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Fire Safety Design for Non-residential Buildings

by

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Abstract

The wood products industry wants to expand its market share in non-residential buildings. This is a challenging goal because building codes exhibit a bias against the use of wood products, particularly in the construction of non-residential buildings. The move towards adoption of performance-based building codes offers the promise of eliminating such biases. However, in order to be prepared for the introduction of performance-based codes, architects, engineers and building code officials have pointed out the need for engineering tools to assess the fire performance of buildings.

This five-year project was initiated to develop fire-safety design tools for non-residential wood-frame buildings, and to foster development and delivery of educational programs to train students and practitioners in performance-based fire-safety design. In order to achieve these goals an NSERC Industrial Research Chair in *Fire Safety Engineering* was established at Carleton University in March of 2001. This report summarises the progress towards these goals made by the Chair in his first year of tenure.

Acknowledgements

Two Steering Committees have been struck to oversee the Chair's research program and to initiate an educational program in Fire Safety Engineering. Forintek Canada Corp. would like to extend its thanks to the members of these Committees for the enthusiastic guidance and dedication exhibited during the first year of tenure of the Chair.

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1 Objectives

To develop fire-safety design tools which will allow the wood products industry to expand its market share of non-residential buildings.

2 Introduction

Because of its design flexibility and cost-effectiveness, wood-frame construction has been very successful in North America. However, as Canada moves from a prescriptive building code to an objective-based building code, flexible and cost-effective engineering-based design solutions are required, in lieu of traditional empirical ones. Therefore, the wood industry's continued success will depend to a large extent on its ability to harness advanced technology for the design of safe, efficient structures. The industry requires computer models and other design tools to demonstrate the fire-safety performance of buildings; and the industry requires qualified people to use such tools for design and enforcement purposes.

More than a decade ago, Canadian manufacturers of wood building products recognised the building industry's need for advanced technologies to aid in performance-based fire-safety design of wood-frame buildings. They foresaw that without such tools, the wood industry's current domestic and export markets would decline and the doors to potential new markets would be closed. Accordingly, they instructed Forintek to initiate fire-research programs that would deliver those technologies. Forintek responded with a series of research initiatives: development of computer models that predict the fire-resistance of wood-stud walls and wood-joist floor assemblies, development of fire-safety design guides for wood-framed non-residential buildings, and a collaborative research project with NRC to develop structural fire resistance models for wood-stud walls. While Forintek's fire research program has resulted in the creation of a number of important components for a comprehensive design tool for light-frame buildings, these do not in themselves constitute that tool.

In fact, Forintek and the Canadian wood industry lack the resources to deliver these new technologies in a timely manner on their own. Because large buildings constructed with concrete and steel are the highest priority for public research institutions such as the National Research Council (NRC), Forintek recognised that it could not wait for them to develop design tools for wood-frame buildings. Forintek might hire the services of NRC, or work collaboratively with NRC to develop these design tools, but that would still leave a gaping hole in the industry's needs: trained professionals capable of using the new technologies to design and regulate construction of new light-frame buildings.

After careful consideration, Forintek, on behalf of all Canadian manufacturers of wood products, concluded that establishment of an Industrial Research Chair on *Fire Safety Engineering* at Carleton University would be the most efficient way to deliver this critical element in the industry's market plan. It was decided that an application be submitted to the Program on Industrial Research Chairs supported by the Natural Sciences and Engineering Research Council (NSERC). The Program is intended to assist in the development of research efforts in fields that have not yet been developed in Canadian Universities but for which there is an important industrial need. Under the Program, a major research effort centred on an established researcher is supported jointly by NSERC and industry for a period of five years.

It was recognised that establishment of an Industrial Research Chair on *Fire Safety Engineering* would result in delivery of the new technologies required by the Canadian wood industry and foster creation of educational programs that would produce professionals trained in the use of these design tools.

Establishment of the Industrial Research Chair at Carleton University in Ottawa would facilitate the Chair's access to both Forintek's and NRC's fire research expertise in the development of those tools.

