Information Technology to Accelerate and Streamline Home Building

September 2003 Status Report

Prepared for:

The U.S. Department of Housing and Urban Development
Washington, D.C.

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PREFACE

The evolution of information technology has led consumers to expect better value for their dollar, higher quality, shorter cycle times and access to current information. This is true in many product areas, and housing although currently experiencing unprecedented demand, is beginning to feel the increasing competetive pressure brought on by more knowledgable consumers. In the same way that information technology plays a role in creating the increased competetiveness, it can also help the industry deliver higher quality at lower prices through reducing the administrative costs of building and increasing the efficiency of the supply chain.

The issue is whether or not PATH can provide research results quickly enough to be beneficial in this highly changeable and fast moving sector. The projects recommended in this report would need to be done in the near term to ensure their relevance.

PATH PROGRAM GOALS

The Partnership for Advancing Technology in Housing (PATH) advances technology in the home building industry to improve the affordability and value of new and existing homes. Through public and private efforts in technology research, information dissemination, and barrier analysis, PATH is adding value to seven of the nation's key housing attributes:

- affordability
- energy efficiency
- environmental impact
- quality
- durability and maintenance
- hazard mitigation
- labor safety

As such, four overarching goals have been established that all bear on those attributes:

To remove barriers and facilitate technology development and adoption

PATH will investigate the barriers, including regulatory barriers, that impede innovation, and will actively propose and develop programs to overcome those barriers. This work will guide the other goals and efforts.

To improve technology transfer, development, and adoption through information dissemination

PATH will coordinate dissemination of innovation information directed to the housing industry and consumers.

To advance housing technologies research and foster development of new technology

PATH will support “background” and applied research as well as technology development activities in the housing industry. This research will be complemented by short-term and long-term assessments of specific technologies that are on the market.

To support the program through appropriate management and resource allocations

Partners in the PATH program-the U.S. Departments of Housing and Urban Development (HUD) and Energy (DOE), the Environmental Protection Agency (EPA), the Department of Agriculture (DOA), the Department of Commerce, the Federal Emergency Management Agency (FEMA),
home builders, researchers, and manufacturers of building materials and products-have long recognized the importance of injecting current and emerging technologies into the home building process. The PATH program has identified many of the relevant technologies and has facilitated implementation of research, pilot, demonstration, and evaluation projects across the United States. In addition, PATH program partners recognize the importance of planning research and setting priorities for technology development that will enable the housing industry to work toward the PATH mission. This priority setting is known as "Roadmapping."

ROADMAPPING PROCESS

The objective of PATH technology roadmapping is to identify technological research in home building to serve as a guide for research investments by government and industry. The PATH Industry Steering Committee (ISC), comprised of builders and manufacturers of building products and materials, oversees the development of technology roadmaps for the site built housing industry.

A significant planning activity for PATH, the roadmaps dictate the main areas for research and development in PATH's research portfolio (which includes background, applied, and development activities) as well as provide the home building industry with a strategic plan for future technology development. Through this process, new technologies and additional research work will be generated as the roadmaps are implemented.

The ISC initiated the overall roadmapping process during early 2000. A group of 40 builders, material and product suppliers, academicians, researchers, and other stakeholders identified and prioritized technologies that hold promise in achieving PATH's goals. The ISC then grouped the technologies with the greatest potential benefits into broad portfolios. These portfolios represent three initial technology roadmaps for new home construction.
At about the same time, additional roadmaps were initiated by the manufactured housing industry and the remodeling industry to address PATH goals and objectives relevant to these sectors of the home building industry. The result is the following five roadmapping activities currently in different stages of development:

1. *Information Technology to Accelerate and Streamline Home Building*
2. *Whole-House and Building Process Redesign*
3. *Energy Efficiency in Existing Homes*
4. *Technology Roadmapping for Manufactured Housing, and*
5. *Advanced Panelized Construction.*

Each of the roadmaps has a separate report. This report deals specifically with *Information Technology to Accelerate and Streamline Home Building.* It differs significantly from the other reports in that the field of Information Technology is changing so rapidly as to make research prioritization difficult. The approach in this document is to give a status on some of the more relevant activities currently underway and suggestions for projects that might be undertaken in the near-term. The fact that it may appear to deviate significantly from the Year One Progress Report is indicative of the rapid evolution in information technology.

The original vision for the Information Technology Roadmap as articulated in the Year One Progress Report appears to the right.

IT Activities Update

In December 2002 PATH sponsored a meeting of the Technology Roadmap Working Group (TRWG). The group covered general roadmap activities then focused on activities in two roadmap areas: Advanced Panelized Construction and Information Technology. A summary of the Information Technology Breakout Group session follows.

During the general session of the Roadmap meeting, Newport Partners staff presented an overview of the contents and status of the PATH IT Roadmap as they were at the time. Some activity was underway in implementing all areas of the roadmap, with significant progress on several fronts. The four implementation strategies being pursued include (1) development of a "common language," (2) using IT to streamline the regulatory process, (3) creation of a non-commercial information portal, and (4) creation of an "Interactive Supply Chain." HUD reported that ongoing work by Builders FirstSource together with the NAHB Research Center and Virginia Tech has led to progress under the first and fourth strategies, and both the Toolbase portal operated by NAHB Research Center, and the HUD-sponsored pathnet portal represents a partial implementation of the third strategy. The need to establish or review suggested priorities in the roadmap was emphasized, and the desirability of addressing needs of small and larger builders alike as part of this work was a recurring theme.

Breakout Session

The goals of the breakout session were to solicit participant views on the four strategies presented in the Information Technology roadmap, to gather input on how to revise the document in order to reflect current priorities, thinking and progress to date, and to identify opportunities for field demonstrations and other work that would advance progress towards the vision in the roadmap.

Common Language: High Priority Items from this section focused on *Section 1.2 Determine Information Requirements* and building on the information developed by Virginia Tech and working it through with small to medium size builders to ensure relevance. (This theme was picked up again in section 4.) There was much discussion on the need to continue activities on

Vision: Year One Progress Report

The vision for the Information Te c h n o l o g y Roadmap calls for information to be available when and where needed by participants in the home building process so they can perform their jobs more accurately, efficiently, and on time.

