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Foreword

The built environment involves two infrastructures: the civil or “constructed” infrastructure, and the built facility or “built” infrastructure. The latter can, in turn, be divided into engineered (commercial, industrial, educational, institutional, medical, etc.) and “non-engineered” (low-rise housing, small industrial and farm buildings, etc.) buildings. In most engineering faculties at most North American universities, the “non-engineered” built facilities, especially housing, are almost totally ignored. Since low-rise residential building constitutes nearly two-thirds of the building business and since this industry has largely sustained the US economy for the last ten years, this is an astonishing situation: economically, politically, socially, and educationally.

The late Mr. Bernard Hankin, to his eternal credit, saw this paradox and sought to do something about it. For the Pennsylvania State University and the Commonwealth of Pennsylvania, the endowment of the Bernard and Henrietta Hankin Chair in Residential Construction was an initiative of considerable foresight. It has been my privilege to have held the Hankin Chair for nearly ten years. I decided that some of the consequences of the Hankins’ foresight should be documented.

Without the endowment there would no Hankin Chair, no PHRC, and no Hankin legacy to write about. This short publication, *The Hankin Legacy*, seeks to acknowledge Bernie Hankin’s vision and to honor his contribution. A record of what has been accomplished over the past decade, *The Hankin Legacy* also provides an opportunity to acknowledge all those who have helped to support, facilitate, and expand on Bernie Hankin’s intentions and to put what has been achieved into perspective. As my own retirement approaches, I am aware that some of these intentions have yet to be realized; I also know that many have been successfully accomplished.

Many people have had a hand in the development of the PHRC. There are three persons, in particular, to whom I wish to express special thanks:

- Roger Glunt for his clear-sighted, eloquent and vigilant support of Bernie’s vision;
- Don DeLess for his wise counsel and sound advice; and
- Scott Cannon for his enthusiastic support, his leadership, his energy, his faith, his passion and his example.

Eric Burnett
Hankin Chair
July, 2005
Background

The Bernard Hankin Professorship in Residential Building Construction was established at the Pennsylvania State University in 1979. In 1988, this position became the Bernard and Henrietta Hankin Chair in Residential Building Construction. The chair was initially funded by a $1,000,000 endowment: testimony to the farsightedness of Mr. Bernard (Bernie) Hankin and the generosity of the Hankin family.

Dr. Jack Willenbrock of the Civil and Environmental Engineering Department at Penn State was the first incumbent of both positions. Dr. Willenbrock held the latter position until his retirement in August 1995. Dr. Eric Burnett was appointed to the Chair in 1995 and he started at Penn State in January 1996.

Dr. Willenbrock initiated the Housing Research Center (HRC) at Penn State in 1988. Dr. Burnett took over as Director of the HRC in January 1996. Dr. Harvey Manbeck of the Agricultural and Biological Engineering Department acted as interim Director between August and December 1995.

In 1997, the HRC was reconstituted as the Pennsylvania Housing Research/Resource Center (PHRC) and, at the same time, a formal partnership with the Pennsylvania College of Technology was created. The PHRC’s mission is to serve the housing industry in Pennsylvania, and this partnership was intended to foster a synergistic combination of research, training and technology transfer.

The table below summarizes the growth of the PHRC in terms of full-time personnel. Milestones to note include the appointment of Mark Fortney as full-time Director of the PHRC, with the Hankin Chair becoming the ex-officio Director of Research. Ken Sagan joined the PHRC as training and education development specialist; Scott Brown was subsequently hired for his expertise in land use and development. In 2003, Penn College was awarded a Ben Franklin grant that enabled Rick Terry to take up the position of Director of Factory Built Housing. Michelle McMullen and Tracy DeSoto are the administrative anchors for the PHRC.

As Director of Research of the PHRC, the Hankin Chair is responsible, through the head of the Civil and Environmental Engineering Department (CEE), to the Dean of the College of Engineering, for all of the activities of the PHRC. The PHRC is well on its way to becoming a full-service housing resource center (as outlined in the Business Plan of 1999, the PHRC Organizational Manual, and the 2002 Position Paper for a Network of Full-Service Housing Resource Centers). Upon joining Penn State, Dr. Burnett chose to be cross-appointed to both the Civil and Environmental Engineering and
Architectural Engineering (AE) Departments. The Hankin Chair and the PHRC are physically located in the CEE Department, and both administratively report to the head of this department.

Each November the Hankin Chair formally reports to the Hankin Advisory Committee. The committee currently consists of Mrs. Henrietta Hankin, Mr. Richard Hankin, Mr. Robert Hankin, and Mr. Sam Hankin; Mr. Roger Glunt, President, Glunt Development Co.; Mr. David Martin, Executive Vice President, Pennsylvania Builders Association; the Heads of the CEE and AE Departments, and the Dean of Engineering or the Dean’s appointee. In addition, Mr. Bruce Silver, President and CEO of the National Housing Endowment (NHE) of the National Association of Home Builders (NAHB), has been a member of the Hankin Committee since 2003. The National Housing Endowment contributes in a number of ways to the Housing program at Penn State (Glunt endowment at NHE, and both the scholarship and the travel award programs).

**Responsible parties and the growth of responsibilities**

<table>
<thead>
<tr>
<th>Year</th>
<th>Hankin Chair</th>
<th>Director of HRC/PHRC</th>
<th>Full-time Staff</th>
<th>Penn College</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988/90</td>
<td>J. Willenbrock</td>
<td>J. Willenbrock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989/94</td>
<td>J. Willenbrock</td>
<td>H. Manbeck</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994/95</td>
<td>Aug/Dec</td>
<td>E. Burnett</td>
<td>M McMullen/Dec. 95</td>
<td></td>
</tr>
<tr>
<td>1996/97</td>
<td>E. Burnett</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999/00</td>
<td>E. Burnett</td>
<td>E. Burnett</td>
<td>K. Sagan / Jan. 2002</td>
<td></td>
</tr>
<tr>
<td>2000/01</td>
<td>E. Burnett</td>
<td>E. Burnett</td>
<td>S. Brown /July 2002</td>
<td></td>
</tr>
<tr>
<td>2001/02</td>
<td>E. Burnett</td>
<td>E. Burnett</td>
<td>R. Terry</td>
<td></td>
</tr>
<tr>
<td>2002/03</td>
<td>E. Burnett</td>
<td>E. Burnett</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003/04</td>
<td>E. Burnett</td>
<td>E. Burnett</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004/05</td>
<td>E. Burnett</td>
<td>E. Burnett</td>
<td></td>
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</table>
Hankin Responsibilities

