

**Review of
National and International
Housing Technology Research**

**A Report from the
US Department of Housing & Urban Development**

**Prepared
Virginia Polytechnic Institute and State University
Center for Housing Research**

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Summary

This project represents the first stage of an effort to map and understand and utilize at the national level both national and international research in Housing Technology. The purpose of the total initiative is to determine how this research can be facilitated and organized to best serve the clear national interest in improving housing stock and delivering on the PATH goals. The total initiative includes three parts: 1. Identify technologies that may be of substantial use for the US affordable housing market and/or federal technology initiatives like the Partnership for Advancing Technology in Housing (PATH); 2. Critically assess foreign housing technology research agendas and strategies to gauge their applicability to HUD initiatives; and 3. Create institutional links between major national and international housing technology researchers that may result in further collaboration and discussion. This project represents begins part one of the initiative.

The project began with an effort to identify national and international research programs. In this identification stage attempts were made to determine: the types of technologies under research; the source of research funds; institutional setting and history; the relationships with local/national home building industry; the research strategy, approach, and directions; relevance to US housing technology research (HUD) or US home building industry. In relation to the international research programs it was found that different nations have varying methods for institutionalizing research efforts (i.e., academic vs. industrial vs. governmental).

Following the identification stage the technologies under research grouped into categories and a matrix was prepared mapping technologies under research into the PATH research categories. Attempts were then made to establish contact with organizations undertaking relevant research. A survey instrument was prepared that attempted to establish more detail about the projects, source of funds, management structure and future research directions. The survey was delivered to potential respondents by email (with a link to a web based survey) and by normal mail.

Response to the survey was disappointing. Possible reasons for this include the diffuse nature of housing technology research in many of the organizations. Even in organizations that claimed to have research in housing technology it was difficult to locate those programs. For example, it is often difficult to locate the person in an organization that knows enough about technology research to be able to answer the survey in an informed manner. The problems encountered in the survey are symptomatic of housing technology research generally. In fact there appears to be a tendency for people to claim research areas by declaring they have projects underway in those areas when in fact the amount of actual research going on is minimal. This behavior is not unusual in under-funded research areas. There are no clear academic forums that provide clear lines of communications to involved researchers. These coordination and communication issues need to be addressed in the future if a comprehensive national approach to housing technology is going to be undertaken.

Despite this disappointing survey response, a large amount of information was collected. Some 195 organizations claiming research in housing technology were identified. The information gathered on these organizations is classified by country, by type of organization, by research area and by project details within research areas. This information will serve not only as a starting point for further linkages across borders, but will also demonstrate the tremendous need there is develop a thriving international research community in the future.

1. Project Background

The US housing industry is famously unique in many regards. Extensive financial safeguards and investment opportunities secure a high volume of production and rehabilitation. Numerous local initiatives and policies link housing to broader community and regional development. Amazingly efficient processes for identifying demand have filled virtually all market sectors and approached demand in all regions of the country. All of these movements have secured a place for the home in American economic progress and the national cultural imaginary.

Not surprisingly, this is reflected in the structure of the average American home. Efforts to engender a nation of homeowners have led to the preponderance of single-family detached houses. Correspondingly, dramatic changes in multifamily and single-family attached homes have occurred abroad. These parallel changes would suggest that there might be opportunities for exploring residential technologies across borders in specific materials and methods that are similar, and in developing markets for techniques that differ.

The purpose of this project, then, was not uncover the barriers to technology transfer or develop mechanism for it, but to simply identify the primary developments and participants in housing technology research globally. Historically, little cross-pollination has transpired between the United States and abroad in this area and, as such, identification of foreign researchers and industry players is critical.

Through the Affordable Housing Research and Technology Division's efforts (and the PATH initiative in particular), HUD has been extensively involved in pushing the limits of housing technology research. Many of the broader advances in residential construction growth in the past few years, in fact, can be attributed to technological developments such as those that HUD has supported. Despite these efforts, however, a significant amount of work remains to be done on housing technology in the United States as a whole.

Development efforts in residential technology have lagged in this country in comparison to other nations due in large part to a lack of shared vision among researchers. The paucity of university-based research in this field is matched only by the traditional lack of governmental resources for this kind of research. Those programs that do exist maintain few institutional contacts with each other besides the occasional funding requests, and are often tailored to only meet their local context. This results in both a fragmentation in research efforts and a lack of dissemination for actual research results.

When one considers the volume of housing technology research that is being done abroad, the disparities are even more apparent. National efforts in Western Europe and Japan are jointly supported by government, academia, and industry in ways that enforce a unified vision for research and compatible strategies for research execution. The technologies that have been developed from this research have similarly been put to use in ways that support extensive housing development needs. US attempts to construct a vision for housing technology research would do well by learning from these approaches, as much as attempts to advance domestic housing technology would do well by studying the resulting technologies. HUD, in particular, would be well served by an assessment of current housing technology research programs and housing technology research results.

This project attempts to begin to bridge both the disparate research programs in housing technologies across the United States and in foreign nations, and assesses the applicability of both their strategies and actual technologies for US housing research and the US housing industry, respectively. In addition to reviewing the research efforts and research work, the project seeks to establish institutional links between these programs in ways that support future research endeavors and HUD-related research activities in the future. The project's underlying objective, is to expand the knowledge base of US housing technology research (and HUD's research, in particular) in both content and approach.

To those ends, the project identifies research programs and pervasive technologies, critically review them, and contact programs whose technologies have significant potential application for US housing, or whose strategy has significant potential application for the US housing research. This research begins to identify international housing technologies and technological research work for incorporation into HUD's programs. This project only lays out a review and program summary of international efforts.

The United States Department of Housing and Urban Development contracted with the Virginia Tech Center for Housing Research to develop a compendium of research in national and international housing technology research programs. The project identifies organizations, research initiatives and construction technologies. A database was developed that includes information on funding, staffing, resources, and projects for each organization. Results are presented by institution, by country, and by research area.

1.1 Methodology

The research for this project incorporated various levels and resources. The NAHB Research Center publication entitled Domestic and International Housing Research was the foundation of the research for institutions involved in international residential construction research. From this paper, several countries were identified as having active research programs. The project began in September by reviewing Internet web-sites of foreign governmental agencies for housing or construction research. From this level, the researchers targeted institutions that were partners of the governmental agencies. These groups included national research institutions, university research departments, and research divisions of private companies.

Initially, the information collected was stored in hardcopy form. During the course of the project, a database was developed to manage the data. In conjunction with the data collection, the researchers developed a survey instrument based on the information HUD wanted to collect. This instrument was made available on the internet as well as in hard copy. After collecting preliminary information on research institutions and their research areas, researchers sent out the survey to the identified institutions. The survey asked for detailed organizational information including staff numbers, budget, and resource allocation. It also asked for detailed project information.

The response to this survey was disappointing. Possible reasons for this include the diffuse nature of housing technology research in many of the organizations and the lack of clear research programs in housing technology. For example, it is often difficult to locate the person in an organization who knows enough about technology research to be able to answer the survey in an informed manner. The problems encountered in the survey are symptomatic of housing technology research generally. There are no clear academic forums that provide clear lines of communications to involved

researchers. The diversity in housing technology research organizations and their location within larger umbrella organizations mean that the survey often reaches the wrong person or someone who has no interest in housing technology or technology research. These coordination and communication issues need to be addressed in the future if a comprehensive national approach to housing technology is going to be undertaken.

With the responses, the researchers developed this report relating information on the institutions and their research in residential construction technologies and on the connections to HUD's research agenda.

1.2 Research Areas

The report structure follows the research areas listed in the survey. In some cases, the scope of a project went beyond one research area. In those cases, the project was listed in the relevant areas. A brief description of the research areas follows:

- **Acoustics**: The ability of the housing unit to insulate its occupants from external noise pollution, or the ability to diminish noises within the house.
- **Doors/Windows**: Research on the efficiency and reliability of doors and windows, and on the reduction of cost and installation time.
- **Energy Conservation**: Projects seek to reduce energy consumption in the materials used as well as the finished structure.
- **Envelope**: External structure of the home, particularly walls. Does not include doors, windows, or roof.
- **Environmentally Friendly Design**: Designs that minimize detrimental effects to the environment. Such designs may incorporate recycled materials.
- **Fire Safety**: Includes research on making materials fire-resistant and research on managing fires within homes along with life safety.
- **Foundation**: Focuses on understanding the failure mechanism for building supports. These systems while relatively simple can lead to major headaches after failure.
- **Information Technology**: IT is the study of managing the information critical to the industry. New efforts work to increase data transfer rate and usability.
- **Manufactured/Pre-Fabricated/Factory Built**: Homes that are entirely or in part constructed away from the job site and later installed. Most structures are mass-produced but with some ability for variation.
- **Materials**: Covers materials used for residential building including cement, steel, wood, plastics, and alternative technologies.
- **Mechanical/Electrical/Plumbing Systems**: Research in these areas includes improvements to existing systems as well as fundamentally new approaches to solving old problems.
- **Production Modeling**: Research that looks at the processes involved with construction in an attempt to streamline their efficiency.
- **Roofing**: Work in this area is focused on the roofing membrane. Improvements to durability and installation have been realized by adopting new technologies.
- **Structure**: The skeleton of the housing unit. New structural systems for new times reflect the changing state of technology.