This report summarises progress in the first four years of this five-year project to establish an NSERC Industrial Research Chair in Fire Safety Engineering at Carleton University. The Chair was put in place in March 2001. Detailed planning of a strategy to develop fire-safety design tools for non-residential wood-frame buildings has been completed. The Chair has attracted a postdoctoral fellow and three graduate students to assist in development of these tools. The Chair has also been awarded a grant under the Canadian Foundation for Innovation program that will provide facilities for the experimental components of the research program. Much effort has also been expended to develop educational programs to train students and practitioners in performance-based fire-safety design. In 2001/02, four new graduate courses in fire safety engineering were offered at Carleton University for the first time.

3 Background

Building codes set fire-protection requirements in order to ensure an adequate level of safety in buildings. The current Canadian requirements are prescriptive, so there is no clear statement of what performance is acceptable and no guarantee that all buildings are constructed to the same level of safety. In fact, for non-residential occupancies, current regulations often demand a higher level of fire safety be built into wood-frame buildings than into their concrete or steel counterparts. The extra costs associated with providing this higher level of safety often make wood-frame buildings less economical to build. Even when the building code and economics are not impediments, concerns about fire safety often cause designers, owners or insurers to avoid the use of wood in non-residential applications.

Building codes around the world are being revised to include performance-based fire-safety requirements. Rather than simply complying with prescriptive requirements intended to address fire safety in generic buildings, the designer will have the option of tailoring fire-safety systems to address the actual fire hazards in a building. By judging the acceptance of building design solely on the basis of performance, performance-based fire-safety requirements are expected to eliminate the inequitable treatment of wood products present in prescriptive building codes and thereby improve market access for wood products. The adoption of performance-based codes will also encourage more flexible and cost-effective design.

In order to be prepared for the introduction of performance-based codes, architects, engineers and building code officials around the world have pointed out the need for engineering tools to assess the fire performance of buildings. If the wood industry has the tools in place, the move to performance-based design could result in increased market share for wood building products. It would be particularly advantageous to develop fire-safety design tools for the non-residential wood-frame buildings governed by Part 3 of the National Building Code of Canada (NBCC) as these buildings must be structurally engineered in any case.

In countries where building codes have parallel prescriptive and performance-based requirements, it has been found that the lack of educational programs addressing fire-safety-engineering principles has been a serious impediment to the use and acceptance of performance-based fire-safety design. In other words, the potential benefits to the wood industry may not be realised as few practitioners and building code officials are conversant with the principles of performance-based design. It is, therefore, important that the wood industry encourage engineers to learn more about this subject.

This five-year project was initiated in 1999/2000 to develop fire-safety design tools for non-residential wood-frame buildings and to foster development and delivery of educational modules to train students and practitioners in performance-based fire-safety design. The proposed mechanism for achieving these goals was to establish an Industrial Research Chair at Carleton University.

4 Staff

J.R. Mehaffey	Project Leader and Research Scientist
L.R. Richardson	Group Leader, Fire Research
L. Poliquin	Program Manager, Building Systems

5 Project Plan

The proposed work plan for this project as envisioned in April 1999 is presented below in Table 1.

Table 1 Project Plan and Milestones (April 1999)

Activities	Planned Completion Date
Prepare draft proposal for a five-year NSERC Industrial Chair	September 31, 1999
Establish NSERC Industrial Research Chair at Carleton University	March 31, 2000
Initiate a research program on wood and fire safety at Carleton University	September 31, 2000
Fire safety design tools for non-residential buildings	March 31, 2004

In November 2000, the work plan was revised to reflect progress in the negotiations to create the Chair. The new work plan is presented below in Table 2.