The responsibilities of the Hankin Chair were explicitly stated in the job description and may be categorized as follows:

Courses: To ensure that, each academic year, at least two senior-level undergraduate courses are provided: one on residential subdivision design and construction and the other on house design and construction. In fact, three courses have been provided each academic year:

- Residential Building Design and Construction (Spring semester—about 26 students per year)
- Sustainable Residential Subdivision Design (Fall semester—about 23 students per year)
- Building Enclosure Science and Design (Fall semester—7 to 8 students per year); introduced by E. Burnett

NAHB Student Chapter: To be Faculty Advisor to, and thereby to maintain, an active National Association of Home Builders (NAHB) Student Chapter at Penn State. Funds for scholarships and for travel to the annual NAHB convention are collected and disbursed each year. To date some 67 scholarships (totaling about $55,500) and 55 travel grants (totaling about $47,600) have been awarded. These funds have been provided by the Pennsylvania Builders Association (PBA), the NAHB, the Builders Association of Central PA, the Glunt endowments at Penn State and the National Housing Endowment, the Hankin family, and companies such as Winchester Homes, Toll Brothers, Ryland Homes, and Ryan Homes. The NAHB Student Chapter participates in local Habitat for Humanity initiatives. On average there are about 33 student members per year.

PBA Liaison: To develop and maintain good relations with the Pennsylvania Builders Association. One formal way to accomplish this is through membership of the following PBA committees:

- Housing Research Committee (PBA/PHRC Committee)
- Workforce Development Committee
- Editorial Review Board
- Land Development Task Force
- Housing Finance Committee
The following responsibilities have been added since 1996:

**Glunt Fellowship and related National Housing Endowment Funds:** The Hankin Chair administers this annual award to a graduate student doing housing-related research at Penn State. Since January 1994, an endowment has been used to fund the annual J. Roger Glunt Graduate Fellowship in Residential Construction. Since 2001 the annual revenue from the Glunt endowment that is maintained at the NAHB by the National Housing Endowment has been used to supplement the Glunt Fellowship and to sustain the National Housing Endowment/Glunt undergraduate scholarship. The Glunt Fellows are listed in the appendix.

**Certificate Program in Housing:** The proposal for a four-course (12 credit) housing certificate was formally approved by Penn State’s Senate Committee on Curricular Affairs on October 5, 2004. Students who accumulate sufficient credits have been eligible for the certificate since the Fall session of 2004.

Over and above these specific responsibilities, there are at least three more general responsibilities: to foster among engineering students an awareness of and an interest in housing, to improve the quality and extent of housing-related education (and training), and to conduct research and development.
**Financial Support**

The activities of the Hankin Chair and the other members of the PHRC may be broadly described as follows:

**Education**: Conducting formal courses at an undergraduate and a graduate level for university or professional credit.

**Training**: Presenting short courses, workshops, and seminars at a variety of levels (professional, trades, building official, inspector, etc.) usually delivered off campus and ranging in length from half a day to two or more days.

**Research, Development and Demonstration (R, D and D)**: Conducting R, D and D of a more technical nature with some emphasis on materials, building science, and the building enclosure.

**Technology Transfer**: Supplying information and assistance on relevant topics to the various constituencies within the housing community by formal means (builder briefs, talks, papers, presentations, etc.) and less formal means (telephone and e-mail communication).

**Process and Service**: Providing liaison, administration, leadership and cooperation: responding to requests and RFPs; providing reviews, sitting on professional committees; answering questions and providing assistance to consumers and businesses; and serving as a proactive resource.

How are the Hankin funds spent? As shown in the table, most of these funds have gone to support graduate students doing R, D and D. However, the Hankin funds are especially valuable because the money can be spent at the Chair’s discretion. Hankin funds have, for instance, been used to pay for prizes in design competitions (e.g., Habitat for Humanity, Sustainability), to subsidize site visits (e.g., Eagle View, Falling Water, Architectural Testing Inc.), and to pay expenses for invited speakers and scholars. No Hankin money is spent on training, but some is allocated to teaching, service and process.
A table is provided to illustrate some of the realities of funding. Because it is direct, non-political and almost guaranteed, the Hankin support is our key funding. The Penn State support is largely indirect (salaries, office and laboratory space, and facilities). This institutional commitment is vital because it enables the Chair and the PHRC to function. Although we do not directly receive money from the housing industry, the industry’s efforts (under PBA leadership) are largely responsible for the financial support provided by the Commonwealth through a line item in the Governor’s budget. These funds are administered by the Department of Community and Economic Development (DCED). State support, especially if it provides a significant and stable level of base funding, is absolutely essential if the PHRC is to function properly. I would like to acknowledge the faith and goodwill demonstrated towards the PHRC by Governor Ridge and Governor Rendell, the Legislature, and our local representatives. In this regard the PBA, both its leadership and many of its members, have been very effective supporters of the PHRC and the Hankin Chair.
Annual State support through DCED went from zero in 1996 to $600,000 in 2001/02. For 2002/03 this base funding was cut to $438,000, and in 2003/04 it was reduced again to $238,000. We received $388,000 for 2004/05 and are hoping for the same allocation for 2005/06. For the continuity of this base funding we are indebted to the home-building community in Pennsylvania and the leadership of the PBA. The uncertainties about base funding, the amount and its timing, continue to be an issue.

### The Main Sources of Financial Support

<table>
<thead>
<tr>
<th>Activity</th>
<th>Type</th>
<th>PSU</th>
<th>State</th>
<th>Industry</th>
<th>Endowed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Education</strong></td>
<td>***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Training</strong></td>
<td>*</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>R, D and D</strong></td>
<td>**</td>
<td>*</td>
<td></td>
<td>***</td>
<td></td>
</tr>
<tr>
<td><strong>Technology Transfer</strong></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td>***</td>
</tr>
<tr>
<td><strong>Process/Service</strong></td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

PHRC training efforts are also supported from other governmental sources (the Department of Energy and the Department of Labor and Industry); the PHRC received $325,000 in 2001/02, $118,750 for 2002/03, $110,000 for 2003/04, and we are expecting to receive $90,000 for 2004/05. In addition, we have established a good relationship with the Pennsylvania Housing Finance Agency and are currently involved in two projects funded by the PHFA.