- **Universal/Flexible Design:** These design concepts stretch the useful life of building shells by allowing new occupants to tailor the space. Designs may be adapted to accommodate handicapped inhabitants or may be easily modified to accommodate the elderly as well as the young.
- **Other:** Categories of research not previously mentioned but reflect agendas of particular organizations.

1.3 Matrix

In order to bridge the differences between HUD's research categories and the research areas of this project, a matrix was devised to show overlapping research interests and to delineate distinct research areas.

The HUD research categories were derived from the website of PATH technologies. The ten categories, listed horizontally, range from "Framing, Panels, and 'Whole House' Systems" to "Sitework and Landscaping." On the vertical edge are the categories as listed on this project's survey instrument. The fifteen areas range from "Manufactured/Pre-Fabricated/Factory Built" to "Fire Safety."

The overlap of research areas is indicated by the marked cells in the matrix. The benefit of this matrix is that suggests common research themes between groups who may not have previously collaborated. There are international organizations which conduct research on building materials. By using this matrix, one may determine that HUD does similar research under the "Construction Methods, Equipment, and Management" category.

Matrix of Research Categories

Used to compare survey categories against HUD technology categories

Survey Categories	HUD Categories									
	Framing Panels, and "Whole House" Systems	Construction Methods, Equipment, and Management	Structure and Foundations	Manufactured Homes	Doors, Windows and Interior Work	Mechanical and Electrical Systems	Plumbing	Roofs	Appliances and Decorative Work	Sitework and Landscaping
Manufactured / Pre-Fabricated / Factory Built	X	X		X						
Production Modeling	X	X		X						
Universal Design or Flexible Design	X				X					
Envelope	X		X							
Materials		X							X	
Mechanical / Electrical / Plumbing Systems					X	X				
Information Technology		X								
Structure			X							
Foundation			X							
Roofing								X		
Door/ Windows					X					
Environmentally Friendly Design										
Energy Conservation										
Acoustics										
Fire Safety										

2. Contacting Research Institutions

This section compiles information from the initial stages of the research, particularly what institutions currently funded or supported technological research for housing construction.

2.1 Research Institutions Identified

The project identified 195 institutions conducting research on housing technology throughout the world. A country-by-country list of these institutions is included in Appendix I, Research Institutions by Country.

2.2 Research Instrument

After identifying the institutions named in Appendix I, the researchers sent out surveys by post and by e-mail. The purpose of the survey was to collect data from organizations about their background and history, staffing, and funding. Organizations were asked to include a descriptive statement of their purpose or mission. This is a general statement about the organization and its operations.

The type of organizational structure is provided next. The choices for organization structure were divided into three groupings: Governmental, Private, and Academic.

Governmental organizations include R & D department of government agency, Free-standing research bureaus, and Multi-national research groups.

Private organizations include Trade or Industry Associations, R & D Departments of Manufacturers, and Independent Research Labs.

Academic or University organizations include Research Institute or Centers, Academic Faculty, Colleges or Departments.

The next section of the survey presents data collected on the staffing resources of each organization. Organizations were asked to provide the number of personnel in each of the following groups.

Lead or principle researchers or investigators

Professional researchers with technical expertise in construction, engineering, architecture or similar fields

Managers (administrators with no technical responsibilities)

Students/Trainees/Apprentices

Office/Support Staff

Others include groups of personnel who contribute significantly to the success of an organization.

Funding and Budget information make up the next section of appendix I. Here organizations were asked to provide information regarding their budget and sources of income. Income sources are noted by percent of contribution to the total budget. These include:

Internal Allocation

Industry

Foundations

Government

Universities

Sales

Fees for Non-research servicesOther Sources

Some organizations also provide funding for other groups. Those that do were asked to report on funding and allocation. Possible beneficiaries include: Government Research Bureaus, Universities, Private Research Organizations, and Trade or Professional Associations.

To view the complete survey, please refer to Appendix II.

3. Results of Inquiry

The organizations from which detailed information was collected are listed in Appendix III. Appendix III also categorizes the organizations by type. Detailed information on projects for many institutions can be found in Appendix IV, which provides an alphabetical list of the institutions and their research projects. Appendix V gives a list of institutions by research area.

Appendix I - Research Institutions by Country

Organization	Country
University of Buenos Aires	Argentina
Australian Cooperative Research Centre For Renewable Energy Ltd	Australia
Australian Housing and Urban Research Institute	Australia
Australian National University:	Australia
Australian Research Centers	Australia
Construction Research Alliance (CSIRO & Queensland University of Technology)	Australia
Commonwealth Scientific and Independent Research Organisation (CSIRO)	Australia
Multi-Residential Timber Framed Construction (MRTFC)	Australia
Queensland University of Technology	Australia
Queensland University of Technology	Australia
The Australian Centre for Construction Innovation, UNSW	Australia
University of Canberra:	Australia
University of New South Wales:	Australia
University of South Australia School of Geoinformatics, Planning, and Building	Australia
University of Sydney:	Australia
University of Western Sydney	Australia
Farmers Helping Farmers--Austria	Austria
Research, Design and Technological Institute of Building Industry (NIPTIS)	Belarussia
BBRI - Belgian Building Research Institute	Belgium
Centre Scientifique et Technique de la Construction CSTC	Belgium
Building Centre International	Brazil
Catholic University of Parana	Brazil
Programa de Tecnologia de Habitacao	Brazil
Universidade Federal de Santa Catarina	Brazil
Universidade Federal do Rio Grande do Sul	Brazil
University of Architecture, Civil Engineering, & Geodesy	Bulgaria
ATHENA Sustainable Materials Institute	Canada
Building Envelope Council Ottawa Region (BECOR),	Canada
Canada Institute for Scientific and Technical Information	Canada
Canada Mortgage and Housing Corporation	Canada
Canadian Office of Energy Research and Development	Canada
Centre for Building Studies	Canada
Centres of Technology Development Engineered Air Centre	Canada
Construction Technology Centre Atlantic (CTCA) University of New Brunswick	Canada
Industrial Materials Institute NRCAN	Canada
Industrial Research Assistance Program (IRAP).	Canada
Institute for Research in Construction (IRC)	Canada
Integrated Manufacturing Technologies Institute (IMTI)	Canada

Organization	Country
McGill University Department of Civil Engineering and Applied Mechanics	Canada
McGill University School of Architecture	Canada
Memorial University of Newfoundland Faculty of Engineering and Applied Science/Civil Engineering	Canada
NRCan Buildings Group	Canada
NRCan Office of Energy Efficiency	Canada
Public Works and Government Services Canada (PWGSC).	Canada
Queen's University Structural Engineering	Canada
School of Architecture of the Université de Montréal	Canada
Southern Alberta Institute of Technology	Canada
University of Calgary Faculty of Environmental Design	Canada
University of Toronto	Canada
University of Toronto Department of Civil Engineering	Canada
University of Victoria	Canada
University of Waterloo	Canada
University of Waterloo Building Engineering Group	Canada
University of Waterloo Department of Civil Engineering	Canada
University of Western Ontario The Centre for Studies in Construction	Canada
Chilean Construction Chamber	Chile
Universidad de Valparaiso	Chile
China Building Technology Development Centre (CBTDC)	China
China Construction Information	China
China Ministry of Construction	China
Chinese National Engineering Research Centers	China
City University of Hong Kong	China
Hong Kong Housing Authority	China
Hong Kong Polytechnic University	China
Tongji University	China
Centre for Building Information Byggecentrum	Denmark
Danish Building and Urban Research	Denmark
RISOE National Laboratory	Denmark
Solar Energy Centre Denmark	Denmark
European Optical Society	Europe
VT/Technical Research Centre of Finland	Finland
CSTB - Centre Scientifique et Technique du Bâtiment	France
European France	France
Langudoc-Roussillon School of Architecture	France
PUCA	France
SCAU--French City Planning and Construction Company	France
Federal Ministry of Education & Research	Germany
Fraunhofer-Gessellschaft	Germany
Institut für Bauforschung der RWTH Aachen Institute of Construction Research Aachen University of Technology (RWTH Aachen)	Germany
Institute of Applied Technologies in Wood Construction--Germany	Germany
Technische Universität München	Germany

Organization	Country
Auroville Building Centre (AVBC)	India
Auroville Centre for Scientific Research (CSR)	India
Indian Institute of Technology--Bombay	India
Enterprise Ireland	Ireland
Building Center of Japan Foundation (BCJ)	Japan
Building Research Institute—Japan	Japan
Daiwa House Industry Co. LTD.	Japan
Japan Ministry of Construction	Japan
Osaka City University	Japan
Sekisui House LTD.	Japan
Tokyo Institute of Technology	Japan
Tokyo Institute of Technology Center for Materials Design	Japan
Metropolitan University of Mexico	Mexico
Mexican Department for Housing (SEDESOL)	Mexico
Conseil International du Bâtiment CIB	Multi-National
European Network for Housing Research	Multi-National
European Network of Building Research Institutes ENBRI	Multi-National
European Organisation for Technical Approval EOTA	Multi-National
International Council for Building (CIB)	Multi-National
International Society for Optical Engineering (SPIE)	Multi-National
Nordic Building Research Cooperation (NBS)	Multi-National
Union Européenne d'Agrément technique dans la construction, (UEATC)	Multi-National
United Nations Centre for Human Settlements (Habitat)	Multi-National
ARPA IntraBouw	Netherlands
TNO-TUE Centre for Building Research University of Technology Eindhoven	Netherlands
TNO Building and Construction Research	Netherlands
VROM	Netherlands
Norwegian Building Research Institute	Norway
Oslo School of Architecture	Norway
Ion Mincu University of Architecture and Urbanism	Romania
Technical University of Civil Engineering of Bucharest	Romania
University of Architecture & Urbanism	Romania
Building and Construction Authority—Singapore	Singapore
Centre for Total Building Performance	Singapore
Swedish Council for Building Research Formas, The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning	Sweden
Switzerland Federal School of Technology	Switzerland
Asian Institute of Technology: School of Civil Engineering	Thailand
British Research Institute	United Kingdom
Building Research Establishment (BRE)	United Kingdom
Construction Industry Research and Information Association (CIRIA)	United Kingdom
DIVERCITY	United Kingdom
Imperial College of Science Technology and Medicine, London	United Kingdom
Science Policy Research Unit at Sussex University (SPRU)	United Kingdom
SMART Thinking Socio-Medical Assistive technological Research for Today	United Kingdom