Realization of the vision will permit designers, specifiers, and consumers to have rapid access to comparative data on product costs, features, limitations, and availability in formats that can easily be compared, selected, and incorporated into computer aided design (CAD)plans. Applications and plans will be submitted electronically without traveling to the permit office or waiting in line. Builders and developers will know their application status at all times, and approvals will be returned electronically. Accurate, up-to-date design details, manufacturers' instructions, safety data, component specifications, and similar information will be available onsite in real time. Change orders, customer option choices, plan revisions, and unforeseen delays will be entered once, then accommodated seamlessly into revisions to working documents and process schedules, with updated information getting to all affected parties. All required inspections for regulatory approvals or loans will be performed on demand, without suspending work or scheduling a site inspection.

The vision will be achievable by small builders as well as by high-volume production builders. Interoperable software available from a multitude of vendors will ensure incremental realization of the vision.

developing common language and a thesaurus but no real agreement. The work done to support product descriptions for the wood industry was recognized as helpful and a good example of how PATH can play a constructive role in standards development (by lending its name and federal presence), to activities carried out with financial support from industry. It was agreed that PATH should aggressively disseminate the findings and benefits from this research project.

Production Management Systems: This strategy was developed in recognition of the major benefits that could be obtained through ensuring real time data flow between the various parties involved in the construction process including: the builder, office staff, schedulers, trade contractors, suppliers, etc.. Home building is both dynamic and unpredictable. Activities are often difficult to anticipate, and construction project plans, drawings, schedules, budgets are often modified. Information technology offers a way to make the construction processes better integrated and more efficient.

The group recognized the real potential for impact and recommended that PATH survey builders and determine what types of systems are currently being used or considered by builders of various size. The results might vary by region as well as size of company. Of particular interest to the builders are systems used for estimating, buying/ordering, and getting feedback from suppliers regarding the fulfillment and tracking of pending orders. This activity might later be followed with field evaluations to better understand the potential for efficiency improvements. A draft survey is included as Appendix B.

In discussing change orders, a distinction was drawn between tracking change orders for internal purposes and propagating updated information reflecting changes to third parties. The greatest interest focused on the internal tracking. While it was pointed out that software does exist allowing change order processing within larger production management systems, it wasn't clear how good the software was, or how it was used.

Production management systems could be adapted for use in land planning and land development. There was interest in a survey of cities and local jurisdictions to assess the state of the art for land planning.

Non-commercial Information Portal: It was reported that the information portal described in the roadmap had been implemented (www.toolbase.org) and was getting good traffic, however, the group felt it was important to understand what types of users are visiting the site (builders, consumers, trade contractors, etc) and suggested that an acceptable way be developed to collect and track user self-classifications.

Breakout Session Participants

Bill Asdal, Asdal & Co. Builders
Liza Bowles, Newport Partners LLC
Patrick Bridges, Bridges and Associates
Wayne Ciccolo, Newport Partners LLC
Mike Crosbie, Steven Winter Associates
David Dacquisto, Newport Partners LLC
Michael Dickens, Build IQ
Gerry Eid, Eid-Co
Tom Leete, Builders FirstSource
Carlos Martin, U.S. Department of Housing and Urban Development
Brad Oberg, IBACOS
Wayne Pignolet, EBuild
Michael Strong, Brothers Strong
Steve Thorsell, BOCA International
Michael Turner, The Home Service Store
Ron Wakefield, Virginia Polytechnic and State University

Meeting December 9 – 10, 2002 in Baltimore, Maryland

The term "non-commercial" was questioned and discussed at length. There was general agreement that what was sought was objectivity and lack of bias, and that the absence of advertising was important in communicating that message. It was recognized that it would be difficult to ever support something that was totally non-commercial unless it was government sponsored (such as NIH) or government funded, and with the growth and expansion of information on the internet, perhaps this should be re-examined. HUD pointed out that the Toolbase site currently hosted predominantly Research Center information and that the information needed to be expanded, or linkages established with other portals such as Builder OnLine and HousingZone. HUD suggested looking at the expansion of the www.pathnet.org.

The roadmap calls for the portal to present users with decision support tools. While PATH may ultimately develop such tools, the group thought it was important to catalog the analytical tools that now exist and evaluate their relevance and potential value. Government sponsored tools that should be looked at exist within EPA, DOE, and NIST. Appropriate tools could be made available directly or indirectly through toolbase. Similarly, it was recommended that existing tools for web-based training of various parties within the building industry be inventoried and possibly offered via toolbase rather than focusing on developing new tools.

Streamlining the Regulatory Process: This is an area where the pace of implementation is controlled by local code authorities, not by builders or manufacturers. Progress has not been systematically assessed, but is believed to have been variable. Even steps as easy as accepting electronic applications for building permits over the Internet have proven elusive. Development of expert systems for plan review is impeded by local amendments to model codes as well as the inherent complexity of dealing with a variety of electronic plan formats that are not object-oriented. The use of GIS and remote sensing for inspections is still just a vision. From a practical standpoint, the highest priorities under this topic may be documenting best practices and cost saving potential for code authorities to use in making their case for greater automation, and developing a simple toolkit for jurisdictions to use in getting electronic operations underway.

Short-Term Follow-Up Items

The following short-term issues were identified for follow-up during the meeting. A summary of the research results for each of these topics are included below.

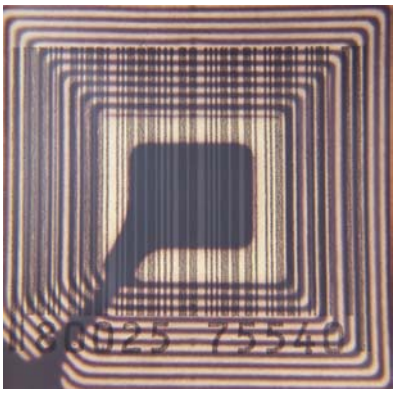
1. Investigate what is being done on "smart tags": low-cost chips containing embedded product codes, a possible successor to current barcoding technology.
2. Investigate work being at Universities that may be relevant
3. Investigate the "Voluntary Interindustry Commerce Standards" work being performed in conjunction with the Uniform Code Council.

1. Smart Tags --Radio Frequency Identification Devices

Radio Frequency Identification (RFID), a technology that has been available for several decades, has attracted renewed attention as system costs have dropped, functionality has improved and new applications have been pioneered. RFID systems are not yet used in home building, but they are used for applications such as automobile ignition security and immobilization systems; identification of animals including livestock and pets; automated vehicle toll collection systems; and patron wristbands with "electronic wallets" at theme parks. In Hong Kong, millions of consumers have used an RFID-based electronic cash system since the 1990's to pay mass transit fares and for other retail transactions. Growing interest among retailers has raised the prospect that RFID tags will ultimately replace item-level barcodes for tracking inventory as well as for customer checkout. The power

and flexibility of this technology suggest that it will find valuable uses in building product distribution, as well as in housing and the home building process.