Until 2005, our technical R, D and D efforts were funded at about $200,000 per year. Projects were funded by ASHRAE, NSF, industry and, to a very limited extent, support from DCED. The Building Enclosure Test Laboratory (BeTL) has been relocated, rebuilt and expanded at Cato Park in State College. This laboratory is probably the only facility devoted to Building Enclosures at a university in the entire country and represents a unique working asset. This resource was funded largely by Penn State with contributions from a variety of other sources.
A third funding table shows all the major sources of funds and provides some idea of the amount and variation in this support over the last few years. Currently, our group at Penn State has an annual operational cost of between 1 and 1.25 million dollars per year. Also note that the leverage we obtain from each contributor is significant; for instance, the multiplier on Hankin, State and Industry funding is of the order of 12, 3 and 20 respectively. In fiscal terms, we operate both efficiently and effectively.

### Funding Sources and the Disposition of these funds

<table>
<thead>
<tr>
<th></th>
<th>PSU</th>
<th>State</th>
<th>State¹</th>
<th>Federal²</th>
<th>Industry²</th>
<th>Industry</th>
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<td>Indirect</td>
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<td>Education</td>
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<tr>
<td>Training</td>
<td>*</td>
<td>***</td>
<td>*</td>
<td>*</td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R, D and D</td>
<td>**</td>
<td>*</td>
<td>*</td>
<td>**</td>
<td>**</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>Technology Transfer</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process/Service</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Annual $ max/min.</td>
<td>250</td>
<td>600/250</td>
<td>250/0</td>
<td>150/0</td>
<td>100/30</td>
<td>60/32</td>
<td>100</td>
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<tr>
<td>Leverage</td>
<td>5</td>
<td>2-3</td>
<td>&gt;8</td>
<td>&gt;8</td>
<td>&gt;12</td>
<td>&gt;20</td>
<td>12</td>
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</tbody>
</table>

What We Do

Educational activities are covered above under Hankin Responsibilities. While a listing of our products is provided in the Appendix, the sections that follow attempt to briefly highlight the nature and worth of what has been done in relation to the other four categories of Hankin and PHRC endeavor.

Training

The PHRC has developed into a major provider of training to the home building industry in Pennsylvania. The main reason for this has been the mandated adoption (for the first time) of a state-wide building code. In November 1999, the Uniform Construction Code Act 45 was signed into law. The code selected was the new International Residential Building Code (IRC 2003). As shown in the table and the two related graphs, nearly 10,000 persons have received training of some sort over the last seven years. We believe that the PHRC has been responsible for the most ambitious and effective program of building-related training ever conducted in Pennsylvania. In addition to the programs directed at the home building community, a number of training programs have been designed and delivered to professional engineers and architects and to the insurance and restoration industries. Programs have been developed for the Concrete Masonry industry and, in response to requests from professional and insurance groups, a number of moisture control workshops have been provided.

Training is only a partial solution to the larger issue of education for the residential building business. This would embrace the whole education system from high school to vo-tech programs to community colleges and universities. The PHRC has a stake in the educational process and is well positioned to play both a leadership and a delivery role in this field. The breadth of its efforts is evident from some of the PHRC’s initiatives:

**Code Training Consortium:** The PHRC put together a consortium of interested organizations, associations and state agencies that either provide building-code training or represent groups that need access to training. Interest in membership in the consortium is increasing as the group comes together.

**PA Construction Code Academy:** The PHRC has partnered with the DCED’s Governor’s Center for Local Government Services, the Pennsylvania State Association of Township Supervisors and the Pennsylvania State Association of Boroughs to provide training
for the Pennsylvania Construction Code Academy (PCCA). The PCCA is the Commonwealth’s mechanism to provide building-code-related training to local government officials and employees.

**Career and Technical Educators Technical Development Program:** A proposal was submitted to the PA Department of Education for a five-year program to develop and deliver a series of training and educational programs and to provide ongoing technical assistance, outreach and liaison to CTEs. The proposal is still pending.

**Train-the-trainers:** One very important by-product of the PHRC’s commitment to training is the fact that we have trained and developed at least 20 Pennsylvanians who are knowledgeable of the Code and capable of teaching this material. Photographs and the names of some of the trainers appear later.

**Stormwater Control:** The PHRC has provided leadership at a time of turmoil and change in the state stormwater regulatory environment. The PHRC has developed and presented numerous workshops and training sessions for design professionals, regulators, builders, and developers. To date, over 600 people have attended PHRC-sponsored training events on stormwater control. We provide a valuable resource for builders and design professionals seeking assistance in resolving stormwater issues.

**Factory Built Housing:** A successful proposal was submitted to the Ben Franklin Partnership by the PHRC at Penn College. This grant enabled the College to appoint a full-time Director. The Factory Built Housing Center is charged with leading, developing, and growing educational and research initiatives, including the expansion of the training programs for the Modular Housing Training Institute (MHTI) and the Manufactured Housing Resource Center (MHRC).
# Training Programs Delivered by the PHRC

<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>No. of Programs</th>
<th>No. of Attendees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive IRC Program for Code Officials</td>
<td>21</td>
<td>497</td>
</tr>
<tr>
<td>IRC’s Plumbing Requirements for Code Officials</td>
<td>14</td>
<td>302</td>
</tr>
<tr>
<td>IRC’s Mechanical Requirements for Code Officials</td>
<td>14</td>
<td>280</td>
</tr>
<tr>
<td>PA’s New Energy Requirements for Code Officials</td>
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<td>492</td>
</tr>
<tr>
<td>Administering and Enforcing PA’s New Energy Code</td>
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<td>12</td>
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<tr>
<td>Comprehensive IRC Program</td>
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<td>3,836</td>
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<tr>
<td>CABO to BOCA Transition Program</td>
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<td>612</td>
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<td>Overview of the IRC’s Plumbing Requirements</td>
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<td>270</td>
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<tr>
<td>Overview of the IRC’s Mechanical Requirements</td>
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<td>709</td>
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<td>PA’s New Energy Requirements</td>
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<td>629</td>
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<td>IRC Update Program</td>
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<tr>
<td>Moisture Control</td>
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<td>229</td>
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<tr>
<td>Comprehensive IRC’s Masonry-Related Requirements</td>
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<td>670</td>
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<tr>
<td>International Building Code for Concrete Masonry</td>
<td>7</td>
<td>226</td>
</tr>
<tr>
<td>Stormwater Management in PA – A New Approach</td>
<td>5</td>
<td>318</td>
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<tr>
<td>Custom Programs</td>
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<td>306</td>
</tr>
<tr>
<td><strong>Total programs delivered</strong></td>
<td><strong>295</strong></td>
<td><strong>9,444</strong></td>
</tr>
</tbody>
</table>
Instructors: A Training Resource

Bob Buddenbohn  Don Forry  Lee Milligan  Don Surrena

Dave Buskirk  Ned Liggett  Merle Musick  Bob Smith

Robert Cartwright  Matt Light  Jim Royer

Cindy Davis  Jim Matscherz  Rodney Sarver
Mark Fortney Delivering Training
Research, Development and Demonstration

The reports, papers and presentations listed in the Appendix provide a good indication of the nature, extent and quality of our efforts in this area of endeavor. Much of this work is of a technical nature. Some projects, however, have been more important, technically or politically, than others; and the following projects deserve special mention.