Organization	Country
South Bank University, Faculty of the Built Environment	United Kingdom
The Housing Forum	United Kingdom
The Virtual Reality Centre at the University of Teesside	United Kingdom
UK Department of Transport, Local Governments, and Regions	United Kingdom
University College London	United Kingdom
University of Salford	United Kingdom
University of Sussex-Building Construction Management	United Kingdom
Walter Segal Self-Build Trust	United Kingdom
Advanced Building Technology and Practices	United States
Alternative Fuels Data Center	United States
American Council for an Energy Efficient Economy (ACEEE)	United States
American Hydrogen Association	United States
American Lung Association of Minnesota's	United States
American Society for Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)	United States
American Solar Energy Society	United States
Architecture Research and Demonstration Facility Virginia Tech	United States
ARGOS Building Design and Information Management Systems	United States
Arizona State University College of Engineering and Applied Sciences	United States
Arizona State University Del E. Webb School of Construction	United States
Association of State Energy Research and Technology Transfer Institutions	United States
Ball State University-Housing Futures Institute	United States
California Energy Commission (CEC)	United States
CEC Energy Efficiency & Demand Analysis Division	United States
Center for Applied Research and Technology Development Natural Resources Research Institute University of Minnesota Duluth	United States
Center for Energy Efficiency and Renewable Energy	United States
Center for Hemispheric Cooperation	United States
Center for Integrated Systems in Housing	United States
Center for Sustainable Building Research University of Minnesota	United States
Center for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET)	United States
City Design Center	United States
Civil Engineering Research Foundation	United States
Colorado State University	United States
Colorado State University Solar Energy Applications Laboratory	United States
Cornell University-Design and Environmental Analysis	United States
Experimental Program to Stimulate Competitive Research	United States
Experimental Program to Stimulate Competitive Research Center for Composite Materials and Structures--S.S. Sternstein-Renselaer Polytechnic Institute	United States
Fannie Mae/Cold Climate Housing Research Center	United States
Florida Solar Energy Center (FSEC)	United States
Gas Research Institute	United States
Geothermal Heat Pump Consortium	United States

Organization	Country
Iowa Energy Center	United States
Lawrence Berkeley National Laboratory (LBNL)	United States
LBNL Building Technologies Program	United States
LBNL Energy and Environment Division	United States
Lighting Research Center	United States
Massachusetts Institute of Technology	United States
Michigan State University, Housing Education and Research Center	United States
National Association of Home Builders Research Center	United States
National Association of Real Estate Editors (NAREE)	United States
National Institute of Standards & Technology/ Building & Fire Research Laboratory	United States
National Renewable Energy Laboratory (NREL)	United States
New York State Energy Research & Development Authority (NYSERDA)	United States
Oak Ridge National Laboratory (ORNL)	United States
Oak Ridge National Laboratory, Energy Division, Buildings Technology Center	United States
Pacific Northwest National Laboratory (PNNL)	United States
Pennsylvania State University Pennsylvania Housing Research Center	United States
Professional Builder and the Greater Chicago-Land Housing Foundation	United States
Purdue University Department of Building Construction Management	United States
State Farm Insurance Companies	United States
Texas A&M University-Construction Industry Advisory Council	United States
U.S. Department of Energy	United States
U.S. Department of Energy Windows & Glazings Research Program	United States
University of Florida-Shimberg Center	United States
University of Georgia-Housing and Demographics Research Center	United States
University of Illinois Urbana-Champaign-Building Research Council	United States
University of Minnesota-Wood and Paper Science Extension and Outreach	United States
University of Nebraska Kearney-Industrial Technology	United States
University of Oregon-Energy Studies in Buildings Laboratory	United States
University of Wisconsin-Madison College of Engineering's Solar Energy Lab (SEL)	United States
Wind Science and Engineering Research Center	United States

Appendix II - International Housing Research Survey

Please answer all questions for your institution.

Prepared by: _____
e-mail: _____
fax: _____
address: _____

country: _____

Institutional Characteristics and History

1. In what year was your institution founded? _____

2. What is your institution's statement of purpose or mission?

3. Which of the following categories best describes the organizational structure of your institution?

Governmental:

- R & D department of government agency
- Free-standing research bureau
- Multi-national research group

Private:

- Trade or Industry Association
- R & D department of manufacturer
- Independent research lab

Academic/University

- Research institute or center
- Academic department or college

4. Please provide the following information on the staff of your institution.

Number of lead/principal researchers or investigators _____

Number of other personnel:

Professional researchers with technical expertise in construction, engineering, architecture, or similar fields

Managers (administrators with no technical responsibilities) _____

Student/Trainees/Apprentices _____

Office/Support Staff _____

Other (please specify) _____

Funding

1. What is your total budget? Amount _____ Currency _____
2. What percent of your total budget comes from the following sources?
 - Internal allocation _____%
 - Government _____%
 - Industry _____%
 - Universities _____%
 - Foundations _____%
 - Sales _____%
 - Fees for Non-research services _____%
 - Other sources _____%
3. Does your organization provide funds for residential technology research?
If yes, please list total amount of funds provided in year 2001:
 - Percent provided to internal research organizations: _____%
 - Percent provided to external research organizations: _____%
4. Which of the following types of organizations do you fund for research?
 - Government research bureaus
 - Universities
 - Private research organizations
 - Trade or Professional Associations

Research areas and projects

1. Please check research areas related to housing construction in which your institution is involved. Check all that apply.

Research Areas:
 - Acoustics
 - Doors/Windows
 - Energy Conservation
 - Envelope
 - Environmentally Friendly Design
 - Fire Safety
 - Foundation
 - Information Technology
 - Manufactured/Pre-fabricated/Factory Built
 - Materials
 - Mechanical/Electrical/Plumbing Systems
 - Production Modeling
 - Roofing
 - Structure
 - Universal Design or Flexible Design
 - Other (please specify) _____

2. Starting with the largest area of research as marked above, please describe your institution's current or recent projects. Please fill out the forms found on the following pages, using a separate form for each project. If you have a comparable description in an annual report or similar publication, you may provide that document for the detail.
GO TO THE NEXT PAGE!

Thank you for taking your valuable time to participate in this survey!
For questions, please contact the Center for Housing Research at Virginia Tech:
e-mail: vchrvt@vt.edu

Center for Housing Research
Mail Code 0451
Virginia Tech
Blacksburg, Virginia 24061 USA

Project I

Research Area (from list) Project Title

Description

Goal of project

Stage of development

Stated measured improvement to housing systems

Project II

Research Area (from list) Project Title

Description

Goal of project

Stage of development

Stated measured improvement to housing systems

Project III

Research Area (from list) Project Title

Description

Goal of project

Stage of development

Stated measured improvement to housing systems

Project IV

Research Area (from list) Project Title

Description

Goal of project

Stage of development

Stated measured improvement to housing systems

Appendix III - Organizations from which detailed information was collected

Organization	Country	Type
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Inc.	USA	Private Trade or Industry Association
Arizona State University, Del E. Webb School of Construction	USA	Academic Faculty, College or Department
Asian Institute of Technology, Habitech Center - School of Civil Engineering -	Thailand	Research Institute or Center
Ball State University, Building Futures Institute	USA	Research Institute or Center
Belgian Building Research Institute (BBRI)	Belgium	Private Independent Research Lab
Building Center of Japan (BCJ)	Japan	Private Independent Research Lab
Building Research Establishment (BRE)	England	Free-standing research bureau, Private Independent Research Lab
Canada Mortgage and Housing Corporation (CMHC)	Canada	R & D department of government agency
China Building Technology Development Centre (CBTDC)	China	R & D department of government agency
Construction Industry Research and Information Association (CIRIA)	UK	Trade or Industry Associations
Civil Engineering Research Foundation (CERF)	USA	Private Trade or Industry Association
Colorado State University, Institute for the Built Environment	USA	Research Institute or Center
Colorado State University, Solar Energy Application Laboratory	USA	Research Institute or Center
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Australia	R & D department of government agency Free-standing research bureau
Danish Building and Research Institute	Denmark	Free-standing research bureau
Helsinki University of Technology, Department of Architecture	Finland	Academic Faculty, College or Department
Hong Kong Polytechnic University, Department of Building and Real-Estate	China	Academic Faculty, College or Department
Indiana State University, Department of Manufacturing and Construction Technology	USA	Academic Faculty, College or Department
Institute for Building Materials Research	Germany	Research Institute or Center
Institute for Research in Construction, National Research Council of Canada	Canada	Free-standing research bureau