Technology Description



RFID is one of a class of "auto-ID" technologies that allow collecting information about a product, place, time or transaction quickly, and without human error. The data link requires no physical contact and can generally be established without any need for line of sight, or concern about harsh or dirty environments that restrict other auto-ID technologies such as bar codes. RFID systems consist of several components, including (1) transponder chips bonded to antennas (see illustration), mounted on substrates and packaged as "tags"; (2) handheld or stationary tag readers and antennas, and (3) input systems for aggregating tag reader data and interfacing to back-end databases or business systems. The tags can be either "passive" or "active." A passive RFID tag is powered either by a magnetic field or a radio signal originating with the tag reader, while an active tag has its own power supply. The tags come in various shapes, sizes and read ranges including thin, flexible "smart labels" which can be laminated between paper or plastic, or mounted with an adhesive backing. Currently available tags and readers operate on frequencies around 135 kHz, 13.56 MHz, 900 MHz and 2.45 GHz. The operating frequency affects the read range (from a few centimeters to as much as 10 meters), the size and design of the tag and reader antennas, the potential sources of interference, and the cost of the reader hardware. Worldwide sales of RFID tags in 2002 were recently estimated at around 300 million units, most of which were passive tags.

The simplest transponder chips used in RFID tags contain small read-only memories (e.g., 64 bits) and are able to broadcast a unique ID code when energized. The analogy to a barcode is straightforward. More complex chips incorporate command sets to support functions such as collision avoidance (two chips broadcasting at the same time). Read-write chips with memories as large as 32 kbits are also available. These are highly versatile because data can be read selectively (in blocks), and can also be updated "on the fly" by the tag reader. The trend is for the newer, more powerful RFID chips to include security features ranging from basic password protection to public key encryption or even Java "virtual machines." These features are designed to prevent forgery, protect privacy and facilitate use in financial transactions.

The unit cost of RFID tags, which has historically ranged from around $1 to $20 (or more) depending on features, has been dropping with increased production, even as their performance improves. Volume pricing of less than $0.50 for passive tags has been reported. These trends have led some observers to predict the emergence of the "nickel tag." Lower tag costs clearly create opportunities for new and innovative applications of RFID technology on a very large scale, although the cost of readers can be high and the systems integration required to make full use of the potential of RFID is sometimes said to be the most expensive piece of all.

Several groups are strong proponents of RFID technology and sources of technical information. One is the industry-sponsored "Auto-ID Center" at the Massachusetts Institute of Technology, a consortium with over 60 members including several very large manufacturers (Coca-Cola, Johnson & Johnson, Kraft, Gillette) and retailers (Wal-Mart, Home Depot). It has sponsored research on topics such as a web-based infrastructure for documenting the properties of any item based on its "Electronic Product Code" (an enhanced version of the UPC) stored in the RFID tag. The goal is to allow users to perform sophisticated processing using the simplest, least expensive tags. Another trade group is AIM (Automatic Identification Manufacturers), the association for the automatic identification and data capture industry. Both groups are working to develop internationally recognized

standards for the tags and receivers, since most current system components are proprietary and must be carefully matched to ensure reliability. The Auto-ID Center anticipates publishing a complete standard in the second half of 2003.

Applications to PATH Roadmaps

The use of RFID technology is cited as one route to improved supply chain integration and management. RFID tags on pallets or cartons can be used to quickly identify shipments and deliveries. Tags on cartons or individual items can be read to keep track of wholesale or retail inventories, or for rapid point-of-sale transactions. The technology allows quick, accurate reading of large numbers of tags (hundreds per second under favorable conditions), which would be ideal for taking inventory or for point-of-sale checkout. In other words, using RFID tags a receipt could be generated and printed in about the time it takes to push a loaded cart past the reader antenna. "Smart shelves" with embedded tag readers have also been demonstrated, designed to allow retailers to identify out-of-stock conditions and locate misplaced items automatically. Wal-Mart recently announced that it will require its major suppliers to include RFID technology at the pallet level by January 2005. Building product retailers can expect to take part in any broader trend towards supply chain management and automated checkout built on RFID tags. Realizing efficiencies in this way will require significant coordination throughout the supply chain to ensure that items only need to be tagged once, tag readers can handle tags from multiple vendors, and the players share information. Information sharing is essential to achieving efficiencies across firms so that, for example, a supplier can track, aggregate and make plans based on inventory data for multiple customers.

Item-level tagging may ultimately find uses even beyond the end of the supply chain. One vision is the RFID-enabled refrigerator or kitchen cabinet that could evaluate items on hand and automatically generate the shopping list. Tags in clothing could be read automatically by the washing machine to determine proper settings. Tags in food packaging could be read to identify items with expired "freshness dates" or to set time and power level for the microwave. On the building site, individual products could be coded to indicate where in the house they are to be installed. For example, window properties could be optimized for each building wall (e.g., high solar heat gain for south-facing windows, low solar gain for east and west facing window) and the tag could specify where each window is to be installed. Kitchen cabinets could also be tagged for installation in specific positions. Ideally these tags would relate directly to the building plans. Complex structures that are prefabricated in many pieces for jobsite assembly could be similarly tagged. RFID chips with larger memories could potentially contain product installation instructions, material safety data sheets, warranty data, operating instructions or other information.

RFID is also finding uses in ID cards for tracking workers, including access control, timekeeping, and even location within a production facility. It can be used to mark equipment or other assets for loss prevention and control. These capabilities could be used in housing production facilities (modular or manufactured housing) as well as on commercial or other job sites where entry and exit is regulated. In automobile manufacturing, RFID tags of cars or car engines under assembly would document options and specifications for that particular unit and allow recording data along the line as an alternative to paperwork. An electronic "audit trail" documenting the manufacturing process could be created for each product. The same concept could apply in housing plants.

Ignition keys for new cars have used RFID technology for theft deterrence since the mid-1990's. The keys include transponder chips that broadcast an ID code when energized by magnetic coils in the steering column. Even if a new key is cut to fit the lock, it will not operate the vehicle until the on-board electronics is programmed to recognize the ID code broadcast by the new key. Entry locks for houses could use similar technology for enhanced security, or completely keyless entry systems could be used. This would require a power source (e.g., batteries) for the lockset. Prototypes have been produced and displayed by Dialock, a division of Häfele.