Pennsylvania’s Alternative Residential Energy Provisions:

In late 1999, legislation was passed to adopt a statewide building code—for housing the IRC 2000 was selected. The passage of the Uniform Construction Code (Act 45 of 1999) required the Pennsylvania Department of Labor and Industry (DLI) to promulgate regulations for prescriptive methods to implement energy requirements that take account of the various climatic regions in the Commonwealth. The PHRC was asked to provide a document that was simpler, more flexible, and focused on and better suited to Pennsylvania. Over a period of five months, the PHRC put a great deal of effort into developing and justifying an alternative, prescriptive energy code for Pennsylvania. The PHRC then submitted to the Department of Labor and Industry a draft code titled Pennsylvania’s Alternative Residential Energy Provisions (The PHRC Alternative to Chapter 11, Energy Efficiency, of the International Residential Code (IRC) for use in Pennsylvania). This code was then formally adopted. It simplified the climate zones for PA and introduced trade-offs for airtightness and energy-efficient appliances. On average, 40 - 45,000 new homes are built in the Commonwealth each year. The PA-Alternative will impact much of this new housing but this code has also had considerable influence outside the state.

Membranes on the Exterior Sheathing — Conducted field investigations, laboratory testing and analysis of various housewraps and building papers to evaluate in-place performance, especially their effectiveness as an air barrier in residential wall assemblies.

Steel Framing Systems — Analysis (computer modeling) and simulation of exterior wall systems to assess the performance of steel stud framing in relation to the control of heat, air and moisture.
Ventilation Drying of Walls — The PHRC recently completed two interrelated R and D projects. One was funded by ASHRAE and the other by NSF. Both relate to the contribution of ventilation drying to the performance of above-grade enclosure wall systems with screen type cladding, e.g., siding, masonry veneer, etc. One objective was to develop and publish practical guidelines for design and construction. This work will have a bearing on the choice and installation of sheathing membranes (housewraps and/or building paper), the sizing of drainage and ventilation capabilities, the choice of cladding, and the provision of weeps and vents. This multi-year research project work was conducted in partnership with the Oak Ridge National Laboratory (ORNL) in Tennessee and the University of Waterloo in Waterloo, Ontario, Canada. The project was successfully completed at the end of 2004. Thirteen reports have been submitted to ASHRAE. Since completing this work, we have been asked to do complementary work for the brick industry; this project will be completed by September 2005.

Wood Research — Largely under Dr Manbeck’s leadership, a number of projects were partially funded by the PHRC. The two main projects were the “Properties of Wood Composite Materials and Structural Response of Wood I-Joists” and “Moment Capacity of Metal Truss Plate Connectors.”

“Visitability” — The PHRC is participating in a project to review the costs and benefits of Visitability Guidelines for Pennsylvania. This Pennsylvania Housing Finance Agency (PHFA) funded project is a partnership between Life and Independence for Today and the PHRC. The PHRC has assisted in the identification of six suitable builders and the building of 13 visitable houses across Pennsylvania. A series of four reports on the advantages, disadvantages, technical and developmental considerations, and costs and benefits have been prepared for distribution by the PHFA. The PHRC received a Certificate of Meritorious Service on October 14, 2004, from PHFA for its research project to evaluate Visitability in PA.
The unique facility for testing walls, roofs, membrane, sheathing, etc., has been assembled over the last six or seven years. The laboratory contains an all-purpose (hot and cold, rain, air pressure differential) testing frame commonly found in a good enclosure testing facility. It also contains a climate chamber designed and built specifically for BeTL. The photograph of this chamber under construction shows three research assistants, Chris Schumacher, Xing Shi, and Joe Piñon, and a technician, Bill Splain. The climate chamber can model any climate and, using lamps, can model any day and any orientation, i.e., solar intensity, temperature and relative humidity. The photographs provide some idea of the equipment available.
The facility has been and still is being used for a comprehensive program of research on the performance of above-grade enclosure wall systems. Of particular interest are sheathing membranes (housewraps, building papers), cladding (brick veneer, metal, vinyl, etc.) and the potential for ventilation drying. Research projects have been funded by ASHRAE, the NSF, private industry and state and PHRC funds. At present, testing is being funded by the Brick Industry Association. In equipping, setting up, designing, operating the lab, the contributions of the following need to be acknowledged:

Land Development Activities

Land development issues have a significant impact on the delivery of residential housing within the Commonwealth. The most pressing site development needs are for updated and consistent residential site development standards, and resolving issues related to recent changes in the State’s stormwater management policy and the implementation of NPDES II requirements.

In the late 1990’s, the PHRC conducted an investigation into how local government was applying the subdivision and land development provisions of the State’s Municipal Planning Code. In 1999, a report was produced that found significant inconsistency in the application of residential site development standards. Most municipal standards are outdated and, in many instances, are in conflict with sustainable or “best practice” development techniques. The report identified the need to develop model land development standards for the Commonwealth. A second conclusion identified the need to form a coalition of representatives from local government, state regulatory agencies, builders, developers, architects, landscape architects, planners, engineers, environmentalists, and other stakeholder groups interested in improved residential site development. The purpose of this group would be to support and participate in the development of the model residential site development standards.

For more than two years, the PHRC has sought funding and initiated efforts to produce the needed model standards. The Land Development Consortium was formed and had their first meeting in July 2004. (See Figure for stakeholder groups represented.)

By the summer of 2004, the PHRC had received partial support for the development of model residential development guideline standards. Some initial seed funding was also received from the Pennsylvania Builders Association and this was followed by a grant from the Pennsylvania Housing Finance Agency. In June 2005, a grant was received from the Water Environment Research Foundation, bringing the total funding for the project to the 65% level.

The residential site development guidelines will include site design, streets, parking, stormwater management, sanitary sewer systems, potable water systems, site and lot grading, and other utility considerations. Completion of the street standards is anticipated by fall of 2005, and completion of all sections of the model standards by early 2007.
The PHRC has also been active in influencing state stormwater policy. Scott Brown is a member of the oversight committee for the development of a Stormwater Best Management Practices Manual for Pennsylvania. He has taken a leadership role in an attempt to ensure that the recommended procedures and practices are reasonable, science based, and appropriate for the residential building industry in Pennsylvania.