McGill University, Minimum Cost Housing Group	Canada	Research Institute or Center
Michigan State University, Housing Education and Research Center (HERC)	USA	Research Institute or Center
National Association of Home Builders (NAHB) Research Center, Inc.	USA	Private Independent Research Lab
National University of Singapore, Centre for Total Building Performance	Singapore	Research Institute or Center
Natural Resources Canada	Canada	R & D department of government agency
Natural Resources Canada, Office of Energy Research and Development	Canada	R & D department of government agency
New York State Energy Research & Development Authority (NYSEDRA)	USA	R & D department of government agency
Pennsylvania State University, Pennsylvania Housing Research Center	USA	Research Institute or Center
South Bank University, London, Faculty of the Built Environment	United Kingdom	Academic Faculty, College or Department
Southern Alberta Institute of Technology (SAIT), Construction Department	Canada	Academic Faculty, College or Department
State Farm Insurance Companies	USA	Private Independent Research Lab
Texas Tech University, Wind Science and Engineering Research Center	USA	Research Institute or Center
University of Architecture, Civil Engineering & Geodesy, Faculty of Architecture	Bulgaria	Academic Faculty, College or Department
University of Florida, Shimberg Center for Affordable Housing	USA	Research Institute or Center
University of Minnesota - Duluth, Natural Resources Research Institute (NRRI), Forest Products Programs	USA	Research Institute or Center
University of Montpellier, School of Architecture	France	Academic Faculty, College or Department
University of New South Wales, Australian Centre for Construction Innovation	Australia	Research Institute or Center
University of New South Wales, School of Civil & Environmental Engineering	Australia	Academic Faculty, College or Department
University of Waterloo, Building Engineering Group	Canada	Research Institute or Center
Virginia Polytechnic Institute and State University (Virginia Tech)	USA	Academic Faculty, College or Department
Virginia Tech, Brooks Forest Products Research Center	USA	Research Institute or Center

Virginia Tech Center for Housing Research	USA	Research Institute or Center
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Appendix IV – Alphabetical Listing of Detailed Information

Appendix IV includes information collected on organization background, funding, and staffing for the following organizations:

American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.
Arizona State University, Del E. Webb School of Construction
Asian Institute of Technology, Habitech Center, School of Civil Engineering
Ball State University, Building Futures Institute
Belgian Building Research Institute (BBRI)
Building Center of Japan (BCJ)
Building Research Establishment
Canada Mortgage and Housing Corporation (CMHC)
China Building Technology Development Centre (CBTDC)
Construction Industry Research and Information Association (CIRIA)
Civil Engineering Research Foundation (CERF)
Colorado State University, Institute for the Built Environment
Colorado State University, Solar Energy Application Laboratory
Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Danish Building and Research Institute
Helsinki University of Technology
Hong Kong Polytechnic University Department of Building and Real-Estate
Indiana State University, Department of Manufacturing and Construction Technology
Institute for Research in Construction, National Research Council of Canada
McGill University, Minimum Cost Housing Group
Michigan State University, Housing Education and Research Center (HERC)
National Association of Home Builders (NAHB) Research Center, Inc.
National University of Singapore, Centre for Total Building Performance
Natural Resources Canada
Natural Resources Canada, Office of Energy Research and Development
New York State Energy Research & Development Authority (NYSERDA)
Pennsylvania State University, Pennsylvania Housing Research Center
South Bank University, London, Faculty of the Built Environment, South Bank University
Southern Alberta Institute of Technology, Construction Department (SAIT)
State Farm Insurance Companies
Texas Tech University, Wind Science and Engineering Research Center
University of Architecture, Civil Engineering & Geodesy, Faculty of Architecture
University of Florida, Shimberg Center for Affordable Housing
University of Minnesota, Duluth, Natural Resources Research Institute (NRRI), Forest Products Program

University of Montpellier, School of Architecture
University of New South Wales, Australian Centre for Construction Innovation
University of New South Wales, School of Civil Engineering
University of Technology, Aachen, Institute for Building Materials Research
University of Waterloo, Building Engineering Group
Virginia Polytechnic Institute and State University
Virginia Tech Center for Housing Research

American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.

ID 7
Web Page <http://www.ashrae.org/>
Year Founded 1894
Mission To advance the arts and sciences of heating, refrigeration, air conditioning, ventilation, their allied arts and sciences and related human factors for the benefit of the public.

Type of Organization Trade or Industry Association

Staff Information

#_Managers	1
#_Support	1

Funding

Budget Information

Total Budget	US \$3,000,000
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Sources of Income

	% Contribution
Internal	47
Government	5
Donations from members	48

Provides Funding for:

- University
- Private Research Organizations

Arizona State University, Del E. Webb School of Construction

ID 40
Web Page <http://construction.asu.edu/>
Year Founded 1957
Mission The Del E. Webb School of Construction is one of 37 accredited construction programs and one of two Schools of Construction in the country. Our mission is to become a national center for construction education, research, and technology transfer, to study innovative technologies for implementation in the construction industry, and to promote international relationships. The School actively seeks industry participation in fulfilling this mission.

Type of Organization Academic Faculty, College or Department

ID 9

Web Page <http://www.sce.ait.ac.th/>

Year Founded 1989

Mission Research construction technologies that can provide affordable housing and social infrastructure buildings to communities and the construction sector that can sustain life without depleting or polluting the environment and disseminate the results of research through educational programs, training and publications.

Habitech develops production and construction systems to build housing, conducts short courses and training in building material production and housing construction. The Self-Contained Housing Delivery System (Habitech Building System), small and medium scale building material industry produce inexpensive, easily erected houses using interlocking and prefabricated concrete components. The cost of these houses undercuts conventional construction techniques. All components are lightweight enough to be handled by no more than four people, eliminating the need for heavy equipment. All the components of a basic house can be produced and assembled by unskilled labor. The small scale industries provide permanent employment for up to 50 persons.

In 1994, Habitech Center was awarded the Matsushita Memorial Prize by the Japan Housing Association “in recognition of excellent achievements in improving human settlements in Asian countries by promoting research and development related to technologies for low cost housing as well as providing educational programs and facilities to disseminate the results of their research efforts”.

Type of Organization **Research Institute or Center**

Staff Information

Lead Investigators	5
Researchers	5
Managers	2
Students	10
Support	3
Technicians	10

Funding

Budget Information

Total Budget US \$1,200,000

Sources of Income

% Contribution

Industry	70
Universities	20
Foundations	6
Sales	4

Ball State University, Building Futures Institute

ID 8

Web Page <http://www.bsu.edu/cap/programs/hfi/hfi.html>

Year Founded 1991

Mission The Building Futures Institute is a research unit in the College of Architecture and Planning at Ball State University. It continues the traditions of engaged research between university faculty and students, and firms, associations and agencies constituting the building industry cluster in Indiana and the region, nationally and internationally. The research we do follows a basic theme:

The study, development and application of methods and processes in architecture, architectural technology and building industry studies, leading to a user-oriented built environment capable of continuous regeneration. BFI has a special emphasis on improving the competitiveness, health and future innovative capacities of Indiana's building industry cluster.

Type of Organization **Research Institute or Center**

Staff Information

Lead Investigators	4
Researchers	2
Managers	1
Students	4
Support	1

Funding

Budget Information

Total Budget US \$2500

Sources of Income

Internal

% Contribution

100

Belgian Building Research Institute (BBRI)

ID 24

Web Page <http://www.bbri.be/homepage/en/navigation/splash.html>

Year Founded 1960

Mission Applied scientific research and information institute for the Belgian construction sector.

Type of Organization **Independent Research Lab**

Staff Information

Lead Investigators	182
Researchers	95

Funding

Sources of Income

Government

Industry
Sales
Revenues of research under contract

Building Center of Japan (BCJ)

ID 27
Web Page <http://www.bcj.or.jp/src/soug-e02.html>
Year Founded 1965
Mission Its purpose is to conduct research projects in the architecture and in the building construction fields, evaluate newly developed building techniques, gather information, and make it available to the public. Over the years, the BCJ has been actively involved not only in developing new materials and construction methods but also in evaluating new technologies as a technical appraisal organization.

Type of Organization **Independent Research Lab**

Building Research Establishment

ID 2 12
Web Page <http://www.bre.co.uk/>
Year Founded 1920
Mission BRE is a world class research based consultancy, testing and certification business. We are independent, authoritative and part of a non-profit making distributing foundation dedicated to improving the built environment.

Type of Organization **Independent Research Lab**
Free-standing-research-bureau

Staff Information

Lead Investigators	50
Researchers	150
Managers	240
Students	6
Support	100

Funding

Budget Information	
Total Budget	£40 million
Sources of Income	
Government	50
Industry	30
Sales	10
Fees	10
Provides Funding for:	
Internal	£1 million

Canada Mortgage and Housing Corporation (CMHC)

ID 10

Web Page <http://www.cmhc-schl.gc.ca/>

Year Founded 1946

Mission The Research and Information Transfer of Canada Mortgage and Housing Corporation (CMHC) improves housing and supports the housing market by being the key Canadian source of reliable and objective housing information.