One very unusual prototype RFID application relevant to residential HVAC systems was described at a recent trade show. Timely replacement of HVAC filters, though often overlooked, improves system efficiency and prolongs equipment life. This particular application involved an active RFID system that used a sensor to monitor pressure drop across the HVAC filter, and an LED display to alert the occupant when it was time to replace the filter. It represents a simple, self-contained approach that separates the sensor and the display, and is appropriate for homes because it requires no network infrastructure. There is considerable interest in other applications that combine RFID chips and sensor technologies.

The best way to view RFID probably is as an enabling technology that enjoys broad potential application but faces challenges including cost, complexity, the need for security, and concerns about privacy. Although the "killer app" for RFID in homebuilding has yet to emerge, this is clearly an area where technology is expanding rapidly and creative new uses are emerging in unexpected areas. Its ultimate role in housing may simply reflect its applications in other sectors, or it may prove to be uniquely tailored to the industry.

Information Sources:

- RFIDJournal.com
- AIM, Inc: Radio Frequency Identification RFID: A basic primer
- Auto-ID Center: Technology Guide brochure
- Auto-ID Center: Research Paper Repository
- *InfoWorld*, RFID is About to Explode, January 31, 2003
- InformationWeek.com, David M. Ewalt, September 30, 2002

2. Relevant Work at Universities

Joint Center for Housing Studies The objective of the residential building materials distribution research is to understand the changes that are occurring or will occur in the businesses that stretch from the final customers of residential building products, through the web of distributors of products, and back to the manufacturers and material suppliers. A more complete project description can be found on page 14.

Massachusetts Institute of Technology The Integrated Supply Chain Management Program (ISCM) is a consortium of non-competing companies that was started in January 1995 by a group of faculty and staff from the Sloan School of Management and the Center for Transportation & Logistics, where the Program is currently managed. The purpose of the program is to accelerate the implementation of supply chain management principles within the sponsor companies, and to advance the state of the art of supply chain management. More information can be found at http://web.mit.edu/supplychain/index.html

Arizona State University Pervasive Production Space: An innovative information technology framework for home building

The overall goal of this research is to realize the vision of making appropriate information available anywhere, anytime in the homebuilding process through the use of innovative information technology tools. The project vision will be accomplished through the design and development of a Pervasive Production Space (PPS) that uses the emerging field of pervasive computing. This research will focus upon the development and identification of pervasive computing paradigms, methodologies, design tools and technologies to meet this vision for the US homebuilding industry. Initially the PPS will be tested for the building code compliance inspection process through

real-time sharing of information between a city department, pertinent trade contractors and the homebuilder. The project vision can ultimately apply to all phases of the homebuilding process including land development, house design, pre-construction, building construction, and postconstruction.

It is envisioned that the proposed PPS will utilize a multitude of networked computing devices including radio frequency identification (RFID) tags. The idea is to transport enterprise data the "last hundred feet" directly to the point of work. RFID tags turn everyday objects into network nodes that uplink IDs and status data to enterprise databases, storing new information as needed. They can provide the proposed PPS capabilities to automate common tasks in the homebuilding process such as tracking location, broadcasting identification information and recording the status of events (Pervasive Computing 2003). Current and future enabling technologies such as Wi-FI and WiMAX will provide wireless connectivity needed to connect devices in the production space. Once the PPS has been designed and developed tests will be conducted with the help of Pulte Homes, its trade contractors, and the City of Mesa.

While pervasive computing is being generally adapted to structured home and office environments, this research will expand fundamental underpinnings of such computing theory through its application in an "unstructured" production environment. The intellectual merit of the proposed research also relates to its confirmation of widely held, but insufficiently documented, hypotheses about the value of IT implementation in the residential construction industry. The broader impacts of the proposed research are dramatic. Housing is a basic human need. Current management methods have led to an increase in the cycle time for the construction of new housing units, and a concomitant increase in the cost. Researchers at Arizona State University estimate that some $90B in excess capital is tied up in the industry due to communications-induced cycle time waste. This capital could be put to other uses in the economy, and the impact on housing prices would increase affordability nationwide. The proposed data collection strategies will provide significant material for classroom instruction in residential construction, improving education methods via conduct of the research. ASU will make every effort to disseminate the results broadly; positive data vetted by industry partners could be a compelling tool to drive other builders to seek similar partnerships, which could in turn lead to wider partnerships. Revolving around the core research activity will be other important activities that will ensure integration of research and education, involvement of persons with diverse backgrounds and career aspirations, creation of an enabling infrastructure that will foster and sustain innovation in the long-term, and transformation of demand generated by diffusion of innovation into new businesses.

3. Status of the Voluntary Inter-industry Commerce Standards Association Initiative

The Voluntary Interindustry Commerce Standards Association (VICS) is an international organization working to establish cross-industry standards that increase supply-chain efficiency in the general merchandising retail industry. In the United States, VICS along with member organizations such as The Home Depot, The Black & Decker Corporation, Lowe's Companies, Inc., 3M and Ace Hardware Corporation have identified data synchronization as a priority for North America. A VICS North American Hardlines E-Collaborative Commerce Implementation Committee was put together to work on this issue.

The goal of VICS is to increase the efficiency of the Hardlines supply chain, through the implementation of an industry solution for data synchronization. The Hardlines E-Collaborative Commerce Committees (USA and Canada) are the unifying forces that bring together buyers and sellers on a North American basis to implement e-commerce solutions that improve consumer value in the overall Hardlines Supply Chain. " (VICS.org).

Data Synchronization is a collaborative initiative where manufacturers and resellers agree to employ a standardized set of data about their products (62 distinct pieces of information), including manufacturer, product and part numbers, and descriptions, cost information, etc. The VICS effort is based on coding such data according to EAN-UCC guidelines. The product information becomes part of the UUCnet Global Registry which delivers an open platform for a variety of commerce services and web based supply chain management tools. The registry, as of June 2003, contained over 40,000 products.

The first business sectors to commit to this effort were softer consumer goods, such as clothing manufactures and retailers, including department stores, and also grocery chains. They were concerned about inventory control – having the right goods and the correct amounts in the right places and at the right time. As they achieved those goals a new opportunity emerged for providing customers direct delivery services through telephone and web-commerce.

Product data was used for both efficient ordering and re-supply, but also to analyze sales and customers. Scanning and point-of-sale technology has provided businesses with important information about what gets bought, as well as when and where it gets bought. Web-based technologies are transforming the raw data into useful business analysis that covers price analysis, geographic and seasonal differences in sales of products, correcting inventories, as well as forecasting sales and replenishing stock.