In the future, we intend to augment our current efforts with research to address stormwater management issues and to assess and develop impact mitigation strategies for residential development.
Technology Transfer

In one sense, all of the training the PHRC does could be viewed as technology transfer; so, for that matter, could all the talks and presentations we deliver. In addition, the reports and publications listed in the appendix are an integral part of our program to transfer technology to the various groups interested in residential construction. The following are supplementary initiatives:

**Annual PA Housing Conference** — In fact, the PHRC holds two simultaneous conferences at two different locations. By holding these meetings at two strategic locations, we have attracted well over 300 attendees. The PHRC held its 13th Annual Housing Conference in Allentown (125 attendees) and Pittsburgh (91 attendees). The morning program consisted of four primary sessions: Common Building Failures, Visitability in Pennsylvania, Ventilation Drying in Walls, and UCC Update. The afternoon started with seven roundtable sessions; then the program split into three different tracks: Flashing for Windows, Doors and Decks; Concrete Performance; and Common Code Violations and How to Avoid Them.

The 2nd Annual Land Development Conference was held in conjunction with the PA Housing Conference. At the Allentown location, there were 86 attendees and the Pittsburgh location had 49 attendees. The morning program consisted of five sessions: Legislative Update; Stormwater Management—Where are we?; Planning for Residential Developments...Today’s Vision, Tomorrow’s Trends; Lot Design...Thinking Outside the Box; and Road Standards...Optimizing for Function and Cost. The four afternoon sessions were: The Impact of Topography and Soils on Site Development; Infiltration: Understanding the Process and Limitations; Soil Testing and Site Investigation...How Much is Enough; and Panel Discussion—Site Selection and Infiltration Issues.

The PHRC has submitted a proposal to the Pennsylvania Department of Education, Bureau of Career and Technical Education (CTE) for the technical training of vocational building construction teachers. The goal of this program is to create a mechanism to keep educators up-to-date on new and emerging technologies, construction methodologies, and building codes. The program will incorporate this information into curriculum and teaching.
The PHRC will provide the CTE subcommittee with input and guidance on the activities that will be pursued under this multi-year initiative. The subcommittee will consist of the PA Department of Education, industry representatives, CTE educators and administrators, and PHRC members. The proposal is pending.

**Briefs** — The PHRC has developed and distributed a series of Builder Briefs, Technical Briefs and Research Briefs. These are short (4 pages or less) reports that focus on a single topic in a manner appropriate to the intended audience.

**PHRC Newsletter** — The PHRC produces two to three newsletters each year to report on the PHRC’s projects, recent reports, and other resources that are available to the housing industry in Pennsylvania.

**Internet Site** — The PHRC continues to improve its web site (www.engr.psu.edu/phrc) to help disseminate information. An executive summary from each of the reports as well as builder, research and technical briefs are available on-line.

Given its limited resources, the PHRC still needs to resolve two related issues. First, how much of the relevant technology should it develop, and how much should it borrow? The internet is by far the most effective and cheapest means of transferring technology, so the second issue is how best to serve Pennsylvania’s needs without unnecessarily duplicating or competing with other websites.
Process and Service

Significant resources—both time and money—are consumed in dealing with the agencies, both governmental and academic, with which we interact. The proposal submission and tracking process, plus the accounting and management procedures, are onerous.

The PHRC is relatively well known and, as a result, staff have to respond to the many questions (often from the public both within and outside Pennsylvania) that arrive by telephone, e-mail, or mail. Mold is an issue that has generated many questions. Both the Hankin Chair and the PHRC have a responsibility to liaise with and provide assistance to the housing industry. In particular, we attempt to stimulate and encourage innovation and enterprise. As a consequence, we meet with individuals and companies, evaluate products, provide assistance to agencies (both local and national) and review proposals, etc. This is a much needed and valuable service for which the PHRC receives little funding.

As a service to the home building and remodeling industry in Pennsylvania, the PHRC offers a speaker service to local and regional associations.

PHRC staff liaise with the PBA and also provide short articles or items of information for the two PBA publications, the *Keystone Builder* and the *Pennsylvania Builder*. The PHRC newsletter and web page are also vehicles for communicating with the builder community and housing consumers.

As the PHRC grows and becomes even better known, the cost of process and service will increase. The R in PHRC stands for Resource as well as for Research and, as the resource role expands, the PHRC will need to find some way of properly funding this important aspect of its mission. It needs to be stressed that this degree of consumer interaction is not customarily expected from a university engineering center. A 15% administration charge on contracts does not cover the cost of many of the services the PHRC is asked to provide.
The People

(The PHRC Crew)
Dr. Burnett is a structural engineer with specialist competence in the broad areas of building science and technology, building performance and structural concrete. He has extensive experience of the building industry, having been involved in the design and construction of buildings on three continents. He has worked with and consulted to a number of R and D agencies in the U.S., Canada and elsewhere.

Dr. Burnett holds the Bernard and Henrietta Hankin Chair at the Pennsylvania State University. He is cross-appointed to the Departments of Civil and Environmental Engineering and Architectural Engineering. He is currently Director of Research for the Pennsylvania Housing Research/Resource Center.

Both as an educator and a researcher, Dr. Burnett was associated with the University of Waterloo in Canada for more than 25 years. He founded and was Director of the Building Engineering Group, as well as being a Professor of Civil Engineering. In addition, as senior Consultant and Technical Director for Building Science and Rehabilitation, he was involved with Trow Consulting Engineers Ltd. for more than ten years. For more than two years he was the first Manager of Building Research for the Canada Mortgage and Housing Corporation in Ottawa, Canada.

Dr. Burnett’s current research interests are directed at the performance of building enclosures, i.e., wall systems, roofs, etc., and the integration of support, finish and control (heat, air, moisture) functions.
Mark Fortney has been with the PHRC since 1998. As Director of the PHRC, he is responsible for the day-to-day operation of the center as well as overseeing numerous contracts and grants.

His professional background includes over 25 years of experience relating to energy efficiency and residential and commercial construction. This includes positions at the Bureau of Sustainable Development, Pennsylvania Energy Office, and Energy Engineer in the Office of Pollution Prevention, Pennsylvania Department of Environmental Protection, as well as positions in the private sector. Mark holds a BS in Structural Design and Construction Management and an AET in Solar Engineering from the Pennsylvania State University.