Table 2 Project Plan and Milestones (November 2000)

Activities	Planned Completion Date
Submit the proposal for establishment of an Industrial Research Chair at Carleton University to the National Science and Engineering Research Council for funding support	Completed
Establish Industrial Research Chair at Carleton University with at least $600,000 in NSERC funding support	Completed
Initiate a research program on wood and fire safety at Carleton University	March 31, 2001
Develop the outline for a multidisciplinary research program for non-residential buildings and establish the first fire research project for that program	March 31, 2001
In conjunction with NRC, initiate an academic program in fire-safety engineering at Carleton University	September 1, 2003
Develop fire safety design tools for non-residential buildings	March 31, 2004

6 Results and Discussion

6.1 Progress during 1999-2000

6.1.1 NSERC Industrial Research Chair

Even before the initiation of this project in April 1999, Forintek had begun to take steps to establish a Natural Sciences and Engineering Research Council (NSERC) Industrial Research Chair in *Wood and Fire Safety* at Carleton University. The Department of Civil and Environmental Engineering at Carleton University had been approached with the idea in late 1998. The Department expressed interest and informed the Dean of Engineering and the President of the University who also expressed interest.

A candidate with a good international reputation was then approached and quickly agreed to pursue the Chair in co-operation with Forintek. The candidate, a research scientist at the National Research Council Canada (NRC), had been leading a research team developing tools to aid in the design and assessment of fire-safe non-residential buildings of non-combustible construction.

As writing the research proposal to NSERC was proving to be very time-consuming, J-C. Havard, a consultant familiar with wood industry issues, was retained to draft the proposal in consultation with Forintek, the candidate and the University. A first draft was nearing completion in the spring of 1999.

During the summer of 1999, an informal meeting was held with NSERC to discuss the draft proposal. A number of revisions were recommended by NSERC in order to strengthen it. The research component of the proposal was completely reworked by Forintek scientists and the candidate during the fall in order to respond to the NSERC comments. The financial component of the proposal, ensuring significant leveraging of Forintek's investment, was finalised during the winter of 1999-2000.

6.1.2 The Research Proposal

The focus of the proposed research was the development of engineering tools that could be used by fire protection engineers to design fire-safe wood-frame buildings in a performance-based code environment. This would entail conducting research into fire growth, fire behaviour of building materials, smoke movement, occupant response and evacuation, fire detection and suppression system effectiveness, and fire risk analysis. Emphasis was to be given to research that would benefit the wood industry by providing design tools which ensure fair assessment of the impact of wood products in building fires. To this end, it was agreed that a fire risk assessment framework and computer model to evaluate the overall fire safety performance of wood-frame buildings would be developed. The framework would be ideally suited to assess the fire performance of three- or four-storey commercial buildings.

6.2 Progress during 2000-2001

6.2.1 NSERC Industrial Research Chair

Carleton University and Forintek finalised the proposal to create an NSERC Industrial Research Chair in Fire Safety Engineering at Carleton University and submitted it to NSERC on June 2. Forintek proposed to provide the wood industry portion of the funding with NSERC covering the balance. Strong letters of support from the Canadian Wood Council and the Canadian Forest Service were attached to the proposal.

On August 15, an NSERC Site-Visit Committee visited Carleton University to learn more about the proposed research program as well as about the University's and the industry's commitments to the Chair. Although the Committee looked favourably on the proposal, it recommended some revisions including increased financial and administrative support from the University. Revisions were made and the revised proposal submitted to NSERC on August 23.

On September 27, NSERC approved the proposal, subject to the following conditions:

- The candidate be granted tenure from the outset;
- NRC acknowledge that its facilities could be employed as stated in the program of work;
- An agreement on intellectual property be secured among NRC, Forintek and Carleton University;
- Carleton University agree to offer a Masters degree in Civil Engineering with specialisation in fire safety engineering within 2 years;
- NRC be invited to participate on the Chair's Steering Committee; and
- Users (an architect and an engineer) be invited to participate on the Chair's Steering Committee.