Type of Organization R-&-D-department-of-government-agency

Staff Information

Lead Investigators	51
Researchers	13
Managers	4
Students	1
Support	5

Funding

Budget Information

Total Budget CAN \$4.5 million

Sources of Income	% Contribution
--------------------------	-----------------------

Government	100
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Provides Funding for: CAN \$1.8 Million

Government Research Bureaus

University

Private Research Organizations

Trade or Professional Organizations

China Building Technology Development Centre (CBTDC)

ID 29

Web Page <http://www.itri.org.tw/k0000/apec/China/CHINA4.htm>

Mission Research on building technology development and residential housing design

Type of Organization R & D Department of Government Agency

Staff Information

Lead Investigators 546

Funding

Budget Information

Total Budget US \$3.6 million

Sources of Income

Government

Construction Industry Research and Information Association (CIRIA)

ID 37

Web Page <http://www.ciria.org.uk/>

Mission CIRIA is a UK-based research association concerned with improving the performance of all involved in construction and the environment. CIRIA is a not-for-profit organization, operating for the good of members and industry and the public good. We have no shareholders and no vested interests.

Type of Organization Independent Research Lab

Civil Engineering Research Foundation (CERF)

ID 39

Web Page <http://www.cerf.org/indexjs.htm>

Mission Facilitate, coordinate, and integrate applied research and innovation for infrastructure as an independent, objective, not-for-profit organization focused on constructing an efficient and renewable future.

Type of Organization Trade or Industry Association

Staff Information

Total Staff 24

Colorado State University, Institute for the Built Environment

ID 46

Web Page <http://www.colostate.edu/orgs/IBE/>

Year Founded 1994

Mission Foster stewardship and sustainability of the built environment through an interdisciplinary research-based educational forum

Type of Organization Independent Research Lab

Staff Information

Lead Investigators	3
Researchers	2
Managers	0
Students	5
Support	1
Board Members	6

Funding

Budget Information

Total Budget US \$40,000

Sources of Income

% Contribution

Internal	20
Government	10

Industry	20
Fees	20
Public school	30

Colorado State University, Solar Energy Application Laboratory

ID 17
Web Page <http://www.colostate.edu/orgs/SEAL/>
Year Founded 1870
Mission Land Grant University
Type of Organization **Research Institute or Center**

Staff Information

Lead Investigators	3
Researchers	3
Students	5
Support	1

Funding

Budget Information
Total Budget US \$500,000
Sources of Income **% Contribution**
Government 100

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

ID 18
Web Page <http://www.csiro.au/index.asp>
Year Founded 1926
Mission CSIRO's mission is to carry out scientific research of benefit to Australia and to facilitate the application or utilization of the results of that research.
 Globally CSIRO is active in more than 70 countries with over 700 current or recently completed projects. Almost a third of CSIRO's international activity is collaboration with leading scientific organizations and firms in the USA.
 Please note. The information provided in this survey only relates to the CSIRO Division of Building Construction & Engineering which is one of 24 CSIRO Divisions

Type of Organization **R & D Department of Government Agency**
Free-standing-research-bureau

Staff Information

Lead Investigators	170
Researchers	170
Managers	10
Students	4
Support	44

Funding**Budget Information****Total Budget** AU \$31 million**Sources of Income** **% Contribution****Government** 75**Industry** 15**Fees** 10**Provides Funding for:** Au \$ 4.5million*Danish Building and Research Institute***ID** 28**Web Page** <http://www.sbi.dk/english/>**Type of Organization** **Free standing research bureau***Helsinki University of Technology***ID** 54**Web Page** <http://www.hut.fi/English/>**Mission** to interpret commonly set goals towards better housing to clear development tasks for the building**Type of Organization** **Academic Faculty, College or Department****Staff Information****Lead Investigators** 3**Funding****Budget Information****Total Budget** US \$100+ million**Sources of Income****Industry****Finnish Technology Agency (Tekes)***Hong Kong Polytechnic University Department of Building and Real-Estate***ID** 52**Web Page** http://www.uacg.acad.bg/UACEG_site/index_e.html**Type of Organization** **Academic Faculty, College or Department***Indiana State University, Department of Manufacturing and Construction Technology***ID** 35**Web Page** <http://www.indstate.edu/mct/newmct/>**Year Founded** 1865

Mission The University's mission to educate men and women to fill rewarding positions in their chosen careers is accomplished through providing students with social competencies, cultural awareness, recreational interests, and quality instruction.

Type of Organization Academic Faculty, College or Department

Staff Information

Lead Investigators	502
Researchers	6
Managers	?
Students	11321

Institute for Research in Construction, National Research Council of Canada

ID 25

Web Page <http://www.nrc.ca/irc/>

Year Founded 1947

Mission Vision: As Canada's foremost centre for construction technologies, the Institute for Research in Construction (IRC) of the National Research Council of Canada will be recognized as the leader in advancing innovation in the construction industry.

Mission: IRC develops and maintains the core competencies and the knowledge base critical to the needs of the Canadian construction industry; supports the development, commercialization and implementation of leading technologies; and fosters the provision of a safe and sustainable built environment through the development of codes and standards.

Type of Organization Free standing research bureau

#_Lead	102
#_Researchers	63
#_Managers	
#_Students	
#_Support	70
Other_Personn	Visiting workers,
#_Other	25

Funding

Budget Information

Total Budget CAN \$23 million

Sources of Income	% Contribution
--------------------------	-----------------------

Government	70
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Industry	30
-----------------	----

McGill University, Minimum Cost Housing Group

ID 13
Web Page <http://www.mcgill.ca/mchg/>
Year Founded 1971
Mission The group carries out research, training, and design projects in housing and human settlements fields.

Type of Organization Independent Research Lab

Staff Information

Lead Investigators 2/3
Researchers 3
Students 20+
Support 1/2

Funding

Budget Information

Total Budget US \$100,000

Michigan State University, Housing Education and Research Center (HERC)

ID 30 41
Web Page <http://www.canr.msu.edu/cm/herc/welcome.html>
Year Founded 1996
Mission The Housing Education and Research Center at Michigan State University will serve the Michigan Housing Industry by promoting and conducting housing research and technology transfer activities and by serving as the adjunct education and research arm of the Michigan Association of Home Builders, and to maintain the status as the recognized resource for housing education and research in Michigan.

Type of Organization Research Institute or Center
 Academic Faculty, College or Department

Staff Information

Lead Investigators 5
Researchers 2
Managers 1
Students 15
Support 2

Funding

Budget Information

Total Budget US \$200,000

Sources of Income	% Contribution
Internal	33
Government	33
Industry	33

Provides Funding for: US \$65,000
 University

National Association of Home Builders (NAHB) Research Center, Inc.

ID 6

Web Page <http://www.nahbrc.org/>

Year Founded 1964

Mission The NAHB Research Center's mission is multi-faceted and aimed at keeping America's builders on the leading edge of technology, while enhancing the quality and affordability of housing for all Americans. At one end of the spectrum is research on the design and construction of homes. At the other end are some of America's most important social and policy issues, such as land use, the environment, affordable and sustainable housing, and special needs housing. Research Center staff is dedicated to bringing technical, regulatory, and practical factors into consideration as they facilitate the adoption of technology that will provide alternatives and improve housing performance.

Type of Organization Independent Research Lab

Staff Information

Lead Investigators	30
Researchers	50
Managers	5
Support	15

Funding

Budget Information

Total Budget US \$12,500,000

Sources of Income	% Contribution
Internal	2
Government	55
Industry	42
Sales	1

National University of Singapore, Centre for Total Building Performance

ID 34

Web Page <http://www.ctbp.bdg.nus.edu.sg/>

Year Founded 2000

Mission

1. To develop and implement an approved R&D plan to promote the best practices in design, construction, maintenance and management of buildings through the application of integrated approach and processes and advanced technology.
2. To coordinate and pool resources, from BCA, NUS and other institutes, government bodies and corporations, for effective research and research output so that facilities and resources can be used optimally to meet research objectives.
3. To promote industry based research through collaborations and engagement at various levels, locally and internationally.
4. To disseminate research findings and output through publications, research seminars and international conferences.

5. To provide training and consultancy services to the industry through the organization of continuing professional development programs focused workshops and interactive forums.

Type of Organization **Research Institute or Center**

Staff Information

Lead Investigators	12
Managers	1
Students	8
Support	1

Funding

Budget Information

Total Budget S \$60,000

Sources of Income	% Contribution
Industry	50
Universities	50

Natural Resources Canada

ID 21

Web Page <http://www.nrcan-rncan.gc.ca/inter/index.html>

Year Founded 1970

Mission Buildings Group is part of the CANMET Energy Technology Centre of the federal department of Natural Resources Canada.

Main purpose of the Buildings Group is to develop, demonstrate and deploy energy and resource efficient housing and building technologies for Canada and export markets.

Buildings Group serves the residential housing and commercial building sectors. The survey information provided here is only for residential housing sector.

Type of Organization **R & D Department of Government Agency**

Staff Information

Lead Investigators	14
Researchers	12
Managers	3
Students	2
Support	4

Funding

Budget Information

Total Budget CAN \$5,500,000

Sources of Income	% Contribution
Internal	40
Government	45
Industry	15

Provides Funding for: \$1,750,000
University
Private Research Organizations
Government Research Bureaus

Natural Resources Canada, Office of Energy Research and Development

ID 45

Web Page http://nrn1.rncan.gc.ca/es/oerd/canerd/whoweare/index_e.html

Year Founded 1974

Mission On behalf of the Government of Canada, the Office of Energy Research and Development (OERD) coordinates non-nuclear energy research and development activities in Canada. This is accomplished by designing and funding interdepartmental R&D programs which support Canada's energy priorities.