He coauthored the Pennsylvania Alternative Energy Provisions for Residential Construction. This document was adopted by the Commonwealth of Pennsylvania as part of the State’s building code and is expected to save the residents of Pennsylvania hundreds of millions of dollars.

Mark was responsible for the development of an infrastructure that has trained over 8,500 builders, design professionals, code officials, teachers and others involved in the residential construction industry. This included the development of over 20 training programs and the involvement of instructors from Penn State and from industry. Most of these programs have been delivered through partnerships with trade and professional associations, and the Commonwealth of Pennsylvania, as well as individual corporations.

He also initiated the Pennsylvania Code Training Consortium (PA-CTC). The CTC was established to create a forum for training providers and those who need training to share information and to coordinate efforts.

He is also responsible for the development and management of the annual Pennsylvania Housing Conference. This technical conference draws upon expertise at Penn State and throughout the industry to address technical challenges facing the housing industry.
Since July 2002, Scott has been the Land Use and Development Specialist for the Pennsylvania Housing Research Center. He has over 25 years of experience as a licensed professional civil engineer, and has unique expertise in residential and commercial site development, urban drainage, stormwater management, and river and watershed engineering.

Scott received his post-secondary education at the Pennsylvania State University where he was awarded his Bachelor of Science and Master of Science degrees in Civil Engineering in 1977 and 1979 respectively.

Early in his career, Scott was selected to manage the Federal Highway Administration’s hydraulics laboratory in McLean, VA. Research areas included investigations of bridge waterway hydraulics, culvert hydraulics, and storm inlet hydraulics. In the mid 1980’s, Scott became involved in land use and land development activities in the Washington, D.C. area. In 1991, Scott’s career took him to Western New York where he served as the director of land development activities for an engineering consulting firm. In addition, he managed a team of 26 professionals working on the design of a project on the New York State thruway, which included all environmental clearances and the widening and rehabilitation of 11 ramp and main-line bridges.

From 1993 – 1995, while continuing to oversee land development activities, Scott served as principal investigator and primary author of a manual on urban drainage for the Federal Highway Administration. This technical design manual of more than 700 pages was published in 1996 as the Federal Highway Administration Hydraulic Engineering Circular No. 22, and continues to be used as a reference for drainage design nationally.

In 1996, Scott returned to Central Pennsylvania to work in the residential and commercial land development industry. Over a period of six years, Scott oversaw the engineering design of a significant portion of the expansion of residential and commercial properties in the State College Area.
Before joining the PHRC in January 2002, Ken served as a partner in a Harrisburg, PA engineering firm that specialized in the design of plumbing and HVAC systems. He is a certified Master Plumber and also holds several International Residential Code (IRC) certifications. Ken has more than 35 years of experience in the construction industry.

Ken holds a BS in Workforce Education and Development and is currently working on his Master’s degree with an emphasis in post-secondary and industrial training. As a McNair Scholar at Penn State, Ken studied the decline in the number of tradespeople and the gap between and employers’ expectations of young people entering the building trades and their education.

As the Training and Education Development Specialist for the PHRC, Ken is responsible for the planning and administration of most training programs. He has developed and held training sessions for builders, remodelers, building code officials, design professionals, teachers, home inspectors, realtors, bankers and other professionals in the residential construction industry. His other responsibilities include overseeing the development of marketing, identifying presenters, and assuring the overall quality of the programs.

Ken and his wife, Deb, recently designed and built their own energy-efficient home in Bellefonte. This house has been recognized by the National Association of Home Builders (NAHB) as a model for their “Green Building” program. The construction of their house was filmed by NAHB and the film shown at the annual Green Building Conference in Atlanta in April 2004. The entire project is scheduled to be shown on Home and Garden TV (HGTV).
Ever since she graduated from the South Hills School of Business some 14 years ago, Michelle McMullen has been employed at the Pennsylvania State University. She joined the PHRC in December 1995, and works closely with both the Hankin Chair as well as the other employees of the Housing Research Center. Michelle was the first fulltime staff member and continues to be the longest serving member of the PHRC.

As the Administrative Assistant of the PHRC, Michelle plays a crucial role in PHRC’s administration. Over the last nine years her responsibilities have increased, as has her work load. She works closely with both the Hankin Chair (about 33% of her time) and the PHRC (67% of her time).

Among other things, she produces (or oversees the production of) the PHRC’s many publications, interacts with and assists undergraduate and graduate students, and keeps the administrative side of the PHRC and its various activities functioning smoothly.
Tracy DeSoto has been working at Penn State for about 15 years. She joined the PHRC in November 2000. Her official title is Staff Assistant, which does not do justice to what she actually does for the PHRC. She works closely with the Administrative Assistant to facilitate operation of the PHRC. She also works with both the Director and the Training Education and Development Specialist to coordinate PHRC’s many training programs.

Tracy is the primary point of contact for industry partners to schedule training, answer questions about the PHRC, and channel technical questions to appropriate PHRC staff or faculty. It is her responsibility to meet the needs of not only the PHRC but also the industry organizations that sponsor the training programs.

Tracy is the PHRC’s main contact person with the industry, especially the Pennsylvania Builders Association and the executive officers of the various Local Builders Associations across Pennsylvania, as well as local, regional and state agencies, consultants, code inspectors, builders, and the general public.
Beyond Pennsylvania

Liaison and involvement with the housing community extends far beyond PA. Over the past nine years, my position as the Hankin Chair has enabled me to take, or promote, initiatives that have national implications. I believe these activities are very much in line with Bernie Hankin’s vision for strengthening the residential construction industry. Some of these activities are listed below.

**BETEC (Building Environment and Thermal Envelope Council, recently revised to the Building Enclosure Technology and Environment Council):** I have been a Board member of BETEC since 1996 and was Vice-chair in 2001/02. In 2001, I was invited to serve as Chair. I relinquished this chairmanship in January 2005. The following are some of the initiatives that I encouraged, or took part in:

- To change the name, but not the acronym, to the Building Enclosure Technology and Environment Council to better reflect the focus of BETEC.

- BETEC is now the national representative to the International Association of Building Physics.

- I participated in both the first international conference held in Eindhoven, Holland, and was on the International Scientific Committee for the second conference held in Belgium in September, 2003. I am on the Scientific Committee for the third conference, to be held in Montreal in 2006.

- The Government Services Administration (GSA) is pursuing the development of comprehensive guidelines for the design and performance of building enclosures through BETEC. A total of $600,000 was committed (mainly by GSA, FEMA, and DOD) to this task, which will have far-reaching effects. I have been, and will continue to be, involved in the management of this project.

