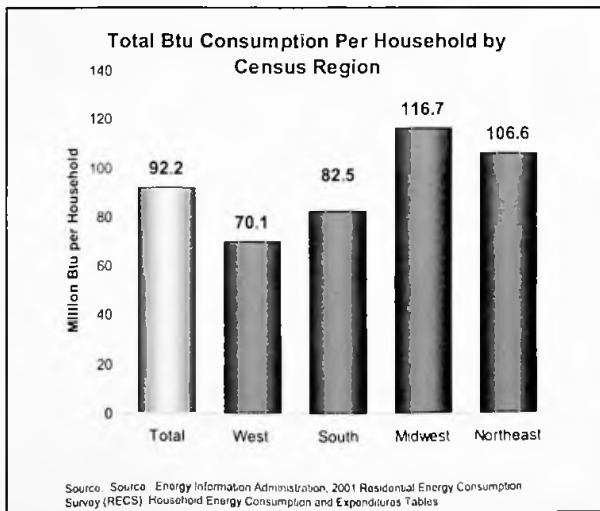
Both intermediaries and manufacturers need market information on builders with regard to each stage of the supply chain, specifically what builders are buying, how much they are purchasing and the value they assign at different stages. Attitudes and preferences of builders are important since they have been a primary innovation driver, and they must be involved in any research or understanding of performance measures.

Potential Actions

The development of a database would allow the calculation of overall productivity in the residential sector, facilitate the analysis of trends at different stages in the business cycle as well as permit comparisons across key housing segments (e.g., production housing construction, custom housing construction, high-rise multifamily construction, improvements to existing housing). Such measures would give industry leaders, as well as policy makers, better insight into the direction of the industry and whether innovations in aggregate are producing desired results.

Developing reliable information on productivity in residential construction is a significant undertaking. However, while detailed information on labor productivity in all phases of construction is the ultimate goal of this initiative, any reliable information on productivity levels for any type or facet of construction is an important start.

However, the kinds of metrics in question are expansive. They might run the spectrum from the physical and engineering performance of building systems and whole houses, to operational performance of homebuilding firms or to the R&D activities of manufacturers. For example, a set of best practices regarding improved business operations would allow for an evaluation of how home building product manufacturers and home builders are doing compared to competitors and other industries. The creation of an industry performance measure can outline the advantages and added value of innovation to builders' and manufacturers' bottom lines. Though there are a number of challenges involved, establishment of new measures will help make the business case for new technology development and the advantages transparent to the market.



Market Research Area: Role and Interests of Other Players or Intermediaries

Numerous other players beyond consumers, builders and product manufacturers are having or can have profound impacts on influencing housing innovation. Understanding these players' motivations and roles can create further mechanisms for leveraging increased technology diffusion.

These other players (or intermediaries) fall into four major categories:

- Technological: subcontractors, installers
- Distribution: dealers, suppliers, retailers
- Informational: media, retailers
- Financial: realtors and appraisers

Intermediaries influence industry players in a number of ways:

- Builders may be influenced by intermediaries, such as subcontractors and installers, who would have to work with the new technologies. Because builders are so risk-averse and perceived as the 'face' of the home building process to the consumer, new technology selection and installation needs to be done correctly.
- For consumers, influential intermediaries include realtors, media and appraisers just to name a few.

Why This Research Area Is Important

Information of other players' influence and behaviors is very limited. However, these industry players can have a profound effect on the supply-demand for new products and technologies. As such, understanding the demographics of these players and how they interact with builders, manufacturers and consumers will shed additional insight into innovation adoption processes. It

is also important to study their own perceptions and valuation of innovation in order to understand and influence their behaviors.

Public Value

Insight into the role of intermediaries directly shapes the industry's ability to predict costs and sales, and therefore, the ultimate costs of producing and purchasing homes. Yet, because of the industry-wide nature of the research that could result from this research, collaborative work among private industry firms with the public sector as convener might be a good solution.

Potential Actions

Symposium participants (see page 7) were not aware of individual firms doing this work likely due to the industry-wide nature of this research. Conducting joint research could yield results that might spur changes in intermediaries' practices in the same ways that studies on homebuilder productivity and manufacturing efficiency improve those.

Such changes could include:

- Improvements in subcontractor and installer training
- Expedited dealer and supplier transactions that lead to improved market choices
- More extensive media and retail providers for builders and consumers
- Corresponding restructuring and reductions of mortgages and insurance premiums based on technological improvements
- Reduced regulatory barriers to innovations in code adoption and enforcement

The challenge and proposed research recommendation highlighted below is just one example of potential research on increasing understanding of how intermediaries influence the industry in terms of innovation adoption.

**Example of a Current Production Change:
Increased Use of Installation Services**

One example of a current production change that requires public analysis is the increased use of installation services. An increasing number of builders are using installation services from their distributor and manufacturer suppliers. Research from the Harvard Distribution Study (Joint Center, 2006)⁴ has determined that although it varies considerably by product line, somewhere between a third and two-thirds of products purchased by larger builders (those that build 500 homes a year or more) are generally purchased installed, meaning that the product and installation are purchased together.

As common as this practice is becoming among certain types of builders and in certain areas of the country, little is known about the implications of this growing practice on construction cycle time and quality, competitiveness, labor needs, construction costs, supply chain integration, liability issues and, more generally, the risks and rewards of having suppliers more involved in on-site construction. It may, in fact, be a subtle change where suppliers are absorbing subcontractor management responsibilities, or it may be the beginning of a more significant change in liability assignment and industry structure.

While it appears that supplier installation for home building and potentially even home remodeling is the wave of the future, little is known about the implications of this shift in the production process. An industry/government partnership could significantly enhance the diffusion of this process. However, the costs and benefits of supplier installation to the industry and to the economy are not well known. More focused analysis of this activity would inform decision-makers on its broader implications.

An evaluation of the benefits and costs of supplier installation programs for a range of different construction products is best undertaken with a field research study. Product manufacturers, distributors, builders and contractors should all be involved in the study. A comparison of supplier installation with traditional builder crew/subcontractor installation would cover issues including the following: efficiency of on-site installation (e.g., installation time frame, labor hours required for installation, total costs of installation); efficiency of supply chain integration (e.g., required inventory levels, communication and ordering issues, supply chain efficiencies); warranties and product liability issues and life cycle costing issues for products that are supplier installed.

Market Research Areas to Drive

Market Research Area: Information and Knowledge Transfer

Beyond barriers, it is critical to understand how information is transferred to those who will adopt the new technologies. Though study has been done on identifying barriers to innovation, there remains a gap in understanding how users actually get information.