By late 2000, Carleton University, NRC and Forintek met all six conditions. On January 15, the Chair was activated and Dr. George Hadjisophocleous was appointed Professor of Fire Safety Engineering at Carleton University. NSERC made an official announcement of the creation of the Chair on March 1. The announcement received favourable coverage by Ottawa radio and television stations.

6.2.2 The Research Proposal

The proposed research entails development of computer models for evaluating and quantifying the overall risk from fires in buildings with initial emphasis on four-storey wood-frame commercial buildings. A system model will be developed whereby the building will be treated as a system, complete with its fire protection options, building characteristics, occupants and functions. This approach will enable comparison of the costs and benefits of different design options available to designers and assist them in selecting safe and cost effective designs. With risk analysis the impacts of various possible fire scenarios on both life safety and property protection may be evaluated.

A comprehensive system model to represent the interactions of fire growth and spread, fire detection and warning, fire suppression and human behaviour will be developed together with subsidiary computer models dealing with the various aspects of the fire problem. The proposed model will be able to handle different types of building characteristics and functions, occupant characteristics, active and passive fire protection systems, construction materials, as well as the variety of fire scenarios that may be encountered in buildings. The subsidiary models will calculate the consequence of fire incidents both in terms of human losses and property damages and the frequency of these incidents.

To assist in the development of the system model, NRC has made FIERA available to the Chair. FIERA is a system model for reinforced concrete or structural-steel industrial buildings that was under development at NRC by Prof. Hadjisophocleous while he worked there. NRC has also agreed to make its testing facilities available to assist in development and validation of the required sub-models.

Table 3 summarises the proposed research tasks, the resource requirements and timeframes. In the Table, M.Eng. refers to a Masters student, Ph.D. to a Ph.D. student, PDF to a post-doctoral fellow. In order to deliver the work in the five-year tenure of the Chair, sufficient funding has been made available to Prof.

Hadjisophocleous to supervise a total of 4 M.Eng students, 1 Ph.D. student and 3 post-doctoral fellows. A detailed copy of the research plan is available from the author.

Table 3 Research Tasks, Resource Requirements and Timeframes

Research Task	Year 1	Year 2	Year 3	Year 4	Year 5
System model development	M.Eng.1	M.Eng.1			
Design fires, fire growth and smoke movement, experiments for input data and validation		Ph.D.	Ph.D.	Ph.D.	Ph.D.
Occupant response and evacuation			M.Eng.2	M.Eng.2	
Reliability of active systems			M.Eng.3	M.Eng.3	
Fire protection costs and direct fire losses				M.Eng.4	M.Eng.4
Submodel integration, graphical user interfaces	PDF 1	PDF 1	PDF 2	PDF 2	PDF 3
Structural response to fire, fire spread model	Forintek	Forintek	Forintek	Forintek	Forintek

During March 2001, Dr. Zhuman Fu accepted a position as post-doctoral fellow under the supervision of Dr. Hadjisophocleous. Dr. Zu received a Ph.D. Degree from the University of Science and Technology of China in 1995. The title of his PhD thesis was "Numerical and Experimental Study of Building Fire Using Zone Modelling Method". From 1995 to 1997 he worked as a Researcher at the State Key Lab of Fire Science and from 1997 to early 2001, under the supervision of Dr. Hadjisophocleous, Dr. Fu worked at the Fire Risk Management Program of NRC as a postdoctoral fellow. His work at NRC was focused on modeling fire growth and smoke movement in buildings. He also participated in the development of FIERAsystem, a comprehensive fire risk assessment model for industrial buildings. At Carleton University Dr. Fu will work on the development of the system model framework, the integration of the various submodels and the development of graphical user interfaces.

6.2.3 Masters Program in Fire Safety Engineering

J.R. Mehaffey met on several occasions with faculty of Carleton University and fire scientists from NRC to develop plans for a Masters Degree in Civil Engineering with specialisation in Fire Safety Engineering. There is currently no graduate program in Fire Safety Engineering in Canada. The demand for fire safety engineers is, however, high and is expected to increase with the introduction of objective-based codes in 2003. Plans are also being made to offer short courses aimed at practicing professionals.