- Because of the dearth of education and R and D in the area of building enclosures and the extent of problems and attendant litigation, BETEC is taking on the lead role for education and information transfer. One initiative was the holding of the first WUFI (Hygrothermal Analysis Software) workshop in the US, which took place in June 2002 at Penn State. This was a joint venture sponsored by the PHRC, the Fraunhofer Institute from Germany, and Oak Ridge National Laboratory in Tennessee. These workshops are now being conducted nation-wide.
The setting up and promotion of BETEC/AIA Building Enclosure Councils (BECs) in cities across the country. This is an attempt to foster the formation of multi-disciplinary groups to provide a local focal point for discussion, promotion, and improvement in regard to the performance of building enclosures. The AIA has given formal support to this initiative and, to date, BECs have been started in Boston, Philadelphia, Pittsburgh, Dallas, Washington, D.C., and Seattle.

In June 2004, Theresa Weston of DuPont and I convened a two-day workshop on “Membranes in Walls” in Crystal City just outside Washington, D.C. This BETEC-sponsored workshop was directed at the contribution of membranes (paints, housewraps, building papers, etc.) to the performance of wall systems and also attempted to address the confusion concerning the need for vapor retarders, air barriers and water barriers.

**National Consortium of Housing Research Centers:** Board member since 1996. Chair for 2000 and 2001. As Chair, I volunteered to write a position paper addressing the future of this consortium. This report, entitled *The Concept of a Network of Full Service Housing Resource Centers*, was distributed in February 2002. The report is also a roadmap for the growth of housing-related education and R and D within a participating university. In February of this year, NSF and HUD/PATH jointly sponsored a workshop on the research needs of the housing industry. I led the focus group addressing the building enclosure and authored the group report.

**National Institute for Building Sciences (NIBS):** As Chair of BETEC, I am invited to attend board meetings of the National Institute for Building Sciences. I am also on the Consultative Council to NIBS. NIBS is concerned with national policy, federal funding, and priorities relating to the built environment. With four presidential appointees, NIBS is the only engineering/construction related agency that has a mandate to report to the President and Congress each year.
Concluding Commentary

The years I have been privileged to spend as the Hankin Chair have been busy, interesting and rewarding. Mark Fortney, the Director of the PHRC, has made it possible for me to spend more time on my teaching, research, and leadership responsibilities. His activities have significantly raised the profile of both the PHRC and the housing program at Penn State. Having joined the PHRC as the Education, Training and Development Specialist, Ken Sagan has taken on a lead role in initiating and delivering training programs. Scott Brown’s appointment represents a milestone. He has taken over the Land Development course and is expanding the PHRC’s commitment to the land development area. The assistance provided by Michelle McMullen, our Administrative Assistant, is invaluable. She has an excellent rapport with the students and plays an important role in the NAHB student chapter. Tracy DeSoto is a tremendous help with all the training programs.

I believe that what we have done and are doing is fully consistent with Bernie Hankin’s intent. A considerable amount has been accomplished over the past nine years. The Hankin endowment makes the activities of the Chair, and thus the PHRC, possible.

The support that the Hankin Chair and the PHRC has received, in particular the support from outside the University, has been most encouraging. The debt we owe to the PBA, its executive and its members, is considerable. Both the PHRC and Penn State are greatly indebted to individuals such as Scott Cannon, Don DeLess, Roger Glunt, Richard Hankin, David Martin and others who have given unstintingly of their time and advice in support of housing at this University.

The groundwork has been laid to make Penn State a national center of excellence for the residential housing industry. To move forward to the next level of development, at least one and preferably two junior faculty members need to be appointed to work in the areas of housing, especially development and building enclosures. These appointments would bring three main benefits. First, they would give the Chair the committed academic support that is needed; second, three faculty members would constitute a viable academic group and facilitate the getting and doing of housing-related R and D; and third, the workload of both the Hankin Chair and the Director of the PHRC would be reduced to a reasonable level. This is the most important recommendation I can make at this time. I believe it would fulfill Bernie Hankin’s vision, and I believe that the housing industry deserves no less.
Directions for the Future

My experiences over the past nine years, as well as the qualifications and experience I brought to the Hankin chair when I accepted my appointment, have led me to some conclusions that I wish to share. I believe strongly that there are clear paths that need to be taken, and I have laid them out here in the hope that they will be given thoughtful consideration.

1. Housing has not received the attention it deserves from the Engineering faculties at our universities. The industry is too important for this situation to be allowed to persist. The housing industry must get actively involved in making the case for the right things to be done at the right places by the right people.

2. For the reasons noted earlier, there should be at least three full-time faculty members whose primary focus should be the delivery (development, design, construction, and operation of residential built facilities) of appropriate housing.

3. The PHRC is too valuable a resource to be so heavily dependent on state and local politics. At the state level, the PBA should continue with its support for the PHRC and attempt to establish a reasonably secure but appropriate level of base funding for the PHRC. At the national level, the NAHB and the NHE need to promote the development of six or seven full-service (education, training, R and D, and technology transfer) Housing Research/Resource Centers.

4. The main need at present is for energetic, active, knowledgeable, and committed faculty members. Land-grant institutions with large engineering, architectural engineering and architecture programs are the appropriate institutions at which to establish full-service housing research centers.

5. The largest educational gap exists in the area of building enclosures and the related building science. Both Engineering and Architectural schools need to come to grips with the notion that the building enclosure, as the environmental separator, is a vital component of any built facility. Most of the performance problems with modern buildings involve the building enclosure, and much of the blame for this situation can be attributed to the lack of appropriate education.

If it were not for Bernie Hankin and the Hankin Chair, neither Penn State nor the Commonwealth of Pennsylvania would be responding to any of the issues mentioned above. That, perhaps, is the most significant legacy of the Hankin endowment to Penn State, the Commonwealth, and the nation.
Products 1996 to 2005

Books:


Codes and Standards:


Position Papers:


Conference Proceedings:


Technical Reports:


Published Papers:


**BRIEFS:**

**Builder Briefs:**

BB0502—Air Leakage in Recessed Lighting, PHRC Builder Brief.

BB0402—So You Want to Become a Construction Code Official.

BB0301—Mold and Buildings, PHRC Builder Brief.

BB0201—Blower Door Testing, PHRC Builder Brief.

BB0200—Wood I-Joist/OSB Residential Floors.

BB0199—New and Improved Basement Wall Systems.

**Technical Briefs:**

TB0302—Window Technology.