Why This Research Area Is Important

In order to knock down barriers to innovation, it becomes essential to understand the different learning processes of consumers, builders, manufacturers and others. It is not only important to understand how users of innovation learn about and incorporate information on new technologies, but also how manufacturers learn about and absorb market feedback.

Specific Areas Needing Understanding:

- Behavioral motivations (how to change a mindset): This information is important because it gets to the heart of changing those behaviors and influencing adoption rates and numbers.
- Data receptivity: Understanding how receptive technology purchasers (e.g., consumers, builders) are to new information is necessary as well as how much data can be absorbed and actually used.
- Ability to implement: It needs to be better understood whether consumers or builders are able to implement new technology as well as how that technology is used. The result is an improved ability to tailor new information.

Participation Needed from Industry Players

This work is clearly of interest not only to manufacturers and home builders, who are in the business of selling product to consumers, but also to those media and sales channels whose business it is to serve as the information conduits.

Sharing of information and greater transparency levels the playing field and makes the industry as a whole more productive. Firms will then have additional information they can use effectively to plan strategically.

This is one area in which the private sector is clearly more effective than the public sector, but one where public sector involvement may ensure a non-commercial nature to information that may help benefit the industry as a whole.

Public Value

As users of information, research in this area is particularly important. Acquiring insight into the behaviors, motives and actions of consumers in particular is essential for governmental programs involved in market transformation. Once achieved, this knowledge is passed on to industry forces attempting the same.

Potential Actions

The issues surrounding content and quality of information is a particular concern, and one in which government can play an active role. These include the level of information detail that is needed for a decision-maker to be able to pass judgment, as well as the manner in which it is delivered (i.e., in the form of marketing or sales information versus unbiased technical delivery).

In numerous focus groups for PATH's ToolBase information resource, builders and remodelers (as well as many architects, homeowners and other homebuilding participants) have demonstrated that they have very specific needs and questions about innovations.

Generally, smaller-scale innovators do not develop adequate materials for these decision-makers. Having unbiased, clear and readily accessible information not only is critical but absolutely necessary for a technology to be introduced to decision-makers, to be considered and to be decided upon.

As we move forward in collecting accurate information, it must be research-based. Because intellectual property and proprietary interest can be a barrier, it may be necessary to look beyond specific product innovation knowledge transfer. For example, research on how homeowners interpret and learn about energy-efficient technologies would help the entire industry and is suited for multi-client studies. On the other hand, research on knowledge transfer for a specific energy-efficient product (such as an HVAC system) would hold greater value for one manufacturer due to the information's competitive advantage.

It will also be important to capture different channels for information dissemination, ways of thinking and learning about technology and rates of efficiency.

Market Research Area: Market Data Collection Methods

Why This Research Area Is Important

Data collection methods should be standardized to allow for data comparisons and easier analysis of known information. In order to make research and data collection most useful, consistent standards of study need to be identified and developed. Consistent data collection and new analysis methods will allow for more efficient data collection, comparison, analysis and results.

Public Value

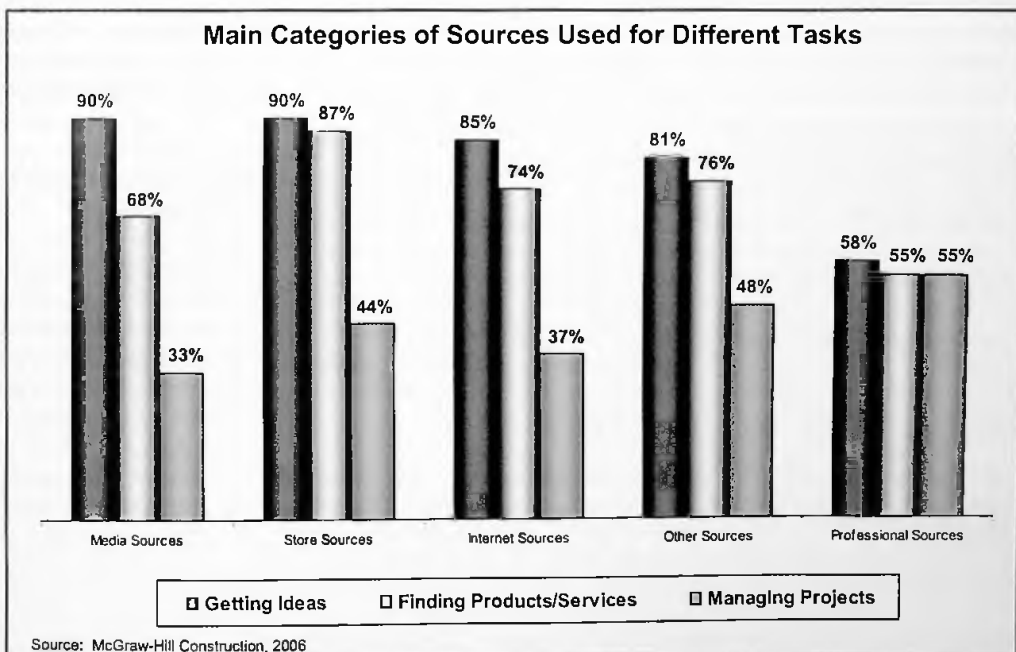
Because of sensitivities to proprietary, product-specific intelligence that firms – specifically manufacturers – will not want to divulge, it is important that researchers (academic, governmental and private) work with industry to develop standards for non-product specific intelligence that will benefit the industry without taking away the competitive market advantage of innovation. This partnership expands the warehouse of knowledge that serves the broader marketplace, helping spur increased activity.

Current Data Methods and Sources

There are currently a number of market research methods and strategies being employed by a number of research groups (academic, governmental and private) to understand better the housing marketplace. Methods employed include surveys (via web and phone), focus groups and interviews. Research is often oriented around market projection, market demand and opportunity, customer satisfaction, brand awareness and market drivers. There is existing research that new research can leverage. For example, under this project, McGraw-Hill Construction used its annual survey of home builders to acquire some additional market information (shown below and on pages 9 and 13).

Potential Actions

Current data collection methods have relied heavily on survey mechanisms that rarely allow for easy comparison, and because of industry fragmentation, development of statistical methods is difficult. Researchers need to use broad-based partnerships to develop better research instruments and find ways to effectively use existing studies (such as the American Housing Survey).



Value of Market Research

Each market research area requires participation from the four key actors listed on page 8. However, the various areas have different priority levels and value to these four players. Below are a summary of how the different research areas could benefit these groups.