The proposed curriculum comprises six core courses that will be offered during a three-term period as shown in Table 4. These courses were selected following a review of courses offered at Universities in other countries and the model curriculum for Fire Safety Engineering developed by the International Association for Fire Safety Science.

Table 4 Proposed Courses in Fire Safety Engineering

Course Title	Instructor	Date Offered
Fundamentals of Fire Safety Engineering	George Hadjisophocleous	September 2001
Fire Dynamics I	Jim Mehaffey	January 2002
Fire Dynamics II	Jim Mehaffey	September 2002
Human factors in fires	Guylène Proulx	September 2001
Fire modelling	George Hadjisophocleous	September 2002
Fire resistance	To be decided	January 2002

6.2.4 Related Developments

Prof. G. Hadjisophocleous submitted a Letter of Intent to the Canadian Foundation for Innovation (CFI) in order to seek funding to construct a unique full-scale fire research test facility. The proposed facility would be used to perform full-scale fire tests to determine their impact on life safety, building structure, contents and the environment. The experimental data obtained from these tests would be used to develop new and validate existing computer models to evaluate fire safety levels in buildings and other structures. The proposed facility would be constructed on the grounds of NRC at its fire test complex in Almonte, Ontario and would thereby complement NRC's facilities.

It was learned that the University of Waterloo intended to introduce an undergraduate program in Mechanical Engineering with specialisation in Fire Safety Engineering. Furthermore, a large-scale burn hall was to be constructed soon just off-campus. On February 21, Prof. G. Hadjisophocleous and Dr. J.R. Mehaffey met with Prof. E. Weckman of the University of Waterloo. During the meeting, it was informally agreed that the two universities would not compete with one another, but instead seek out opportunities to collaborate in delivering courses and in undertaking research.

6.3 Progress during 2001-2002

6.3.1 NSERC Industrial Research Chair

The focus of the proposed research is the development of engineering tools that can be used by fire protection engineers to design fire-safe wood-frame buildings in a performance-based code environment. In order to achieve this during the five-year tenure of the Chair, sufficient funding has been made available to Prof. Hadjisophocleous to supervise several students and post-doctoral fellows. His research team has already expanded to include:

- Dr. Zhuman Fu, a post-doctoral fellow, who started in March 2001. He is working on the development of the system model framework, the integration of the various sub-models and the development of graphical user interfaces.
- Mr. Ehab Zalok, a Ph.D. candidate, who started September 1. The topic for his thesis has not yet been decided, but he is considering studying the reliability and effectiveness of active fire protection systems or developing models of design fires for commercial buildings.
- Ms. Ineke Van Zealand, a Ph.D. candidate, who started September 1. She is working in the area of human response to fire. She will conduct surveys to determine occupant characteristics in

commercial buildings, develop an occupant response model, incorporate this occupant response model into an existing evacuation model and develop a hazard analysis model.

- Mr. Steven Craft, a M.A.Sc. candidate, who started September 1. He received his undergraduate degree in Forest Engineering from the University of New Brunswick.

Steve Craft is undertaking a sensitivity analysis on WALL2D for his Masters thesis under the co-supervision of Dr. J Mehaffey and Prof. Hadjisophocleous. He intends to determine to what parameters or properties the fire-resistance rating of wood-stud walls is most sensitive and to what properties it is not sensitive. He has created a list of the parameters in WALL2D. As some parameters are "hard-wired" in WALL2D, Forintek has given him the source code to assist in his deliberations. While Mr. Craft's proposed assessment would relate to heat transfer, Dr. Bénichou at NRC has carried out a sensitivity analysis on the structural model developed in Project 2397. It is planned to combine the thermal and structural findings.

The Advisory Committee for the Chair in Fire Safety Engineering met at Carleton University on November 30. The Chair and several of his students provided a progress report. The industry representatives expressed pleasure and surprise with the progress to date.