Type of Organization R & D Department of Government Agency

Staff Information

Lead Investigators	10
Researchers	1
Managers	5
Support	7

Strategic planning, evaluation and communications

Funding

Budget Information

Total Budget CAN \$57 million

Sources of Income	% Contribution
--------------------------	-----------------------

Government	100
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Provides Funding for: \$4.5 million

University
Private Research Organizations
Government Research Bureaus

New York State Energy Research & Development Authority(NYSERDA)

ID 22

Web Page <http://www.nyscrda.org/residential/residentialprograms.html>

Year Founded 1975

Mission Support innovation and technology development to solve New York's most difficult energy and environmental problems in ways which promote economic development.

Type of Organization R & D Department of Government Agency

Staff Information

Lead Investigators	57
Researchers	15

Managers	15
Students	7
Support	9

Funding

Budget Information

Total Budget US \$100+ million

Sources of Income % **Contribution**

Government 100

Provides Funding for: \$3 million

University

Private Research Organizations

Trade or Professional Organization

Pennsylvania State University, Pennsylvania Housing Research Center

ID 42

Web Page <http://www.engr.psu.edu/phrc/>

Year Founded 1988

Mission To serve the home building and remodeling industries and the citizens of Pennsylvania by improving the quality and affordability of housing.

Type of Organization Research Institute or Center

Staff Information

Lead Investigators 1

Researchers 3

Support 2

Faculty

Funding

Budget Information

Total Budget US \$1,000,000

Sources of Income % **Contribution**

Government 60

Industry 15

Sales 1

Fees 15

Other 9

South Bank University, Faculty of the Built Environment, South Bank University

ID 3
Web Page <http://www.fbe.sbu.ac.uk/>
Year Founded 1910
Mission To provide comprehensive education, training and research in built environment subjects (Faculty mission).

Type of Organization Academic Faculty, College or Department

Staff Information

Lead Investigators 8
Researchers 21
Managers 7
Students 1020
Support 6
Teachers 15

Funding

Budget Information

Total Budget £5 million

Sources of Income	% Contribution
Government	80
Industry	10
Sales	5
Fees	5

Southern Alberta Institute of Technology, Construction Department

ID 38
Web Page <http://www.sait.ab.ca/flash.htm>
Year Founded 1922
Mission SAIT shall be an innovative organization equipping people to compete successfully in the changing world of work by providing relevant, skill-oriented education.

Type of Organization Academic Faculty, College or Department

Staff Information

Students 5000
College Staff 1200

Funding

Sources of Income	% Contribution
Government	40
Industry	35
Sales	25

State Farm Insurance Companies

ID 15

Web Page <http://www.statefarm.com/homesafety.htm>

Mission State Farm's mission is to help people manage the risks of everyday life, recover from the unexpected and realize their dreams.

We are people, who make it our business to be like a good neighbor; who built a premier company by selling and keeping promises through our marketing partnership; who bring diverse talents and experiences to our work of serving the State Farm customer.

Our success is built on a foundation of shared values -- quality service and relationships, mutual trust, integrity and financial strength.

Our vision for the future is to be the customer's first and best choice in the products and services we provide. We will continue to be the leader in the insurance industry and we will become a leader in the financial services arena. Our customers' needs will determine our path. Our values will guide us.

Type of Organization **Independent Research Lab**

Staff Information

Lead Investigators	9
Researchers	9
Managers	1
Students	0
Support	3

Funding

Sources of Income	% Contribution
Internal	100

Provides Funding for:
University
Private Research Organizations
Trade or professional Organizations

Texas Tech University, Wind Science and Engineering Research Center

ID 16

Web Page <http://www.wind.ttu.edu/>

Year Founded 1970

Mission To perform advanced and innovative multidisciplinary research to mitigate the deleterious effects of windstorms on the built environment, people and the quality of life.

Type of Organization **Research Institute or Center**

Staff Information

Lead Investigators	19
Researchers	8

Managers	1
Students	90
Support	8

Funding

Budget Information

Total Budget US \$2,700,000

Sources of Income % Contribution

Internal	13.5
Government	81.5
Industry	2.5
Foundations	1
Fees for research	1.5

University of Architecture, Civil Engineering & Geodesy, Faculty of Architecture

ID 48

Web Page http://www.uacg.acad.bg/UACEG_site/index_e.html

Year Founded 1943

Mission To provide higher education in Architecture; to educate architects who can perform a wide variety of activities: complex investigation and planning of regional, landscape and urban sites; urban planning of towns, villages, urban areas, centers and functional zones; architectural design of residential, public, industrial and agricultural buildings; design and organization of interior and exterior spaces; management and organization of construction and construction elements fabrication; institutional and corporate investment policy; investigation and control functions in the city councils with respect to urban planning and architecture; research, implementation and

Type of Organization Academic Faculty, College or Department

Staff Information

Lead Investigators	27
Researchers	50
Managers	11
Students	800
Support	5

Funding

Sources of Income % Contribution

University 100

Provides Funding for: 8000 levs = ~ US \$ 4000

University

University of Florida, Shimberg Center for Affordable Housing

ID 51

Web Page <http://www.shimberg.ufl.edu/>

Mission The Shimberg Center for Affordable Housing (www.shimberg.ufl.edu) is located within the Rinker School of Building Construction in the College of Design, Construction & Planning at the University of Florida in Gainesville, Florida. The Shimberg Center focuses its research programs in three areas: 1) Florida Housing Data Warehouse 2) Alternative Building System Technology 3) Housing Policy & Community Development.

Type of Organization **Research Institute or Center**

*University of Minnesota - Duluth, Natural Resources Research Institute (NRRI),
Forest Products Programs*

ID 11

Web Page <http://www.nrri.umn.edu/default/>

Year Founded NRRI - 1983

Mission NRRI General: Economic development of regional resources in an environmentally sound manner.
Forest Products Programs: To further the economic development of the forest products and associated industries by: developing products, processes, and markets; improving and enhancing products and processes; and providing technical assistance through research, development, and technology transfer.

Type of Organization **Research Institute or Center**

Staff Information

Lead Investigators	3
Researchers	7
Managers	2
Students	3
Support	1

Funding

Budget Information

Total Budget US \$925,000

Sources of Income

% Contribution

Government	60
Industry	40

Provides Funding for: \$245,000
University

University of Montpellier, School of Architecture

ID 23

Web Page <http://www.univ-montp2.fr/>

Year Founded 1986

Mission Research

Type of Organization R & D Department of Government Agency
Research Institute or Center
Academic Faculty, College or Department

Staff Information

Lead Investigators 6

Researchers 6

Managers 2

Students 2

Funding

Budget Information

Total Budget EURO \$14,000

Sources of Income % Contribution

Government 80

Industry 20

University of New South Wales, Australian Centre for Construction Innovation

ID 43

Web Page <http://www.fbe.unsw.edu.au/ACCI/>

Year Founded 1985

Mission We are a network of academics centered at Australia's leading technical university and through us you gain access to the resources of UNSW.

Our focus is the construction industry and we are committed to improving its processes.

Leading International researchers are a part of our network increasing our capability and linking us globally

Type of Organization Research Institute or Center

Staff Information

Lead Investigators 2

Researchers 4

Managers 1

Students 5

Support 1

P/T Academics 6

Funding

Budget Information**Total Budget** AU \$750,000**Sources of Income****% Contribution****Government****30****Industry****30****Universities****8****Sales****1****Fees****31***University of New South Wales, School of Civil & Environmental Engineering***ID** 47**Web Page** <http://www.civeng.unsw.edu.au/>**Year Founded** 1949**Mission** University**Type of Organization** Academic Faculty, College or Department**Staff Information****Lead Investigators** 40**Researchers** 7**Managers** 2**Students** 7**Support** 3**Funding****Budget Information****Total Budget** AU \$2 million*University of Technology, Aachen, Institute for Building Materials Research***ID** 31**Web Page** <http://www.ibac.rwth-aachen.de/>**Year Founded** 1948**Mission** Teaching, industrial and basic research regarding building materials**Type of Organization** Research Institute or Center**Staff Information****Lead Investigators** 3**Researchers** 15**Students** 50**Support** 55**Funding****Budget Information****Total Budget** EURO \$2,500,000**Sources of Income****% Contribution**

Government	50
Industry	50

University of Waterloo, Building Engineering Group

ID 5

Web Page <http://sunburn.uwaterloo.ca/beg/>

Year Founded 1982

Mission The Building Engineering Group (BEG) is a multi-disciplinary group which undertakes research, development and demonstration (R & D) for the building industry. BEG is a non-profit, non-proprietary organization operating within the Civil Engineering Department at the University of Waterloo

Type of Organization Research Institute or Center

Staff Information

Lead Investigators	1
Researchers	3
Managers	1/2
Students	55
Support	1/2

Funding

Budget Information

Total Budget CAN \$100,000

Sources of Income % Contribution

Government	40
Industry	60

Virginia Polytechnic Institute and State University

ID 56

Year Founded 1872

Mission Through our three missions of instruction, research, and public service (outreach), Virginia Tech accomplishes the charge of its motto: "Ut Prosim" -- "That I May Serve."