Builders

Builders are often seen as the key influencer of technology adoption in the residential construction industry, driving the market value of such technologies. They influence both homeowners and manufacturers at driving trends in new products, materials and processes. Below are the market research areas outlined on pages 12-19 above with specific detail on how this research will benefit builders.

Value and Valuation of Housing Technology and Innovation

Builders may be underestimating the demand of their customers (homeowners and homebuyers) for new technologies. Generally risk-averse due to low profit margins, some home builders (particularly smaller ones) are cautious to adopt new technologies or processes. Some builders, though, have had great success with new innovation (see one example below).

Builders may also consider themselves the sole drivers of new technology. With increased understanding of consumer opinion, builders will be able to match their perceived valuation with true market value, thus making decisions about innovation based on sound data.

If builders understand even better the increased value of homes with innovation features, they will be more likely to promote their use of new technologies. This research could help shed light on how builders can market homes and new technologies more effectively than is already being done by some.

Assembly-Line-Produced Houses: One Example of Builder Innovation

Pulte Home Sciences (PHS), the research-and-development arm of Pulte Homes, has been experimenting with production line manufacturing of modular housing. In a new plant, they are using digital design data to drive a production line, house by house. This process consists of concrete forming set-up equipment to produce basement/foundation walls and machines to fabricate steel studs from flat stock. It drives machines to create structural floors and panelized interior and exterior walls with openings for doors, windows and utilities. Parts come off the line grouped for each home, and the plant can switch designs with the press of a button.

The computer-assisted manufacturing technology that sets up and drives the machines allows each home in the line to vary from others in the chain. The result is stiff floors, wide spans, high R-values and fast construction. New software was also developed to convert architectural design into engineered construction data that could automatically drive component-producing machines.

Source: Tom Sawyer, "Demand Drives home builders to Build Fast and Innovate," *ENR*, January 2/9, 2006.

Performance Measures

Builders will find great value in this information. It will help them gauge the market and provide beneficial end-user information that they can then use to capture benefits of technology integration. Builders should consider funding more research of this type and being an active participant in research initiatives.

Builders need benchmarks and performance standards they can use in selection and use of new technologies. In particular, they need to encourage this research in order to identify useful technologies more easily.

Research on Role and Behaviors of Intermediaries

Builders will greatly benefit from increased understanding of intermediaries. This research is a critical unknown link in the innovation chain. Builders should be especially interested to know how suppliers and distributors are sharing information, motivated and how they might be hindering or encouraging innovation adoption. This study should be one which builders fund and actively support.

Information and Knowledge Transfer

Builders can use this information to formulate appropriate dissemination and marketing strategies. Transparency and awareness of benchmarking and the ways knowledge transfers will help increase the rate of technology adoption and create market awareness of new products.

Manufacturers

Manufacturers, or the innovators, perform two important roles (accelerator functions) in the innovation process: (1) reduce risk by providing information, and (2) generate demand through advertising and consumer-oriented communications. Manufacturers provide information about the product, and in many cases, they also provide the training required to use the product efficiently. These two factors – information and training, –are a constant and necessary condition in all successful innovations.

Below are the market research areas outlined on pages 12-19 above with specific detail on how this research will benefit manufacturers.

Value and Valuation of Housing Technology and Innovation

Manufacturers, the chief suppliers of new technologies, need quantifiable market data to justify increased investment in new technology development and perhaps even more importantly, marketing and supporting third-party promotion of new innovations. By perceiving market interest and attributing revenue and competitive gains as a result of innovation, manufacturers will be more inclined to support the marketplace and increase efforts to drive demand.

Performance Measures

Manufacturers will be the primary users of most of this information. It is critical in justifying expenditures and risk involved with the development of new technology and innovative processes.

Manufacturers should also consider investing in this research because its results could also transform the ways builders see the supply-demand chain, and it may spur demand for new products.

Research on performance measures would allow manufacturers to compare their performance with their competitors' and within the marketplace through understanding the full cycle of product delivery.

This research would help manufacturers because it would be a non-biased source of intelligence manufacturers could provide to their customers, who typically do not trust individual manufacturers to be objective about the advantages of their products and services.

Furthermore, understanding the motivations and buying decisions of consumers and builders will help manufacturers better understand the end user and whether they are a viable direct customer channel.

The results could help create strategies to increase innovation adoption. The EnergyStar® program is an example of how some consumer preference data can be used to change buying habits and create markets for new technologies. Delving more into broad innovation drivers could have the same effect.

Research on Role and Behaviors of Intermediaries

Manufacturers could use this data to effectively influence adoption of their products and lower risk for new research and development efforts.

Information and Knowledge Transfer

Manufacturers can use this information to formulate appropriate dissemination and marketing strategies. Transparency and awareness of benchmarking practices and the ways knowledge transfers will help increase the rate of technology adoption and create market awareness of new products. For example, manufacturing 'best practices' allow manufacturers to learn from both their mistakes and successes.

Intermediaries

Many industry leaders acknowledge the role affiliated industry sectors, such as realtors, appraisers, retailers and distributors, play in influencing innovation adoption rates. Though very little is known about the exact role and influence these players have on innovation adoption, it is clear that they play a significant role influencing consumer behavior. More than ever, retailers such as Home Depot and Lowes have become the major educational conduit for homeowners.

The role of such builder intermediaries, such as suppliers and distributors, can also be included under this umbrella since they are key stakeholders in builder information. Dealers/suppliers serve as the intermediaries in the supply chain delivering new products to the builder.

Below are the market research areas outlined on pages 12-19 above with specific detail on how this research will benefit intermediaries.

Value and Valuation of Housing Technology and Innovation

Housing intermediaries require data on how the insurance and mortgage industries measure risk and how they find data and information. As a result, intermediaries – from retailers to real estate agents to suppliers to contractors – will benefit from understanding how technologies lead to increased value.

Research on Role and Behaviors of Intermediaries

Intermediaries themselves may gain an understanding of the value they add in a changing industry – particularly given the consolidation among both the manufacturing and homebuilding circles and the increased presence of retail competition. As key members of the distribution chain for new technologies from product design and manufacture to the marketplace, understanding how this knowledge flows is important for strategic planning purposes.

Information and Knowledge Transfer

Intermediaries can learn to filter information more efficiently. This information will enable intermediaries to gain power in order to influence the innovation marketplace. As key members of the distribution chain for new technologies from product design and manufacture to the marketplace, understanding how this knowledge flows is important for strategic planning purposes.

Intermediaries in Action:

Below: A supplier/distributor has an impact on builders.