6.3.2 Masters Program in Fire Safety Engineering

When NSERC approved the proposal for a Chair in Fire Safety Engineering, it did so with the proviso that Carleton University offers a Masters degree in Civil Engineering with specialisation in Fire Safety Engineering. This was acceptable to Forintek because, in order to take full advantage of the introduction of performance-based codes, the industry requires qualified people to use the tools developed by the Chair for design and enforcement purposes. Forintek and the Chair have developed a draft curriculum comprising six core courses that will be offered during a three-term period as depicted in Table 4.

Four graduate courses in fire safety engineering were offered at Carleton University during the 2001/2002 academic year:

- During the fall term, Prof. Hadjisophocleous taught a course on "Fundamentals of Fire Protection Engineering". He had 10 students in Ottawa and 13 students across Canada taking the course by video. He demonstrated the use of several computer models in the classroom including WALL2DN, Forintek's model for predicting the thermal response of wood-stud walls exposed to fire.
- During the fall term, Dr. Proulx (NRC) taught a course on "People in Fires" to 10 students.
- During the winter term, Dr. J. Mehaffey taught a course entitled "Fire Dynamics I". He had 8 students in Ottawa and 8 students across Canada taking the course by video. The course provided a foundation for understanding fire growth and severity in buildings, and for understanding how building components react under fire conditions.
- During the winter term, Dr. N. Bénichou (NRC) taught a course on "Fire Resistance" to 9 students. During one class, he demonstrated the use of the fire-resistance model for wood-stud walls developed in Project 2397 Structural Fire Performance of Wood-stud Walls.

6.3.3 Funding for a Fire Research Facility at Carleton University

Prof. Hadjisophocleous applied to the Canadian Foundation for Innovation (CFI) for funding to permit Carleton University to construct a full-scale fire research facility for buildings and other facilities. In January, CFI approved the proposal for the development of a $10 million facility. CFI's contribution to

this project is $4 million. Other contributing partners include NRC, the Ottawa Fire Services and the Toronto Transit Commission. Funding is also expected from the Ontario Innovation Trust.

The facility will be used to conduct research to identify and improve fire safety levels in residential and commercial buildings, as well as transportation facilities, such as tunnels and underground stations. Full-scale fire tests that represent realistic fire scenarios in these buildings will be conducted to determine their impact on life safety, building structure, contents and the environment. The experimental data obtained from these tests will be used to develop new and validate existing computer models to evaluate fire safety levels in buildings.

This facility will be of great value to the research program of the NSERC Chair at Carleton University as it will provide unique research opportunities to graduate students at Carleton specialising in fire safety Engineering. The facility, which will be constructed on the grounds of NRC's fire test complex in Almonte, Ontario, will meet the needs of Carleton University, NRC, the Ottawa Fire Services, the Toronto Transit Commission and Canadian industry. It will complement existing full-scale facilities at NRC and it will become a unique world class test site that will provide unequalled capabilities for fire and explosion research and be marketable to Canadian and international clients.

The facility will be designed and constructed to accommodate research projects dealing with building and tunnel fire safety, as well projects for subway stations and underground parking/storage spaces. It will also provide opportunities for studies on environmental damage due to run-off water from fire fighting and toxic gas production; in addition research in these two areas will address issues related to the health and safety of fire fighters.

Some specific research projects that could be performed at the proposed facility include: development of design fires and fire scenarios for residential and commercial buildings; smoke movement in low-rise buildings; fire spread from compartment to compartment; prediction of life hazard in buildings as a result of toxic gases production, heat flux, temperature and smoke development; smoke management in tunnels and subway stations; large-scale calorimetry; fire spread between buildings / infill construction; impact of wind and ventilation conditions on fire spread and smoke movement in buildings and tunnels; fire detection and suppression in large spaces; heat release rate of train cars; explosions and fires in confined spaces; arson investigation; fire fighting strategy and tactics; evaluating fire fighting equipment and techniques; development of fire fighter training material; and environmental and health impact of fires on fire fighters and the public.