Over the last year, 2002-2003, the building/lumber and hardware sectors have committed to the VICS initiative. In many ways this seems to dovetail with parallel efforts for interoperability in the architectural/construction sector that focus on design and logistics. Business analysts assure participants that the considerable effort and expense involved will have a quick return on investment through better efficiencies in product selection, logistics, and labor, and consequently less waste, better service, etc.

An outline of the process includes:

1. Synchronization of product data between manufacturers, wholesalers, and resellers on the UCCnet Global Registry. This is the first requirement in order to have data that can work throughout the supply chain.
2. Implementation of the technology and systems for inventory control, ordering procedures, RF tools for setting prices of products on the shelves, and POS. The data resides in a database that can be accessed by a variety of analysis tools.
3. The data can now be analyzed, using business tools, for effective *supply chain management*. Planners can understand sales; products can be ordered; pricing can be adjusted; logistics can be fine-tuned. One of the outcomes of this process is direct delivery from the manufacturer to the store aisles, eliminating warehousing.
4. The system in place also allows for another opportunity – Direct To Consumer services (D2C). This holds particular promise for the building sector if it can provide efficient delivery of large, complex orders of building supplies and satisfy the logistical requirements of construction plans.

Items 1 and 2 are prerequisites for accomplishing 3 and 4. Lowes, Home Depot, Ace Hardware, TruValue Hardware, Weyerheauser, and Georgia-Pacific are now in various stages of implementing step 2. Vendors of the

business/supply chain management, Customer Relationship Management (CRM/eCRM), and eCommerce tools are customizing them for the lumber and hardware sectors.

Additional information on building companies involved with the various supply chain initiatives is contained in Appendix A.

ASSESSMENT AND RECOMMENDATIONS FOR MOVING FORWARD

The reality of the PATH program and its cyclical funding together with the composition of the homebuilding industry with its many small players is counter to the nature of the task, developing a roadmap for information technology, which to be successful would require large amounts of funding, consensus, and flexibility. That said, there are many efforts currently underway which the homebuilding industry can clearly benefit from and positive steps and research projects which PATH can undertake. A brief write-up of the strategies and suggested activities which if completed in the near-term could be helpful follows.

The first strategy described in the Year One report is ***Develop a Common Language.*** The PATH program sponsored a project addressing the desire for a common language. The project description is shown below.

> ***During the second half of 2001 and all of 2002, the emphasis for PATH has been upon developing a standard for the lumber supply chain - from lumber producers, through lumber exchanges, and to builders, with the plan to include other vertical supply chains as the momentum builds. The standard has two important pieces. One is a definition of the attributes that describe the product - for example, nominal size (e.g. 2X4), actual size (e.g. 1-1/2" x 3-1/2"), length (e.g. 6 feet), type of lumber (e.g. fir) and so forth. The second important piece is an XML schema that describes the structure of the information comprising documents such as purchase order and invoice. By early CY 2003, a preliminary standard will be in place for the basic business documents in the lumber supply chain. A demonstration and evaluation pilot involving several stakeholders is being planned for the first half of CY 2003.***

This project was a worthy goal but illustrates the problem of trying to be a player in a fast moving industry sector. Follow-up indicates that interest in the project has declined significantly. One reason for the decline in interest is that large builders are now having the large lumber dealers not only supply the materials to the job site but also frame and sheath the houses. The big builders are lightening their administrative load by bundling services under single invoices. On-line invoices are common and not much more sophistication is needed. Converting to the xml system requires a pretty large upfront investment and the savings just are not there. Beazer and Centex participated in the project in the early stages but dropped out. Another suggested reason for the declining interest is that the distribution system for building materials is pretty mature and there is not much money to be saved by developing the xml-based standard. The main lesson learned is that projects need to be done quickly and with great flexibility, and that it is unlikely that PATH can undertake projects intended to drive a process in a given direction. Quick turn-around flexible projects tend to not be the type of projects government efforts like PATH fund. It seems more likely that PATH can contribute best by understanding industry needs in regards to technology and ensuring that these needs are heard and the interest represented.

Project: PATH should fund representation at the relevant standards bodies. The representative should be knowledgeable in both residential construction and in information technology.

The second strategy ***Streamlining the Regulatory Process*** suggests the need for information and communication technologies to address one of the most critical impediments to housing production: the regulatory approval process. While inroads in "streamlining" regulations have been made in many progressive cities (see box on San Jose effort on the following page), there are still two overwhelming barriers to be overcome. The first deals with the technology of processing permits, inspections, and code enactment electronically while maintaining the legal and ethical strength of building codes and code departments. The second hurdle is the reality of current building code department procedures, both in terms of their uncertainty in relinquishing authority for interpreting the codes, and because many do not have the resources to adequately streamline—though these are often the same jurisdictions that need streamlining most. The roadmap approaches the possibility of streamlining by documenting those jurisdictions that have made significant steps on their own, publicizing their work, and suggesting potential regulatory areas and tools for automation and standardization.

Online Permitting Pilot Underway in San Jose By Patrick L. O'Toole, Senior Editor

The idea makes so much sense that it is universally met with enthusiasm. Making the idea a reality, however, is a lot more complicated and has taken years of cooperative effort to launch.

That said, late last month the city of San Jose, the largest municipality in the fast-growing Silicon Valley began offering builders and contractors a way to apply for permits and to track their applications through various approval stages.

Called "Smart Permits," the program employs Internet technology to streamline and reduce costs in the building permitting process. When fully implemented, the program will allow computer-aided graphic design (CAD) files and specifications to be submitted electronically to the city, and for corrections or modifications to be submitted within hours, without requiring new printed plans. Anyone who has ever rushed blue prints to city hall sees the benefit. A key focus of the pilot is to implement complete online systems that handle everything form submission review, fee payment and inspection scheduling.

The e-permit web site operated by the city of Sunnyvale, California as part of an intergovernmental pilot project in the Silicon Valley.

At first simple permits -- reroof a building or replacing a furnace or water heater--will be available online. Gradually, by April of next year, San Jose will consolidate all development review activities into one comprehensive system accounting for 50,000 permits of all types per year, a release from the public/private partnership called Joint Venture: Silicon Valley Network said.

The City of San Jose is the biggest jurisdiction to get on board a three-year-old program stewarded by Joint Venture, but not the first. Pilot permitting projects are also underway in the Silicon Valley communities of Fremont, Milpitas, Mountain View, Palo Alto, San Carlos, Santa Clara and Sunnyvale. With the San Jose launch, the program is close to its goal of solidifying a core group of community-users in the region, says Randy Tsuda, the Smart Permit project manager.