Type of Organization Academic Faculty, College or Department

Staff Information

Support	3405
Faculty	3089

Funding

Budget Information

Total Budget US \$740 million

Virginia Center for Housing Research at Virginia Tech

ID 55
Web Page <http://www.arch.vt.edu/CAUS/RESEARCH/vchr/VCHR.html>
Year Founded 1989
Mission The Center strives to improve the affordability, durability, and quality of housing by creating knowledge through research. The Center serves as a resource to policy makers, communities and businesses for research, information, and technical assistance on affordable housing.

Type of Organization Research Institute or Center

Staff Information

Lead Investigators	2
Researchers	1
Students	12
Support	1

Funding

Budget Information	
Total Budget	US \$789,800
Sources of Income	
Government	% Contribution 85
University	15

Appendix V - Organizations by Research Area

5.1 Acoustics

Institution	Research Project
ASHRAE, Inc.	Sound Attenuation Properties of HVAC Plenums
Building Research Establishment	<ul style="list-style-type: none"> • Sound insulation • Building acoustics and environmental noise
Canada Mortgage and Housing Corporation	
CSIRO	Acoustic Rating of Windows
Institute for Research in Construction, National Research Council of Canada	<ul style="list-style-type: none"> • Insulating Buildings Against Noise from Aircraft (IBANA) • Acoustic and Fire Evaluation of Wall and Floor Assemblies
NAHB Research Center, Inc.	
National University of Singapore, Centre for Total Building Performance	Community Noise Study of Singapore with Specific Reference to the Preparation of Planning and Design Guides (PWD)

5.2 Door / Windows

Institution	Research Project
ASHRAE, Inc.	
Asian Institute of Technology, Habitech Center - School of Civil Engineering	
Building Research Establishment	<ul style="list-style-type: none"> • Cladding and curtain walling
Canada Mortgage and Housing Corporation	
Institute for Research in Construction, National Research Council of Canada	Building Envelope and Structure Program
NAHB Research Center, Inc.	
Natural Resources Canada	Development of low-profile fiberglass frames for windows and doors
Natural Resources Canada, Office of Energy Research and Development	
New York State Energy Research & Development Authority	
Pennsylvania State University, Pennsylvania Housing Research Center	
State Farm Insurance Companies	
Texas Tech University, Wind Science and Engineering Research Center	Window/door testing for wind pressures and debris impact resistance
University of Minnesota - Duluth, Natural Resources Research Institute (NRRI), Forest Products Programs	
University of Waterloo, Building Engineering	

Group	
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5.3 Energy Conservation

Institution	Research Project
ASHRAE, Inc.	Improved ways to measure residential duct leakage
Building Research Establishment	<ul style="list-style-type: none"> • Energy Efficiency/Best Practice Programme • Integrated New and Renewable Energy in Buildings (INREB)
Canada Mortgage and Housing Corporation	
Colorado State University, Institute for the Built Environment	
Colorado State University, Solar Energy Application Laboratory	
CSIRO	Thermal & Ventilation Engineering
Indiana State University, Department of Manufacturing and Construction Technology	Using Three-Parameter Models to Evaluate the Good Cents Program in College Station, Texas
Institute for Research in Construction, National Research Council of Canada	Building Envelope and Structure Program
McGill University, Minimum Cost Housing Group	
Michigan State University, Housing Education and Research Center (HERC)	<ul style="list-style-type: none"> • Energy Efficient Design and Construction Techniques in Home Building • Energy Assessment of campus Buildings
NAHB Research Center, Inc.	
National University of Singapore, Centre for Total Building Performance	Solar Induced Ventilation
Natural Resources Canada	Technical support to R-2000 and EnerGuide for Houses Program
New York State Energy Research & Development Authority	<ul style="list-style-type: none"> • Submetering Multifamily Buildings • Radio Frequency Thermostat • Eaton Center Combined Heat & Power Microturbine Installation
Pennsylvania State University, Pennsylvania Housing Research Center	<ul style="list-style-type: none"> • Energy Star • Million Solar Roofs Program • Federal Energy Management
University of Florida, Shimberg Center for Affordable Housing	
University of Waterloo, Building Engineering Group	
Virginia Tech	Partnership for Advancing Technologies in Housing: Designing Panelized Systems to Minimize Impact on Indoor Air Quality in Tightly-Sealed Buildings

5.4 Envelope

Institution	Research Project
ASHRAE, Inc.	Characterization of framing factors for low-rise residential building walls
Asian Institute of Technology, Habitech Center - School of Civil Engineering -	
Ball State University, Building Futures Institute	
Building Research Establishment	
Canada Mortgage and Housing Corporation	
Colorado State University, Solar Energy Application Laboratory	Phase change floor tile
CSIRO	An integrated approach to the design and performance of Facades & Structural systems
Hong Kong Polytechnic University Department of Building and Real-Estate	Mandatory use of large panel steel formwork systems for structural walls
Institute for Research in Construction, National Research Council of Canada	<ul style="list-style-type: none"> • Building Envelope and Structure Program • Durability and Repair of Concrete Structures • Wall and Window Systems
NAHB Research Center, Inc.	
National University of Singapore, Centre for Total Building Performance	Performance of Building Facades under Tropical Conditions (SETSCO)
Natural Resources Canada	Development of Durable Walls
Natural Resources Canada, Office of Energy Research and Development	
New York State Energy Research & Development Authority	
Pennsylvania State University, Pennsylvania Housing Research Center	Weatherization Assistance
State Farm Insurance Companies	
University of Florida, Shimberg Center for Affordable Housing	
University of New South Wales, School of Civil & Environmental Engineering	Developing software for the design of masonry structures
University of Waterloo, Building Engineering Group	Strategies for Rainscreen Cladding

5.5 Environmentally Friendly Design

Institution	Research Project
ASHRAE, Inc.	
Asian Institute of Technology, Habitech Center - School of Civil Engineering -	Khao Kho Reforestation Project - Petchabun - Thailand
Ball State University, Building Futures Institute	
Building Research Establishment	
Canada Mortgage and Housing Corporation	
Civil Engineering Research Foundation (CERF)	Green Building Techniques

Colorado State University, Institute for the Built Environment	Innovative Use of Small Diameter Timber
CSIRO	
McGill University, Minimum Cost Housing Group	
NAHB Research Center, Inc.	Development of the National Green Building program
Natural Resources Canada	Eko ¹⁰ concepts for future housing
Natural Resources Canada, Office of Energy Research and Development	
New York State Energy Research & Development Authority	
Pennsylvania State University, Pennsylvania Housing Research Center	
University of Architecture, Civil Engineering & Geodesy, Faculty of Architecture	
University of Florida, Shimberg Center for Affordable Housing	
University of Waterloo, Building Engineering Group	

5.6 Fire Safety

Institution	Research Project
ASHRAE, Inc.	Field testing and analysis of high altitude installation of gas-fired furnaces
Building Research Establishment	
Canada Mortgage and Housing Corporation	
China Building Technology Development Centre (CBTDC)	
CSIRO	Fire Safety Design and Risk Assessment – Research
Institute for Research in Construction, National Research Council of Canada	<ul style="list-style-type: none"> • Fire Risk Management Program • FiRECAM™ • FIERAsystem • Fire Suppression Systems • Fire-Resistant Construction • Positive Pressure Ventilation • Acoustic and Fire Evaluation of Wall and Floor Assemblies
NAHB Research Center, Inc.	
National University of Singapore, Centre for Total Building Performance	Evaluation of the Performance of Fire Doors – An Integrated Approach
State Farm Insurance Companies	

5.7 Foundation

Institution	Research Project
Building Research Establishment	
Canada Mortgage and Housing Corporation	
Institute for Research in Construction, National Research Council of Canada	
NAHB Research Center, Inc.	
Natural Resources Canada, Office of Energy Research and Development	
Pennsylvania State University, Pennsylvania Housing Research Center	
State Farm Insurance Companies	
University of Waterloo, Building Engineering Group	

5.8 Information Technology

Institution	Research Project
Building Research Establishment	
China Building Technology Development Centre (CBTDC)	
CSIRO	
Indiana State University, Department of Manufacturing and Construction Technology	Urban Planning Module Indiana
Michigan State University, Housing Education and Research Center (HERC)	
NAHB Research Center, Inc.	ToolBase Program
Natural Resources Canada, Office of Energy Research and Development	
State Farm Insurance Companies	
University of Architecture, Civil Engineering & Geodesy, Faculty of Architecture	
University of Florida, Shimberg Center for Affordable Housing	Florida Housing Data Warehouse
University of New South Wales, Australian Centre for Construction Innovation	Viability of E pilularis as a laminated product
Virginia Tech	Information Technology for Enabling Dynamic Immersive and Interactive Visualization of Construction Operations
Virginia Tech, Center for Housing Research	<ul style="list-style-type: none"> • Industrializing the Residential Construction Site Phase I, Phase II, and Phase III • Residential Construction Information Mechanisms and Procedures • Measuring Housing Technology Diffusion and Diffusion Mechanisms