6.3.4 Related Developments

The following related developments stress the importance of continuing to develop expertise at Forintek and Carleton University on Fire Safety Engineering for wooden structures. As architects, engineers and building code officials have pointed out, in order to be prepared for the introduction of performance-based codes, there is need for engineering tools and expertise.

LABEIN, a research organisation in Spain, developed a Fire-Engineering Annex for Spanish Regulations pertaining to industrial buildings. The goal was to develop a performance-based methodology for ensuring that an industrial building retains structural stability in the event of fire for a sufficient period of time that occupants can safely evacuate the building. In principle, the building's structure could be steel, reinforced concrete or wood. Because of his participation in ISO/TC92/SC4 on fire safety engineering, a contractual agreement was signed whereby Dr. J. R. Mehaffey assisted in developing the Annex.

An Ottawa engineering firm, Morrison Hershfield, is involved with an investigation of a recent barn fire. There is considerable uncertainty as to why the fire grew beyond the fire department's suppression capabilities. Forintek's Dr. J.R. Mehaffey has been retained on a contractual basis to model the advance of the fire through the wooden structure.

Gage-Babcock & Associates (GBA), a fire protection engineering firm in Vancouver, submitted a bid to undertake the fire-safety design of a new ski lodge. Although it was planned that the top four storeys of the lodge be framed with wood, the proposed building height exceeded the limit permitted for combustible construction in the building code. Furthermore, given the remote location of the lodge, it was not possible to provide the required fire department access. As the lodge could not be built in compliance with the building code, GBA recommended that the fire-safety design be done employing performance-based techniques. GBA approached Forintek for assistance since Forintek is developing tools and strategies for the performance-based fire-safety design of wood buildings. A joint GBA / Forintek contract proposal was prepared and submitted to the builder. Unfortunately, the joint proposal was not successful. The owner decided to comply with the Building Code; that is, to construct it of reinforced concrete. The cost of performance-based design for a wood-frame building was deemed too large with respect to the total project cost. Clearly, as the Chair at Carleton University develops design tools, performance-based design for wooden structures will become more competitive.

7 Conclusions

The wood products industry has requested that Forintek undertake research supporting its goal to expand its market share in non-residential buildings. This is a challenging goal because current prescriptive fire-safety requirements in building codes exhibit a bias against the use of wood products, particularly in the construction of non-residential buildings. The international trend towards adopting performance-based building codes offers the promise of eliminating such biases. By judging the acceptance of building design solely on the basis of performance, performance-based fire-safety requirements are expected to ensure equitable treatment of all building products and thereby improve market access for wood products.

In order to be prepared for the introduction of performance-based codes, architects, engineers and building code officials have pointed out the need for engineering tools to assess the fire performance of buildings. This five-year project was initiated to develop fire-safety design tools for non-residential wood-frame buildings, and to foster development and delivery of educational modules to train students and practitioners in performance-based fire-safety design.

In order to achieve these goals, an NSERC Industrial Research Chair in Wood and Fire Safety has been established at Carleton University. The focus of the research program is the development of engineering tools that can be used by fire protection engineers to design fire-safe wood-frame buildings in a performance-based code environment. In order to achieve this during the five-year tenure of the Chair, sufficient funding has been made available to Prof. Hadjisophocleous to supervise several students and post-doctoral fellows. His research team has already expanded to include a post-doctoral fellow, two Ph.D. candidates and one M.A.Sc. candidate. Efforts have been made to establish a Masters Degree Program in Fire Safety Engineering. Four new courses were offered in 2001-2002 and an additional two courses will be offered in 2002-2003. Graduates of the proposed Masters Program will find employment in the design and regulatory communities, and will be equipped to undertake performance-based design of wood-frame buildings. The Chair has secured additional funding from CFI to establish a unique fire test facility that will assist in delivering the research program funded by Forintek and NSERC.