Below Right: A realtor has an impact on consumers.



Government

The government's role in market intelligence is that of a user of data and analysis for policy formulation and as a generator of data and analysis either through funding, coordinating and/or executing that market research work. Because of these multiple activities, it is critical to revisit the context within which housing statistics in general – and housing technology and industrial practice statistics in particular – are generated. Then, a review of the primary themes for data collection presented in the Symposium can be viewed with regard to public sector involvement.

Below are the market research areas outlined on pages 12-19 above with specific detail on how this research will benefit government.

Value and Valuation of Housing Technology and Innovation

The public value of research directed toward technology valuation stems directly from public interest in improving the condition of American housing (through incentives rather than regulation, to the greatest extent possible) and from decreasing the costs of housing in order to increase the number of households in actual housing.

Knowing whether changes in production and products can alter the cost structure and, in turn, demonstrate improvements in the quality and/or increases in the quantity of homes is critical to all of the governmental programs that have either of these as a goal. Moreover, the simple measurement of that valuation is critical for creating industrial incentives – thereby spurring further cost considerations without additional public resources.

Performance Measures

Probably no greater problem exists in trying to understand how innovation has affected residential construction than the near impossibility to measure definitively the impact of these innovations on industry performance.

While the public interest is served by both spurring market intelligence that might increase industrial R&D as well as evaluate other governmental programs, the need for government to produce such investigations also stems from its role as a common arbiter. Reliable, unbiased and easily available information on home performance and industry productivity can only be provided by the public sector, though with significant industrial assistance.

Research on Role and Behaviors of Intermediaries

Insight into the role of intermediaries directly shapes the industry's ability to predict costs and sales – and, therefore, the ultimate costs of producing and purchasing homes. It also allows for better understanding of how government regulations impact the level and cost of construction

By explicitly measuring the potential impact of the permitting process, building codes and land-use restrictions or innovations, there will be a better knowledge base of the ways these processes can encourage or discourage innovation. It would then help policy makers to identify those provisions and procedures that are particularly conducive to encouraging more innovation (or those that discourage it).

Information and Knowledge Transfer

As users of information, research in this area is particularly important. Getting insight into the behaviors, motives and actions of consumers in particular is essential for governmental programs involved in market transformation. Once achieved, this knowledge is passed on to industry forces attempting the same.

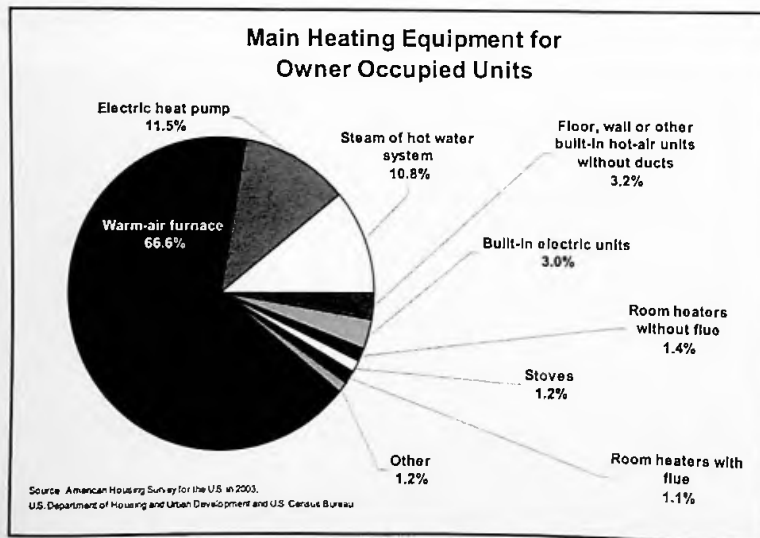
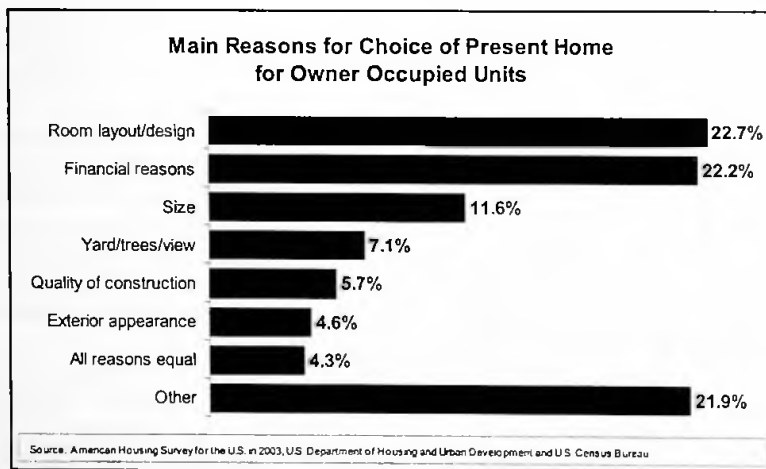
Market Research Action

The areas Symposium participants proposed, which were outlined above, comprise the recommended key market research topics. In order to build on those needs, the participants identified seven research action strategies around which industry players can engage to increase market understanding about the challenges of innovation development and implementation.

These proposed market research strategies are:

- Conduct Research Studies to Acquire Industry Performance and Market Segmentation Data.
- Create Product and Process Performance Measures.
- Research the Effects of New Technologies on Asset Performance.
- Conduct Market Research Studies to Understand How Intermediaries Drive Innovation.
- Conduct Market Research on Consumers: Characteristics, Decision-Making Process and Motives for Adopting New Technologies.
- Conduct Studies on the Acquisition and Knowledge Transfer of Innovation Information.
- Develop Business Process Best Practices (Including Success and Failure Information) In Homebuilding Product Manufacturing Sector Applications.

On pages 25-31, each proposed strategy is discussed, including descriptions of each and why they are important to industry players. Additionally, each strategy area contains a roadmap, which includes potential action, priority levels (ranked low, medium and high in order of importance to furthering understanding), proposed funding sources (public, private or public-private (joint funding by private and public sources)) as well as tentative timeline for task completion.



Strategies

Research Strategy: Conduct Research Studies to Acquire Industry Performance and Market Segmentation Data

Manufacturers presently have limited public sources of available residential information which produces a breakdown at each stage of the supply chain. They need information on who is buying, how much they are buying, which products they are buying and what value is added at each stage of delivery. Federal government historical and continuous industry performance data and industry segmentation/market mapping data will also contribute data on homebuilding industry performance.