"When online permitting in Silicon Valley reaches a critical mass, further incubation by Joint Venture will not be required," says Tsuda. Eventually, builders, developers and contractors will be able to fill out a universal online form for submittal to any of 10 Silicon Valley communities. The hard part was getting to this point. There were numerous committee meetings among government planners and information technology officials with each jurisdiction. The structure of existing permitting systems varied greatly from town to town and many ended up streamlining their permit processes to get with the Smart Permit program,

says Tsuda. Then there were long committee meetings before agreement could be reached on issues like technical formats, and what requisite amount of information is needed for each type of permit application.

In the end the intergovernmental online permitting system among Silicon Valley communities may serve as model for simplifying the approval process around the country. Ultimately it can remove many of the approval-related inefficiencies that have traditionally existed in the construction business -- a goal that is hoped for by San Jose Mayor Ron Gonzales. "Smart Permit systems will help businesses meet their critical schedules and let cities become more efficient."

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http://www.housingzone.com/topics/pb/build/pb00ca621.asp

PATH recently released the publication titled “Electronic Permitting Systems and How to Implement Them” prepared by the National Institute of Building Sciences to look at examples, such as the San Jose effort described above, in actual jurisdictions of different sizes to assess their success and function in implementing electronic permitting. This is a useful document and would provide a good base for a next step project to assess the costs and benefits as well as impediments. A second project that was recently funded will identify the innovative technologies and processes used by local governments processes currently in use by building departments as well as selected methods used in other industries that might be adapted for building department use.

A third effort is underway through the National Alliance for Building Regulatory Reform in the Digital Age, a public-private sector partnership comprised of 42 national organizations representing state and local government, the construction industry and several state governments and federal agencies. The Alliance was formed in July 2001 to enhance both public safety and the economic competitiveness in the global economy by developing and promoting streamlined model building regulatory practices that enable state and local governments to make effective use of information technology to enable our construction industry to "build faster, safer, better and at less cost."

Among the projects conducted by the Alliance is an effort by National Conference of States on Building Codes and Standards, FIATECH, the New York City Department of Buildings, and the National Institute of Standards and Technology (NIST), to speed the development of technologies and requirements needed to advance the creation of a state-of-the-art integrated interoperable building regulatory system. The project brings together a core work group of representatives from National Alliance partners to develop interoperability guidelines for use by New York City in its proposed procurement and in the Alliance’s existing model procurement guidelines. Interoperability allows independent hardware and software systems to work together by enabling data to be seamlessly passed from one application to another as well as the dynamic interaction of software components that complete common tasks or business functions. Interoperability makes it possible for various enterprises (government, owners and industry) to build bridges between disparate systems based on agreed upon standards and frameworks without extensive software development. Such a system also enhances the ability for jurisdictions and the private sector to rapidly share over secure networks critical information about buildings in response to manmade or natural disasters.

There is also a recently produced report that makes the economic case for streamlining. The report offers case studies of saving being achieved by state and local governments.

Project: PATH should fund an independent analysis of costs and benefits of implementing the electronic permitting systems. This study should include market research of local government staff and builders to solicit their views of advantages and problems. There are enough localities with implemented systems that such an assessment can now be conducted.

The third strategy ***Build a Non-Commerical Information Portal*** should be re-examined in light of the evolution in information available on the Web. The concept of portals as a place to go for information was widely held as useful in the late 1990's as the web was evolving into every day use. As search engines such as Google have become increasingly popular, the usefulness of portals has declined. It is the evolution of a more efficient system.

> *"Portals are best for general queries and varied information. But web users looking for more specialized answers are using search engines in increasing numbers and it would seem, with increasing success."*
> *Source: Toni Fitzgerald, Media Life Magazine*

It has proven to be very difficult and expensive to keep a portal with sufficient information to compete with information available through the search engines, and, in fact, in today's world probably unnecessary. The goal is having the necessary information available when and where you need it and an information portal (which at one time may have been a preferred approach) may no longer be the best approach.

Project: Evaluate the effectiveness of toolbase.org and pathnet.org in terms of providing information as a portal versus having all PATH publications available on line and searchable. The strategy might need to be redefined as information dissemination via the web rather than building a portal. This point was emphasized by the Industry Steering Committee in its meeting September 18, 2003.

The fourth strategy ***Create Production Management Systems from Concept to Closure*** is an area where PATH has contributed research and there are other major initiatives underway. For example, scanning activity uncovered work on mobile communications for site based construction Production Management Systems, substantial work is being undertaken on supply chain management, and the work performed at VA Tech is contributing significantly. Several efforts are underway to improve the supply chain including efforts at the Joint Center for Housing Studies as described below. However, other areas of the work identified in the earlier roadmap need to be refocused due largely to the significant changes that have occurred in the IT industry as it impacts home building. The discussion that follows describes some of the recent activity in the IT industry as a background for the suggested projects.

Joint Center for Housing Studies

Project Summary: Residential Supply Chain in Transition
(Draft: June 14, 2002)

The objective of the residential building materials distribution research is to understand the changes that are occurring or will occur in the businesses that stretch from the final customers of residential building products, through the web of distributors of products, and back to the manufacturers and material suppliers.

Although ideally, one would like to create a research design that would allow us to investigate all of these components simultaneously, we believe a more tractable approach is to start at the segment experiencing most systemic change. We believe that to be the firms involved in distribution of building products. This is not to imply that all change stems from this segment of supply channels.

However, the pressures in the residential construction industry toward improving efficiencies and reducing costs inevitably are felt by distributors. Particularly for distributors serving high production homebuilders, where large quantities of commodity products need to be

transported from production facility to the jobsite, and where they need to arrive at the site in a just-in-time manner, the distribution function is facing increasing demands from customer and supplier alike. Firms distributing building products to builders often are operating under a scale disadvantage relative to their suppliers and customers. But by focusing on this part of the channel in the first phase, it will allow us to better understand changing demands both "forward" and "backward."

The second phase of the project will look at the role of the customer in promoting change in the distribution process. The consolidation among production homebuilders in recent years, coupled with the industry consensus that consolidation in this segment will continue if not accelerate over the coming decade, indicates that distributors serving these customers will need to respond to their evolving needs, while continuing to serve the lower-volume homebuilder. Simultaneously, the remodeling contractor is a segment that will increasingly place demands on the distribution system. While still very fragmented, the $200 billion home improvement industry is steadily moving from a D-I-Y focus to one of installed sales and direct contracting with the professional remodeler for products and services.