TB0201—Site Design Considerations for Manufactured Housing.

TB0101—Soil Freeze Depth Guide for Manufactured Housing in PA.

**Research Briefs:**

RB0199—Composite Action and Floor System Stiffness.
Training Manuals:

Pennsylvania’s Uniform Construction Code (UCC) (ACT 45 of 1999) and the 2003 International Residential Code (IRC) ~ “Just tell me what I need to know!”

- Comprehensive International Residential Code
- IRC’s Plumbing Requirements
- IRC’s Mechanical Requirements
- PA’s New Energy Requirements
- IRC Refresher and 2003 Update
- Comprehensive IRC for Code Officials
- IRC’s Plumbing Requirements for Code Officials
- IRC’s Mechanical Requirements for Code Officials
- PA’s New Energy Requirements for Code Officials
- Administering and Enforcing Pennsylvania’s New Energy Code for Code Officials
- Comprehensive IRC’s Masonry Related Requirements
- International Building Code Program for Concrete Masonry
- Wood Frame Design - NDS Based (Harvey Manbeck)
- Stormwater Management in PA (Scott Brown)
- Moisture Control (Eric Burnett)

Some Representative Presentations:

**PennBOC Conference:** Mark Fortney presented a talk entitled “Masonry Requirements of the IRC and Updating to the 2003 IRC Program,” Hidden Valley, PA, October 2003.

**Affordable Comfort Conference:** Mark Fortney presented a session “Building Codes and Building Science: Is There a Link?” 2003.

**Pennsylvania State Association of Township Supervisors Conference:** Scott Brown delivered a presentation on “Site Level Hydraulic Process” to over 55 township engineers, 2003.


## Hankin Theses

<table>
<thead>
<tr>
<th>Name</th>
<th>Degree</th>
<th>Dept.</th>
<th>Year</th>
<th>Title</th>
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<tbody>
<tr>
<td>Brian Kozy</td>
<td>M. ENG</td>
<td>CEE</td>
<td>1996</td>
<td>Seismic Performance of Masonry Ties</td>
</tr>
<tr>
<td>John deGraauw</td>
<td>MS*</td>
<td>CE</td>
<td>1997</td>
<td>Simplified Hygrothermal Analysis – Methodology for Wall Enclosures</td>
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<td>Brennan Glantz</td>
<td>MS</td>
<td>CEE</td>
<td>1998</td>
<td>Design and Construction of a Performance Test Facility for Building Enclosures</td>
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<tr>
<td>John Straube</td>
<td>Ph.D.*</td>
<td>CE</td>
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<td>Moisture Control and Enclosure Wall Systems</td>
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<td>Edward Bosack</td>
<td>MS</td>
<td>AE</td>
<td>1999</td>
<td>Evaluation of Housewrap Performance in Buildings</td>
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<tr>
<td>Robert Bombino</td>
<td>MS</td>
<td>AE</td>
<td>1999</td>
<td>Hygrothermal Design Issues with Steel-Framed Enclosure Wall Systems</td>
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<tr>
<td>James Mendygral</td>
<td>MS</td>
<td>AE</td>
<td>1999</td>
<td>Structural Considerations for the Use of Helical Reinforcement in Masonry Assemblies</td>
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<td>Anthony Chamra</td>
<td>MS</td>
<td>AE</td>
<td>2001</td>
<td>The Structural Performance of Housewrap in Enclosure Systems</td>
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<td>Danko Davidovic</td>
<td>MS</td>
<td>AE</td>
<td>2004</td>
<td>Characterization of Ventilation Airflow in Screen-Type Wall Systems</td>
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<tr>
<td>Xing Shi</td>
<td>Ph.D.</td>
<td>CEE</td>
<td>2005</td>
<td>Ventilation Drying and Performance of the Exterior Membrane in Building Enclosure Systems</td>
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<td>Fred Peters</td>
<td>MS</td>
<td>AE</td>
<td>2005</td>
<td>Visitability for New Housing in Pennsylvania</td>
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* At the University of Waterloo.
### Glunt Fellows

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<th>Year(s)</th>
<th>Fellow</th>
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<td>1995/96</td>
<td>Brennan Glantz</td>
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<td>1999/00</td>
<td>Benjamin Wisniewski</td>
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<td>Steven Bentz</td>
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<td>Julie Masser</td>
<td>ABE</td>
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<td>2002/03</td>
<td>Joseph Piñon</td>
<td>AE</td>
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<tr>
<td>2004/05</td>
<td>Jesse Burow</td>
<td>ABE</td>
<td>Harvey Manbeck</td>
</tr>
</tbody>
</table>

**Products prior to 1996:**

**Reports:**


PHRC Research Series: Report No. 33, The Pennsylvania State University,
University Park, PA, November 1994.

Willenbrock, J. H., “Management Guidelines for Growth Oriented Home-
building Firms,” PHRC Research Series: Report No. 37, The Pennsylvania
State University, University Park, PA, October 1994.

Willenbrock, J. H., “Course Manual for Management Guidelines for
Growth Oriented Homebuilding Firms,” PHRC Research Series: Report
No. 38, The Pennsylvania State University, University Park, PA, October
1994.

Julo, J. A., “Comparative Analysis of State Mandated Contractor Licensing
Examinations,” PHRC Research Series, Technical Support Series: Docu-
ment No. 5, The Pennsylvania State University, University Park, PA, October
1994.

Julo, J., J. H. Willenbrock, “Suggested Competency Standards for the Penn-
sylvania Builders Association State-Wide Builder Certification Program,”
PHRC Research Series: Report No. 35, The Pennsylvania State University,
University Park, PA, August 1994.

Adams, P. F., “A Manufacturer’s Reference Guide to the Design and Opti-
mization of Energy Efficient HVAC Systems for Modular Houses,” PHRC
Research Series: Report No. 36, The Pennsylvania State University, Univer-
sity Park, PA, August 1994.

McIntyre, C., M. K. Parfitt and J. H. Willenbrock, “A Residential Land De-
velopment Model (Phase I of a Continuing Study Concerning the Land
Development Process),” PHRC Research Series: Report No. 28, The Penn-
sylvania State University, University Park, PA, August 1994.


University, University Park, PA, May 1994.

Julo, J., J.H. Willenbrock, S. Taylor and M. Syal, “Technology Transfer


Willenbrock, J.H., “Summary of the Sabbatical Year of Dr. Jack H. Willenbrock as the First “Scholar in Residence” at the National Association of Home Builders and of the NAHB Research Center (August 24, 1992 to


**Proceedings:**