Manufacturers want to be able to follow products from upstream raw materials and component suppliers downstream, through pre-assembly and batching, to site installation and first-use by homebuyers. Beyond sales numbers, manufacturers would also be interested in reasons and motivations behind those numbers. Understanding market drivers behind sales will then lead to forecasts that will allow fine-tuning of production and product planning.

This research is critical, most significantly to manufacturers but also to builders and consumers. It will bring homebuilding product manufacturers closer to the customer, ultimately making them more competitive as individual organizations and as an industry. The information will reduce risk and, because of efficiency, should increase overall affordability of housing.

Why Should Manufacturers Want to Participate in This Research?

- Provides justifications for risk in fostering new technologies
- Offers critical mapping information to understand market drivers to increased sales
- Brings them closer to customers, increasing competitiveness

Federal government historic and continuous industry performance reporting may be the most useful substitute for 'real-time' activity tracking. In addition, product manufacturers will want case studies and survey information as well as specific analysis to answer detailed questions. Purveyors of information related to homebuilding markets already use government information or information from other organizations and sources to build upon and derive specific interpretations. Therefore, market segmentation by industry, conducted collaboratively or independently by industry, will logically follow and build upon the initial federal government data collection effort.

Proposed Action	Recommended Priority	Recommended Funding Source	2006	2007	2008	2009	2010
1.1 Create a stakeholder consortium. • Invite appropriate experts. • Use group to identify data gaps.	Medium	Public-Private	■				
1.2 Aggregate existing information. • Collect and organize existing information. • Leverage off existing data. • Analyze existing data.	High	Public		■			
1.3 Map market. • Use Consortium to take existing results and map out market.	High	Public		■	■		
1.4 Acquire needed data. • Identify data gaps. • Acquire additional data using appropriate survey mechanisms and partnering.	High	Public-Private			■		

Market Research Action

Research Strategy: Create Product and Process Performance Measures

Reflecting the need for greater access to performance data from objective sources, Symposium participants stress the importance of third party verification and publicly available data that would allow comparisons among products, including building code and installation requirements (including ease and cost of installation and the relationship between installation labor and product performance).

Presently, manufacturers with building products and materials with long-term superior performance, such as improved disaster resistance or durability, are disadvantaged because it is difficult to communicate these benefits to builders and potential home buyers. The performance information needed spans the entire cycle of product delivery → production → delivery → distribution → installation → post installation).

It is important that the benchmarks and ultimate information delivery system be provided or managed by a credible, third party because builders do not rely on manufacturers for objective evaluations and product/process comparisons.

Potential Questions for Survey Instruments

- What information currently exists quantifying product and process performance?
- What is the price/time on market of new technology?
- What are the value, cost and benefits of new technologies?
- What are other data collection methods possible for use?
- How is profitability measured? How profitable are current innovations?
- What areas have the greatest opportunity for improvement?

Why Should Manufacturers Want to Participate in This Research?

- Creates increased opportunity for unbiased analysis and objective third-party verification, which builders often use to supplement manufacturer product information
- Provides a way for innovators to gain market advantage
- Can provide justification for R&D investment into new technology development

Proposed Action	Recommended Priority	Recommended Funding Source	2006	2007	2008	2009	2010
2.1 Review current evaluation programs on diffusion and adoption processes. • Analyze current programs. • Develop alternative models.	High	Public-Private	■	■			
2.2 Document private data sources.	Medium	Public-Private		■			
2.3 Establish alternative research methods. • Outline limitations of surveys. • Create methods for research and data collection aligned with goals.	High	Public		■			
2.4 Create independent information broker for results.	Low	Public				■	

Strategies

Research Strategy: Research the Effects of New Technologies on Asset Performance

Data on houses that contain new technologies and the performance of those houses, both from a safety standpoint as well as the resale value, will help acceptance of new technologies provided that the data support better safety records, more efficient operation of the house (lower costs of operation) and higher resale values. Additionally, consumers may be motivated to adopt new innovations if there is quantifiable data on how these technologies can improve the performance of their homes.

Why Should Industry Players Want to Participate in This Research?

- Will help acceptance of new technologies
- May be used for sales purposes – data may tie innovation to increased house values

Potential Questions for Survey Instruments

- What consumer reports exist for products and performance?
- What are the most important products and elements of product performance to consumers?
- What outcomes of technology interest consumers most?
- What data do the insurance and mortgage industry use to quantify advanced technology risk reduction? How do they acquire such data?

Proposed Action	Recommended Priority	Recommended Funding Source	2006	2007	2008	2009	2010
3.1 Determine focus group/area. • Analyze current housing programs that include new technologies. • Set a representative sample for investigation.	Medium	Public	■				
3.2 Acquire baseline data. • Gather safety and operating data of sample.	Medium	Public		■	■		
3.3 Conduct market research tracking increases in innovative home value. • Track resale value of sample.	Medium	Public-Private		■	■		
3.4 Conduct studies of customer satisfaction. • Gather market data on real estate agents' preferences and satisfaction with new technologies. • Use customer satisfaction studies.	High	Private (lead)		■	■	■	■

Market Research Action

Conduct Market Research Studies to Understand How Intermediaries Drive Innovation

Little is known about the role of dealers, suppliers, retailers, realtors and other industry players in moving new building products to the market. However, these intermediaries can have profound impact on the behaviors of builders, consumers and manufacturers in adopting new housing innovation.

To date, Symposium attendees were unaware of any publicly available research or information measuring this influence. Industry leaders, as a result, believe emphasis within new research should be on under-

standing the role, behaviors, motivations and processes affecting knowledge transfer from manufacturers through intermediaries to builders and consumers.

As with builders, intermediaries also respond to the incentives and risks that influence their profitability. They depend on past practices and experiences to minimize their risks in introducing new products. As a result, they are motivated to serve existing customers with familiar products that have demonstrated value.

Why Should Manufacturers Want to Participate in This Research?

- To gain an understanding of how intermediaries behave and drive sales, such as how retailers influence consumers and suppliers influence builders
- Determine best incentives to maximize interest from intermediaries in new technologies

Potential Questions for Survey Instruments

- What are the roles of intermediaries in transferring information to builders and contractors?
- How do they select products to stock? Is it driven by manufacturers?
- What motivates them to introduce an innovative product?
- What do they know about the cost to adapt a new product, and how do they communicate this to builders?
- What role do they play in transferring risk/liability to builders?