The third phase of the study will look at the role of the manufacturer in the distribution process. Discussions with our advisory panel have confirmed that home building companies and residential contractors and subcontractors are increasingly looking for direct delivery and installation of products from manufacturers. Performing these distribution and installation functions requires manufacturers to develop new competencies.

Expanding the project to cover manufacturers, distributors, builders and remodelers necessitates focusing other aspects of the study. The research project will limit the product lines covered in the first wave of the study (encompassing the first three phases) to lumber and engineered wood products; building materials (including roofing, siding, wood panels, gypsum, and insulation); and millwork (moldings, windows, doors, and cabinetry). That works out to be most of the products included in NAICS code 4213 under wholesaling.

While the fourth strategy called for a review of the state-of-the-art and benchmarking of successful programs the *dot.com* bust which started in 2000 created a wave of transformations in the builder software industry. This shakeup and period of uncertainty has led to concern throughout the industry about the viability of companies. Many builders had "bought in" to the IT promise and invested in software by companies such as BuildNet and then complained that they were so dependent on BuildNet technology that they were forced to hand write checks after the bankruptcy declaration. Having been burned once will make companies more cautious in the next purchase, or foray into the IT marketplace. BuildTopia founder and CEO, Stephen Porten, is quoted by Builder magazine as cautioning, "The challenge is to know what is happening in the back-office market to better guess which systems will survive before spending time, money and effort to ensure your system can communicate with theirs."

With this background the following projects are recommended:

Project: Assess the financial implications for adoption of IT-based approaches by homebuilders and industry players. This assessment should examine IT solutions, not just for large production builders, but also for small and medium sized builders and specialty trade contractors who are much slower to adopt computerized systems for managing various aspects of their businesses.

Project: Document cases where builders have tied elements of their production process to the software management of their key suppliers and benchmark successful software collaborations between builders and their key trade contractors.

Project: To address the strategy of IT in the Management of Change Orders, the survey as suggested by the TRWG (see discussion p.4 and draft survey in Appendix B) really needs to be undertaken as a first step before logical projects can be defined.

The Year One Information Technology Progress Report defines pre-construction as the series of steps leading up to breaking ground for construction of a new home. It describes each of the steps involved from land acquisition through zoning and planning leading to approval to proceed. The process of pre-construction planning can take

several years if it moves smoothly and longer if delayed by regulatory issues. Pre-construction also includes the design of the house.

The Year One Progress Report stated that there is uncertainty about the extent to which developers rely on computer software to lay out subdivisions, estimate development costs, develop schedules, or track work in progress. The IT Roadmapping group suggested that there are large opportunities to use information technology in the land development process, particularly with respect to global positioning systems (GPS) and computerized topographical mapping data to generate maps, evaluate environmental factors related to development, and optimize solutions.

The following steps were proposed in the report:

1) Define a generic subdivision process, including all of the parties involved, and review current software tools for land developers
2) Implement key steps of the process using existing software tools as a starting point
3) Demonstrate application of the system and evaluate its accuracy and utility compared to existing approaches. Study the ease or complexity of use of the system and the accuracy of its outputs. Assess in quantitative terms the potential for improved efficiency and any drawbacks to this approach.
4) Refine the system based on what is learned through the demonstration process and make the system available on a larger scale.

Status Update

A review of the software offerings of major vendors suggests that land developers are well served across a wide range of specialty areas relating to land development. The software falls into three distinct categories: 1) financial analysis software designed to assist land developers in evaluating a property for its return on investment and net present value, 2) software for the civil engineering and landscaping professions, and 3) computer aided building design software.

Financial analysis software allows a user to quickly analyze the profit potential of any land parcel appropriate for residential development. The software works by entering data on the prices of land, the cost to develop it, the effect of time on unit sales profit. With these inputs, the software generates monthly and annual Pro Forma income statements. It measures the worth of an investment in terms of rates of return and net present value. A financial analysis tool like this is only as accurate as it is precise in defining the assumptions upon which the analysis is based. Unforeseen delays in obtaining clear title to land or in meeting regulatory requirements could significantly affect financial returns. Some of these software programs include sensitivity analysis to show the effect on these measures should one of the assumptions change. Risk analysis allows the user to investigate how these measures vary with a change in one of the assumptions.

Two of the vendors offering financial analysis software for land developers are Land Value Analysis and PlanEASe.

There are extensive offerings to support the technical side of land development. Two of the major vendors are Eagle Point and Autodesk. The software provided by these two organizations supports such activities as surveying, mapping and infrastructure management, civil engineering design and analysis, land planning, GIS and

digital design data management, online collaboration and project management services, and transportation and infrastructure analysis and design.

One of the principal areas where IT tools are used in land development today is in property acquisition. Developers hire professional services firms who conduct due diligence assessments of land prior to acquisition. They conduct environmental assessments, soils analysis, investigate for pre-existing structures or easements – all factors that could impact the viability of a land development project. GIS analysis is commonly conducted by accessing known databases. This information is critical to making a go/no-go decision.

A second area where service providers assist developers is in the permitting process. Most permitting offices now post their forms online but do not provide them in a format that can be filled out and submitted electronically. Some companies reproduce these forms in an electronic format to facilitate decision making on any given parcel. As mentioned previously, there are many technical analyses that are required prior to investing in land. IT software is becoming critical also to the approval process because it enables the developer to analyze complex factors relating to various parcels. Financial management software depends on accurate assumptions in order to produce realistic assessments of return on investment and net present value. Technical consultants can now produce dozens of layers of mapping on any given site that expose each of the assumptions critical to investment decision making and the approval process. These include: location of pre-exiting easements, location of pre-existing structures, soils analysis, vegetation indices, location of springs and other site water characteristics, including the presence of designated wetlands, contaminants analysis, and topography, to name a few.

Resolution compliance is a growing area of concern. Companies now provide support not only to the approvals process but collect and analyze data for regulatory compliance as much as 10 years after a project is approved.

The use of computers in the home design process has increased in recent years. Approximately eight to ten vendors of computer aided design (CAD) software programs sell to architects, building designers, builders, and remodelers. The programs have improved in their ability to conceptualize in three dimensions a project under design. This enables a builder to use the output for presentations to potential customers. Until now, most architects would go through the creative process of designing a house and then hand the plans over to a technician to turn it into an electronic drawing. The CAD technician tends not to be an architect and does not know too much about construction. The electronic version of the plans produced by the CAD technician offers a more efficient manner of preparing the plans for approval and making any necessary revisions under the supervision of an architect.