5.9 Manufactured / Pre-Fabricated / Factory built

Institution	Research Project
Asian Institute of Technology, Habitech Center - School of Civil Engineering	Medium enterprises producing building materials
Ball State University, Building Futures Institute	Conversion of vacant office buildings to housing
Building Center of Japan (BCJ)	
Building Research Establishment	
Canada Mortgage and Housing Corporation	
Hong Kong Polytechnic University Department of Building and Real-Estate	Use of prefabricated building components (semi-precast concrete slabs, staircases, kitchen sets, etc.)
Michigan State University, Housing Education and Research Center (HERC)	<ul style="list-style-type: none"> • Modeling of Manufactured Housing Production and Material Utilization • Manufactured Housing Trends and Regulations in Michigan • Manufactured Housing Construction Quality Guidelines
NAHB Research Center, Inc.	
New York State Energy Research & Development Authority	
Pennsylvania State University, Pennsylvania Housing Research Center	
South Bank University, Faculty of the Built Environment	Affordable Housing Adaptations using Modular Construction
Texas Tech University, Wind Science and Engineering Research Center	Full-scale testing of manufactured and modular homes with C-130 propwash
University of Architecture, Civil Engineering & Geodesy, Faculty of Architecture	Tenants' participation in Housing Renovation and Design
University of Minnesota - Duluth, Natural Resources Research Institute (NRRI), Forest Products Programs	<ul style="list-style-type: none"> • Kato Sangyo Building System • Manual Wood Frame Digital House Process Line • Discovery of Building System Technology from Europe.
University of Waterloo, Building Engineering Group	Durisol ICF

5.10 Materials

Institution	Research Project
ASHRAE, Inc.	Catalog of material thermal property data
Asian Institute of Technology, Habitech Center - School of Civil Engineering -	Interlocking Block Wall tests
Ball State University, Building Futures Institute	
Belgian Building Research Institute (BBRI)	
Building Research Establishment	
CIRIA	Strengthening existing metallic structures using externally bonded fibre reinforced polymers

	(FRP)
Civil Engineering Research Foundation (CERF)	<ul style="list-style-type: none"> • Light Weight Concrete Project • High-Performance CONstruction MATerials and Systems (CONMAT) program
CSIRO	Cleaner construction materials and processes
Danish Building and Research Institute	Materials and components
Hong Kong Polytechnic University Department of Building and Real-Estate	Encouraged use of precast concrete facade elements
Institute for Research in Construction, National Research Council of Canada	Durability and Repair of Concrete Structures
NAHB Research Center, Inc.	Support for the Partnership for Advancing Technology in Housing (PATH) Program
National University of Singapore, Centre for Total Building Performance	Durability of Sealants in Precast Joints under Local Climate Conditions (HDB)
Natural Resources Canada	
Natural Resources Canada, Office of Energy Research and Development	
New York State Energy Research & Development Authority	
Pennsylvania State University, Pennsylvania Housing Research Center	
State Farm Insurance Companies	
University of Florida, Shimberg Center for Affordable Housing	
University of Minnesota - Duluth, Natural Resources Research Institute (NRRI), Forest Products Programs	
University of Montpellier, School of Architecture	
University of New South Wales, Australian Centre for Construction Innovation	
University of Technology, Aachen; Institute for Building Materials Research	<ul style="list-style-type: none"> • Binders and Concrete • Composite Materials and Modeling • Masonry • Conservation and Repair • Steel and Corrosion
University of Waterloo, Building Engineering Group	

5.11 Mechanical / Electrical / Plumbing Systems

Institution	Research Project
ASHRAE, Inc.	HVAC Design Guide for Tall Buildings
Ball State University, Building Futures Institute	Matura Infill System
Building Research Establishment	
Canada Mortgage and Housing Corporation	

Colorado State University, Solar Energy Application Laboratory	Robust Reinforcement Learning Control for Building Energy Systems
Institute for Research in Construction, National Research Council of Canada	Alternative Ventilation Systems for Houses
NAHB Research Center, Inc.	
Natural Resources Canada	Ekocomfort - Advanced Integrated Mechanical Systems
Natural Resources Canada, Office of Energy Research and Development	
New York State Energy Research & Development Authority	<ul style="list-style-type: none"> • Self-powered, Oil-fired Heating System • Pulse-combustion Space-heating Boiler
Pennsylvania State University, Pennsylvania Housing Research Center	
Southern Alberta Institute of Technology, Engineered Air Center	Boiler Research
State Farm Insurance Companies	
University of Florida, Shimberg Center for Affordable Housing	Alternative Building System Technology

5.12 Production Modeling

Institution	Research Project
Ball State University, Building Futures Institute	Product Supply Channel Mapping
Building Research Establishment	
CSIRO	
Hong Kong Polytechnic University Department of Building and Real-Estate	Standardization of block designs and construction sequences
Michigan State University, Housing Education and Research Center (HERC)	
University of New South Wales, Australian Centre for Construction Innovation	<ul style="list-style-type: none"> • DSTS for defect avoidance • Innovation review into construction methods, materials, technology e-design for affordable housing • Interactive CD Rom and characterize quality assessment criteria • DSS for Waste Management

5.13 Roofing

Institution	Research Project
ASHRAE	
Asian Institute of Technology, Habitech Center - School of Civil Engineering -	
Building Research Establishment	
Institute for Research in Construction, National Research Council of Canada	Building Envelope and Structure Program

NAHB Research Center, Inc.	
Natural Resources Canada, Office of Energy Research and Development	
New York State Energy Research & Development Authority	
Pennsylvania State University, Pennsylvania Housing Research Center	Million Solar Roofs Program
State Farm Insurance Companies	
University of Waterloo, Building Engineering Group	

5.14 Structure

Institution	Research Project
Asian Institute of Technology, Habitech Center - School of Civil Engineering - Building Center of Japan (BCJ)	Interlocking load bearing concrete blocks (no mortar) for medium rise buildings
Building Research Establishment	
Canada Mortgage and Housing Corporation	
China Building Technology Development Centre (CBTDC)	
CIRIA	
CSIRO	
Institute for Research in Construction, National Research Council of Canada	Building Envelope and Structure Program
NAHB Research Center, Inc.	Program of Research on Optimum Value Engineering (PROVE)
Natural Resources Canada, Office of Energy Research and Development	
New York State Energy Research & Development Authority	
Pennsylvania State University, Pennsylvania Housing Research Center	
State Farm Insurance Companies	
University of Minnesota - Duluth, Natural Resources Research Institute (NRRI), Forest Products Programs	
University of Montpellier, School of Architecture	Tensarch
University of New South Wales, Australian Centre for Construction Innovation	
University of Waterloo, Building Engineering Group	
Virginia Tech	Partnership for Advancing Technologies in Housing: Advanced Replacements for Mechanical Fasteners in Housing Construction for High Wind Zones

5.15 Universal Design or Flexible Design

Institution	Research Project
Asian Institute of Technology, Habitech Center - School of Civil Engineering -	Low cost housing - Bandung Indonesia
Ball State University, Building Futures Institute	INO Hospital Project
Building Research Establishment	
Canada Mortgage and Housing Corporation	
McGill University, Minimum Cost Housing Group	
NAHB Research Center, Inc.	National Center for Seniors Housing Research
Pennsylvania State University, Pennsylvania Housing Research Center	
University of Architecture, Civil Engineering & Geodesy, Faculty of Architecture	Development of the housing system in the city of Sofia
University of Montpellier, School of Architecture	
University of New South Wales, School of Civil & Environmental Engineering	

5.16 Other Research Areas

Institution	Research Project
Arizona State University, Del E. Webb School of Construction	<ul style="list-style-type: none"> • Arizona Partnership for Advanced Technologies in Housing (AzPATH) • Construction Research and Education for Advanced Technology Environments (CREATE)
Ball State University, Building Futures Institute	Open building research
Building Center of Japan (BCJ)	Hyper Building Design
Building Research Establishment	Quality issues
Danish Building and Research Institute	Building design and technology
Indiana State University, Department of Manufacturing and Construction Technology	Building Codes
Helsinki University of Technology, Department of Architecture	Infill Systems for Open Building in Housing
Institute for Research in Construction, National Research Council of Canada	<ul style="list-style-type: none"> • Indoor air quality; lighting • Canadian Centre for Housing Technology (CCHT) • Consortium for Material Emissions and Indoor Air Quality Modeling (CMEIAQ)
McGill University, Minimum Cost Housing Group	<ul style="list-style-type: none"> • Low Cost housing and human settlements • Gender and Native Housing • Transformations in Native Housing • Youth Training in International

	Development
Michigan State University, Housing Education and Research Center (HERC)	<ul style="list-style-type: none"> • Construction Management • Innovative Ways to Provide Urban Affordable Housing
NAHB Research Center, Inc.	Quality assurance/certification
National University of Singapore, Centre for Total Building Performance	For more details, please visit our website: http://www.ctbp.bdg.nus.edu.sg/main.htm
Pennsylvania State University, Pennsylvania Housing Research Center	Building America
State Farm Insurance Companies	Natural and man-made hazard reduction and mitigation
Texas Tech University, Wind Science and Engineering Research Center	Sheltering from High Winds
University of Architecture, Civil Engineering & Geodesy, Faculty of Architecture	<ul style="list-style-type: none"> • Urban planning aspects • SEA Centre - Institutionalization, Methodology and Transfer of Knowledge • The small settlements of Sofia municipality: Directions to sustainable spatial development
University of Minnesota - Duluth, Natural Resources Research Institute (NRRI), Forest Products Programs	<ul style="list-style-type: none"> • Interior finishing - cabinetry, flooring, stair parts • Hardwood Flooring using Sawn Veneer Technology • RTA Cabinetry "Off the Wall Cabinets" (current)
University of New South Wales, Australian Centre for Construction Innovation	Production Management
University of New South Wales, School of Civil & Environmental Engineering	<ul style="list-style-type: none"> • Structural Systems, Foundations & Masonry • Performance Indicators for housing Foundations • Establishing Surface development guidelines for areas subject to mins subsidence