Proposed Action	Recommended Priority	Recommended Funding Source	2006	2007	2008	2009	2010
4.1 Document existing information. <ul style="list-style-type: none"> • Aggregate existing research on suppliers (as first group for study, can be expanded to other intermediaries based on funding, etc.). • Analyze results and identify data gap areas. 	High	Public	■				
4.2 Set study sample. <ul style="list-style-type: none"> • Establish study group and research methodology. 	High	Public		■			
4.3 Conduct market research determining supplier preferences, communication methods with manufacturers and builders, information exchange, etc. <ul style="list-style-type: none"> • Analyze results. 	High	Public-Private		■	■		
4.4 Determine supplier impact on profitability.	High	Private (lead)			■		

Strategies

Research Strategy: Conduct Market Research on Consumers: Characteristics, Decision-Making Process and Motives for Adopting New Technologies

Industry has little information about what consumers know about the homebuilding process and what is in their homes. Another unknown is how consumers find information about residential innovations, as well as the perceived reliability of that information. Industry leaders assume that most consumers make that decision only when there is a problem to solve, but that conclusion is anecdotally based.

From an energy-efficient product side, Energy Star® and Building America have acquired some of this data, and research groups, such as J.D. Power and Associates, have information on homeowner satisfaction drivers, but this information is not the core of what is needed.

The American Housing Survey contains some demographic information but is inadequate for a deeper understanding as it relates to innovation-adopters. There is a need to understand the 'switches' or motives that drive adoption and how users interact with new technologies.

Why Should Industry Players Want to Participate in This Research?

- Demystifies drivers to consumer decision-making processes beyond demographics
- Delves more deeply into drivers behind customer satisfaction

Potential Questions for Survey Instruments

- What are the characteristics and demographics of innovative technology adopters versus non-adopters? What motivates their behavior?
- What are the most important socio-economic drivers for adopting new technologies?
- How much do consumers know about technology in their homes?
- How do they find information about new processes, design and products? How do they perceive the reliability of those sources?
- What are the most influential social incentives to new technology adoption (e.g., safety, value)?
- How do consumers interact with technology?

Proposed Action	Recommended Priority	Recommended Funding Source	2006	2007	2008	2009	2010
5.1 Create public/private partnership group. • Gather existing consumer demographic and preference data. • Determine data gaps.	Medium	Public		■	■		
5.2 Set study sample and research methodology.	Medium	Public			■	■	
5.3 Conduct market research, examining the following areas: • Knowledge of housing technologies, • Create methods for research and data collection aligned with goals, • Behavior drivers, • Interaction with technology, and • Sources for information.	Medium	Public			■	■	■
5.4 Analyze results and disseminate widely.	Medium	Public					■

Market Research Action

Research Strategy: Conduct Studies on the Acquisition and Knowledge Transfer of Innovation Information

The goal of knowledge transfer from the builder's perspective is to ensure that the correct information (e.g., installation instructions) is present and known by all key actors at every step of the building process. There are both behavioral and motivation impediments to knowledge transfer. Open transfer of knowledge could result in unanticipated exposure to liability and other risks particularly if the quality of information is faulty. Competition rewards proprietary information that is controlled rather than widely shared.

Why Should Manufacturers Want to Participate in This Research?

- Enables easier transfer of new information to consumers and other technology users
- Allows insight into other motivational factors that go into decision-making as it relates to innovation
- Provides insight into transfer rates for effective planning in moving technology to market

The primary challenge is improving knowledge transfer associated with understanding an innovation, the implications of use and lessons from previous trial from every use of the innovation. Manufacturers and suppliers need to bundle product information with incentives to early adopters (e.g., enhanced financing, training, warranty).

There are both tangible and intangible costs associated with not having better knowledge about new products. By supplementing existing information with new studies, the industry will be able to better leverage knowledge and transfer it to builders and/or consumers, who purchase and adopt new technologies. For reliable comparisons, the performance of existing systems needs to be benchmarked.

The process of transferring knowledge across the supply-chain should be modeled to help identify problems in getting the required information to builders and contractors.

Potential Questions for Survey Instruments

- What information currently exists/is used to gain knowledge?
- What are the cycle-times, callbacks and warrantee claims?

Proposed Action	Recommended Priority	Recommended Funding Source	2006	2007	2008	2009	2010
6.1 Aggregate existing information.	High	Public		■			
6.2 Conduct multi-stage study. • Establish research methodology. • Identify and model the transfer of knowledge about new products. • Identify best practices.	High	Public-Private			■		
6.3 Document sources of data. • Identify data sources for technology measures. • Identify methods for generating information.	Medium	Public			■		
6.4 Create case studies.	High	Public			■	■	

Strategies

Research Strategy: Develop Business Process Best Practices (Including Success and Failure Information) In Homebuilding Product Manufacturing Sector Applications

As opposed to a set of 'how to' and 'why' case studies, homebuilding product manufacturers need to understand the effectiveness of their practices and business processes. This proof of a particular process' effectiveness for many manufacturers will only be recognized when their competition introduces them successfully. These manufacturers contend that they will not be able to speak intelligently about options until they hear more than anecdotal evidence of what worked and what did not for their direct peers. It is important to note that in order for best practices to be of most use, they also must include information on failures as well as successes, and they should be comprehensive and highly detailed.

Fundamentally, homebuilding product manufacturer business success requires effective business process:

- Business process innovation requires the identification and implementation of 'best practices' or proven strategies for improving business operations.
- 'Performance metrics,' primarily related to time, cost and deviation from planned outcomes, are necessary and key components of best practices.
- Industry benchmarks enable evaluation of how homebuilding product manufacturers are doing compared to competitors and other industries.

Why Should Manufacturers Want to Participate in This Research?

- Provides insights that could lead to competitive advantage through innovation
- Offers justifications for engaging in new R&D efforts because of hard measures and benchmarks
- Gives smaller firms the opportunity to gain intelligence they could not gather internally

Efforts should be similar to those practiced by leading management consulting firms in other industries, evaluating practices and processes in specific companies and comparing them to the practices and processes of the most successful operations. The result would be increased efficiency in operations and home production.

Proposed Action	Recommended Priority	Recommended Funding Source	2006	2007	2008	2009	2010
7.1 Convene a consortium of homebuilding product manufacturers.	Medium	Public		■	■		
7.2 Establish collaboration with business schools. • Gather business information. • Document data collection.	Low	Public-Private			■	■	
7.3 Collaborate with research groups. • Analyze results. • Prepare final outcome for third-party credibility.	Medium	Public			■	■	
7.4 Create case studies.	Medium	Public				■	■

Existing Research Review

There is a limited amount of public information on the three primary groups involved in home technology decisions: consumers, builders and manufacturers. These players differ from the actors described above (though there is some overlap) who represent groups that generate and use market data on the participants described in this section.

The following reviews the extant literature on those groups that can be used to augment market research gathered through any research actions described above.

Consumer Research Review

Although more research has been conducted on consumers (defined as homeowners or homebuyers) compared to builders and manufacturers, there are still few non-commercial resources of information regarding consumers and new home technology. Not only are there market data gaps on consumer motivations and behavior, but there are also gaps in knowledge about how consumers get new technology information and how they perceive that information.

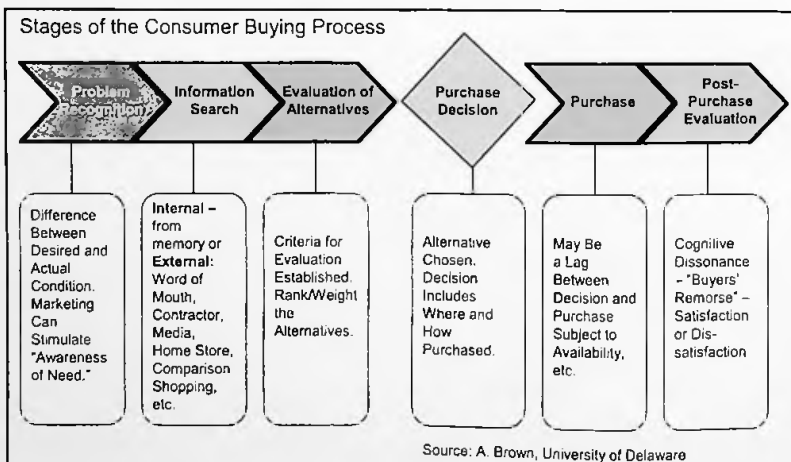
Generally, private firms commission most of the research conducted on consumer behaviors and preferences and, in turn, use the findings for proprietary purposes. As a result, the information that exists is either not available for public use or focused on a specific product versus broader behavioral patterns.

At the same time, there is a perception that consumers care more about product features of their homes, such as granite countertops, than in more involved technological changes. In fact, according to a recent study by PATH, it has "almost become an industry-wide prophecy."⁵ Consumers have been believed to be at the tail end of technology adoption where their interests were deemed sufficiently represented by the builder community. As a result, consumer preferences, behaviors and motives regarding homebuilding innovation diffusion have been mostly ignored by innovation adoption studies and research. This information gap has

created a new area for market researchers to determine consumer trends about new homeowners' perceptions of technologies, willingness to pay and customer satisfaction due to innovation. To date, the little existing research has focused on energy-efficient technologies, which is still not conclusive.⁶

Most of what is known is in the context of general purchase processes and decisions, rather than the specific home buying or home remodeling scenarios. For example, it is known that many consumers make purchase decisions in a six-step process outlined below.

Consumers rely heavily on major media sources for information compared to home builders. Consumer publications and television appear to be strong general vehicles for this group. One unique information channel, however, is the sales force of home builders. New homebuyers rely heavily on this group for information about all of their prospective home's characteristics, including new technologies and the benefits of the technology. For consumers that are remodeling their homes, similarly, the sales staff at large home and hardware stores are critical to informing and guiding technology decisions. For the early adopters among both kinds of consumers, exhibits and demonstrations at consumer events are likely very effective communication channels, as are non-commercial vehicles like Consumer Reports or simple word-of-mouth.



Builder Research Review

The home builder and the home remodeler play a critical role in the diffusion of innovation within the residential construction industry. For the most part, building materials and products originate upstream of the homebuilder and the latter is rarely engaged in manufacturing. However, builders do act as either a single purchaser of materials and building products or as specifiers of purchasing requirements for the subcontractor. As such, builders can influence innovation creation.

Home builders are the bridge between the consumer (homebuyers and owners) and the various products that constitute the house. Some of the consumer's desires are explicit and some are implicit. Based on the experience of the builder, the consumer is most likely to have explicit choices on exterior cladding options, finishing options, fixtures and appliances. Similarly, builders perceive consumers being less likely to have choices (or preferences) in the basic building materials and electrical and mechanical systems that are largely hidden and unobservable. Home builders respond to explicit consumer preferences but often not to other modifications. Due to the intense competition between homebuyers in many market areas, builders need only deliver a reasonably performing product. This tendency is not conducive to adoption of innovation.

Because builders often determine the design and primary characteristics of the house, consumers often see builders as the 'architects' of homes. As such, if materials and products fail or perform poorly, the consumer turns first to the home builder. Call-backs (returning to the house to fix problems) reduce profit margins and can diminish customer satisfaction and hurt the reputation and potential market of the builder. Consequently, homebuilding firms are extremely sensitive to the risks associated with new products and materials. Through direct experience and well-known examples, home builders know that lab testing does not substitute for field-testing where challenges and benefits of new technologies can be best understood.

Builders look upstream to manufacturers to produce new products and materials. They look to manufacturers and suppliers to provide information about new products, to provide technical and marketing assistance, to train installers, to conduct field tests and to address liability issues. Although building material and product manufacturers receive signals from home builders about improvements and innovations, their decisions about innovation are made on the basis of their own business models.

Production builders, particularly larger firms, are likely to focus on innovations that allow them to manage assembly better rather than change the process significantly. Innovations in process management can improve quality, supply-chain management, scheduling, delivery of the finished house as well as customer relations and satisfaction. Builders can signal the need for product improvements up-stream to manufacturers, and they can market innovations down-stream to consumers.

Builders also look to their subcontractors to provide the training and supervision needed to install new products correctly. Builders manage this relationship through the specifications issued to subcontractors and through on-site monitoring of performance. Since subcontractors have few resources to provide training and are facing increased shortages of skilled labor, they have little capacity to manage innovation.

In short, there are numerous gaps in our knowledge of builders' and remodelers' acquisition of information, decision-making and general propensity to innovate.

Existing Research Review

Manufacturer Research Review

Manufacturers, or the innovators, perform two important roles (accelerator functions) in the innovation process in addition to actually innovating:

- 1) Reduce risk by providing information, and
- 2) Generate demand through advertising and consumer-oriented communications.

Manufacturers provide information about the product, and in many cases, they also provide the training required to use the product efficiently. These two factors, information and training, are a constant and a likely condition in all successful innovations, though they are not the only condition.

Despite the need for understanding manufacturers' role in innovation, there is little study on the actual market characteristics or behaviors of these firms. The information that has been documented focuses on the prescriptive steps to innovation adoption as well as its advantages rather than on empirical or even descriptive studies. Patterns and variances in the product development process across firms are still largely unknown. Figure 1 below, adopted from the J. Hickling diffusion of innovation model, illustrates an example of such product development phases.⁷ This also suggests that manufacturing firms have largely done most of the market research in the homebuilding industry, where little inquiry into the firms themselves has been done.

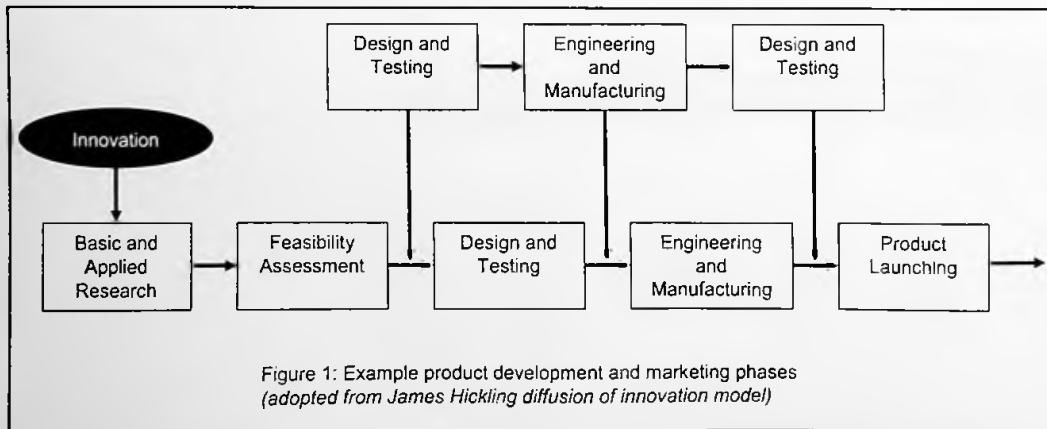
When considering the work that firms do, though, we open up a huge terrain for investigation. For example, one key activity of these firms with regard to innovation is commercialization. Commercialization involves the full spectrum of activities required to move a new technology, product, or process from its conceptual stage to the marketplace.⁸ Commercialization can be said to

have occurred when a new product or process is actually being sold into the market. Commercialization has two main components:

- Technical: Efforts to transform technology into a viable and desirable product, and to produce it in sufficient quantities and quality. This work involves product development and design as well as manufacturing engineering functions.
- Business management and market analysis: Processes needed to ensure that the product demand is adequate and profitable, that intellectual property is appropriately managed and that parts of the firm built around the new product are well run. This work involves business planning, market characterization, marketing strategy, manufacturing supply chain, distribution and services systems, management and intellectual property rights.

Innovation is the core function within a company with the most competitive value. According to Bernstein in the Civil Engineering Research Foundation's 2002 paper "Guidelines for Moving Innovation into Practice" the benefits of innovation are tremendous and have accrued to practitioners, users and society as a whole.⁹ However, despite these advantages, innovation is managed with the least discipline.¹⁰

Understanding how residential product manufacturing firms manage the ideation, product development and commercialization processes is a critical component of future market research. It is just as important to understand the motivation, history, personnel and resources involved in embarking on these processes in order to improve public assistance to these firms – particularly when there is public need for them to innovate.



Acknowledgements

Contributors

Project Leaders

This project was coordinated and conducted as a joint effort between McGraw-Hill Construction and the Partnership for Advancing Technology in Housing.

Three key individuals provided leadership on this project:

- Harvey M. Bernstein, F.ASCE, vice president, Industry Analytics and Alliances for McGraw-Hill Construction, served as the lead on the project as well as the overall chief facilitator for the Symposium on Market Data for Housing Innovation, the key element of the project from which recommendations and conclusions were drawn.
- Michele A. Russo, LEED AP, Director of Industry Communications for McGraw-Hill Construction, served as the project manager, coordinating the many elements of the project, including preparing an overview of existing governmental resources, coordinating the Symposium information and preparation of project papers and reports, and acting as liaison with project partners.

Dr. Carlos Martín, U.S. HUD, PATH provided project oversight for PATH and HUD. He also provided expertise on available literature, research and other information related to moving innovation into the marketplace.

Symposium Leaders

Six key industry experts served leadership roles at the Symposium. Their role in the project consisted of serving as co-chairs of the Symposium breakout sessions, presenting group consensus voting results at the Symposium closing plenary session, participating on the Project Task Force, and collaborating to provide a written report of industry information as it related to their breakout sessions. This information served as a summary of the outcomes of the Symposium and helped formulate the research strategies presented herein.

These key individuals were

- Ed Hudson, National Association of Home Builders Research Center
- Dr. C. Theodore Koebel, Virginia Technology University
- Lexi Moriarty, McGraw-Hill Construction
- Dr. Anne Sweaney, University of Georgia
- Dr. Walid Thabet, Virginia Technology University
- William Whiddon, Building Technology, Inc.

Policy Advisor

The policy pieces of the project were led by Dr. Kermit Baker, Senior Research Fellow at Harvard University's Joint Center for Housing Studies and Chief Economist for the American Institute of Architects (AIA).

The Joint Center for Housing Studies is Harvard University's center for information and research on U.S. housing. The Joint Center analyzes the dynamic relationships between housing markets and economic, demographic, and social trends, providing leaders in the public and private sectors with the knowledge needed to develop effective policies and strategies.

The Joint Center is generally considered to be the leading housing research center in the country. It has an active Policy Advisory Board comprised of the leading home builders and building product manufacturers and distributors in the country that serve as a valuable resource in helping the research staff at the center to better understand industry practices and motivations.

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Residential Market Research Needs to Stimulate Innovation

2006 Technical Report

Prepared for the Partnership for Advancing Technology in Housing (PATH)

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About PATH

The Partnership for Advancing Technology in Housing (PATH) is dedicated to accelerating the development and use of technologies that radically improve the quality, durability, energy efficiency, environmental performance and affordability of America's housing.

PATH is a voluntary partnership between leaders in homebuilding, product manufacturing, insurance and other industries and representatives of Federal agencies concerned with housing. Working together, PATH participants improve new and existing homes and strengthen the technology infrastructure of the United States.

HUD's Office of Policy Development and Research (PD&R) coordinates all PATH activities. PD&R manages PATH's budget, strategy, and daily operations. Staff in PD&R's Affordable Housing Research and Technology Division have expertise in various construction systems, housing issues and technology policies.

Because PATH involves many participants from diverse parts of the home building community, PATH seeks guidance from the Industry Committee and other Federal agencies. PATH also works with industry partners to advance housing technology.

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