In addition to the 3D aspect of CAD software, more and more attention is being paid to building information modeling (BIM). The idea is that one designs with customizable building objects like windows, walls, and doors instead of drawing lines and boxes. Some of the programs allow the creation of a bill of materials, while others are starting to offer project management in what the industry calls “4D.”

With all of the upgrades that make CAD programs more user friendly and powerful, it is estimated by industry professionals that only ten percent of builders use CAD as a tool for designing their homes and producing plans. Between forty and fifty percent of builders use CAD in some capacity. Many outsource the design process and typically receive an electronic version of the plan. Often the builder will have a CAD technician in-house to make necessary plan changes and prepare final plans for submission.

Builders generally have not invested in CAD programs because they do not find economic advantage yet in doing so. Using CAD is a time-intensive process and it requires programming to make the bill of materials application work properly. Until now, the programs were not user friendly enough to allow builders to work with the program or powerful enough to produce updates quickly. CAD works in other industry settings where the data on parts and pieces used in the manufacturing need to be maintained for easy access when repair or replacement is needed. Imagine an escalator in a shopping mall, for example. The CAD program can pull up details relating to the broken part and where it can be obtained for replacement. Builders typically don't maintain this type of data on their houses after sales and leave warranty repairs and future service calls to contractors in the community. If builders would find that they are keeping longer term relationships with their customers and the homes they build, CAD would service and important tool for tracking information on the materials and products in each of their houses.

Participants in the December TRWG meeting suggested that a survey of state and local governments to assess their capabilities in regards to land planning IT would be helpful to the industry.

Outstanding Issues

Software to support the land development industry is more pervasive than ever before. Yet, there are some major issues that need to be addressed. These are listed below:

1) Technical consultants make large investments in software but the software becomes obsolete even while it is still functional. New software applications often drive users to invest in expensive hardware upgrades.
2) Training investments are enormous, yet many software programs are not compatible across platforms. Many engineering programs, for example, do not work very well on Microsoft Windows platforms.
3) Information technology does not speed up the initial process of analysis and design. It does save a large amount of time, however, in the revision process.
4) Consolidation in the software industry leads to greater compatibility in "suites" of programs, but there are applications that are cast off in the mergers process that do not tie in as well as before.
5) Many firms do not have the capability to integrate various software packages into a coherent business offering, yet their clients expect it and are unwilling to pay extra for this integration.
6) Information technology offers the ability to help improve communications between developers, builders, and regulatory officials, yet there are gaps that create inefficiencies.
7) Historic project data must be re-keyed using current software in order to be accessible in a format that allows analyses between projects. This is time intensive and raises concerns about compatibility with future software releases.
8) Some of the software technologies used by technical professionals today could be used directly by builders and developers, but they are pretty low on the learning curve and do not have the confidence to make these investments in software and training.
9) Many databases that could support technical analysis for land development are not very accessible or are too expensive to access.
10) Software for home design has not been very user friendly for builder audiences and is not a useful creative tool for architectural audiences.
11) CAD software does not tie in to other construction business management software very easily.

Given these outstanding issues, the following projects would be useful:

Project: Evaluate the utility of software tools for the land development process, particularly in small to medium sized operations, and identify technology gaps in available software.

Project: Identify large government databases that could provide utility to the development community and make it accessible in GIS software applications.

Project: Document the impact on construction cycle time of computer aided design software for plan development, revisions, permitting, issuing a bill of materials for small to medium sized builders and their trade contractors. This should also include an evaluation of how well the technology connects into builder software tools for estimating, scheduling, and project management and whether it ties into builders accounting programs and their sales and marketing function.

Appendix A.

Building Sector Companies involved with Supply Chain Initiatives

Company	Contact	System Vendor
ACE Hardware	Greg Lenard Lynda Moriarity	Microstrategy EagleVision POS System; Terradata data warehouse; JDH Software Group Portfolio 2003.5 (collaborative planning and inventory replacement system with hosted accounting applications, RF inventory control, POS data collection and management)
Black & Decker	Ed Sofia Bruce Twery	Collaborating with Home Depot.
Georgia-Pacific Corp	Terrell Ivey Charlotte Wood, 404-652-3709 re Builder Connection	On-line transportation exchange service; Builder Connection, a supply chain tool for managing delivery of over 28,000 products to over 50,000 customer locations.
Home Depot	Mark Healey	Terradata data warehouse; Mobile Ordering technology for item replenishment
TruServ Corp.		Business Objects SA; Data warehouse

Software/Hardware Vendors of Supply Chain Systems

Company	System
JD Edwards & Co.	Supply Chain Management 9.0
JDH Software Group	Portfolio 2003.5 (collaborative planning and inventory replacement system)
Retek, Inc.	Java based POS systems and tools for product replacement planning
SAP	Staffware- labor management
NCR Corp.	Electronic/RF shelf labeling and price optimization tools
Cognos	GERS merchandising system including sales and inventory reports, sales trends, inventory management, gross profit margin calculator
Hyperion Solutions Corp.	Essbase

VICS Hardlines Steering Committee – (Members with Construction/Building Sector)

ACE Hardware	Greg Lenard Lynda Moriarity
Black & Decker	Ed Sofia
Georgia-Pacific Corp	Terrell Ivey
Home Depot	Mark Healey
3M	Peggy Spofford
Weyerhaeuser	Carolee Zinzow

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Home Depot	Ed Seemann	2455 Paces Ferry Rd NW Atlanta GA 30339-4024	770-384-5698 770-384-3063	ed_seemann@homedepot.com
Lowe's Companies, Inc	Greg Forester	PO Box 1111 N. Wilkesboro, NC 28656	336-658-4944 336-658-5995	Greg.L.Forester@Lowes.Com

APPENDIX B

INFORMATION TECHNOLOGY SURVEY

- Builder information
  - _____ SFD homes/year
  - _____ SFA homes/year
  - _____ MF homes/year
  - _____ # of employees
  - _____ Principal market area of firm or division

- What software package does your firm use for house design (e.g. AutoCAD)?

- What software package does your firm use to do material estimation and take-offs?

- What software package does your firm use to generate construction schedules and track progress?

- What basic business accounting software package does your firm use to track payables, receivables, etc.?

- Does your firm use special on-line tools for purchaser/customer relations (e.g. web site with options, construction progress tracking)?

- Does your firm offer a third-party "collaboration"-type web site to facilitate coordination of your subcontractors and suppliers?

- How do you typically submit applications for building permits?
  - ____ by fax
  - ____ by electronic submission
  - ____ in person at the permit office

- Do you submit any purchase orders electronically?

- Do you pay any bills electronically?

NAME:

COMPANY:

EMAIL ADDRESS: