Presentation by Jake Pauls, CPE

Falls and Mobility Network Meeting Sunnybrook Health Sciences Centre Toronto, ON, May 10, 2010

This is based partly on a presentation:

Stairway Usability and Safety: Use by individuals in homes and other buildings

Half-Day Educational Presentation by Jake Pauls, CPE at OAA Continuing Education Conference Windsor, ON, May 7, 2010

Outline for OAA Continuing Education Session:

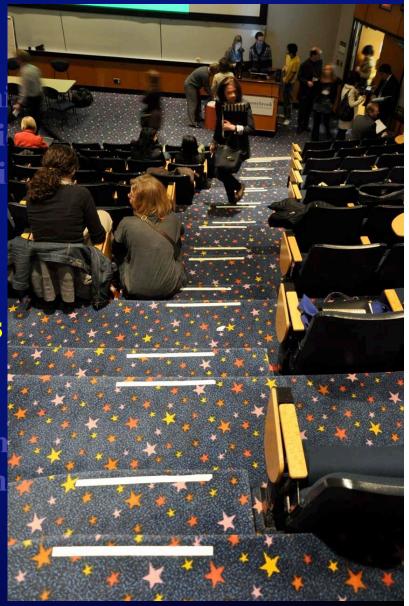
- 1. Introduction
- 2. Acknowledgements
- 3. Terminology and Epidemiology
- 4. Economics and Ergonomics
- 5. Introduction to model building code grading
- 6. Key factor of visibility
- 7. Key factor of geometry
- 8. Key factor of handrails
- 9. Special stairs
- 10. Home stair geometry
- 11. Home stair railings
- 12. Home design codes and the double, lower standard
- 13. Litigation-related and other inspection techniques
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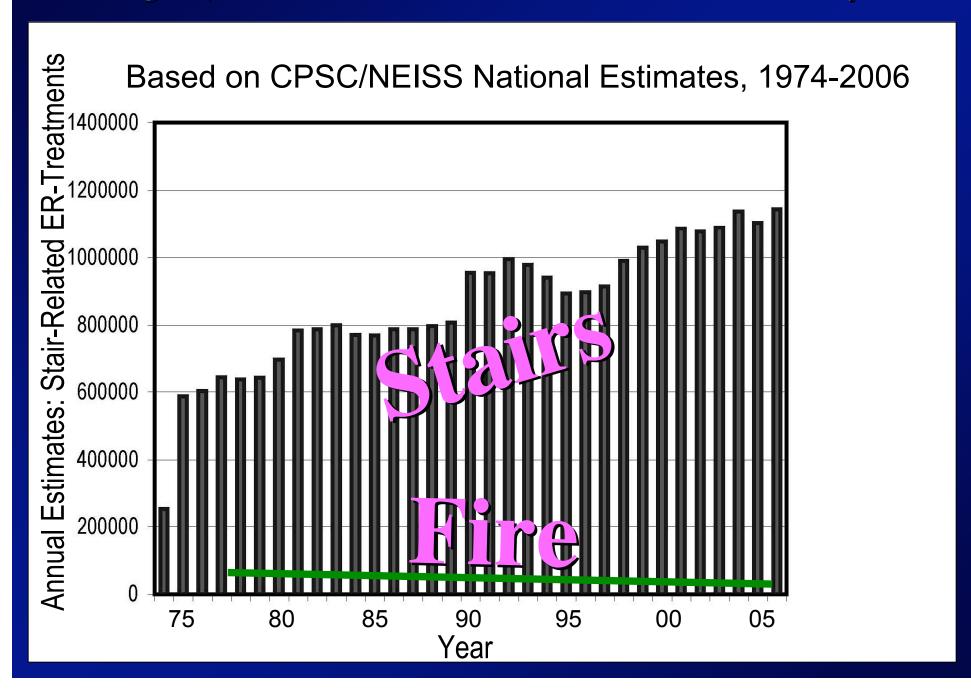
1. Introduction

Goals of Presentations and Discussions

By the end of the session you will have

A. A clear appreciation of how big the problem of stairway safety and usability is relative to other problems addressed in building codes.

Section 3, Terminology and Epidemiology, deals with this, as does Section 4, Economics and Ergonomics.

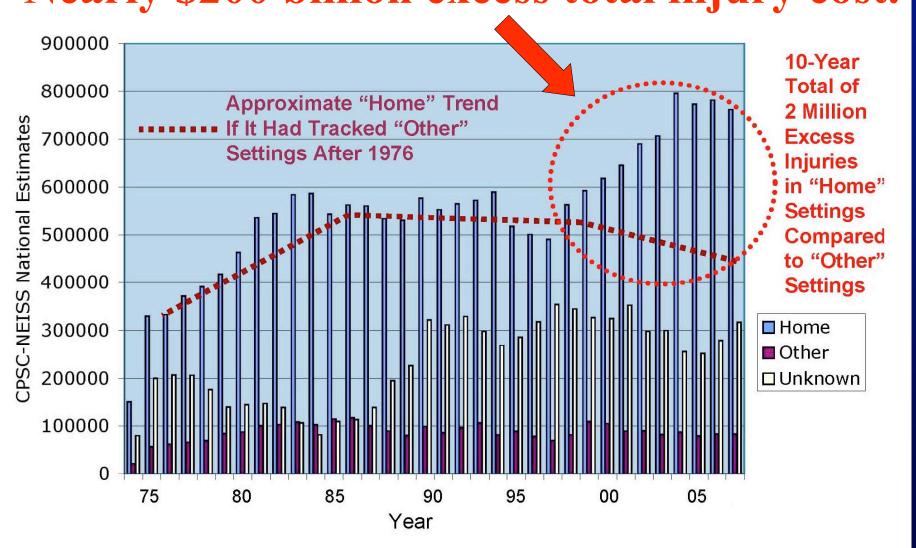


Over the last few decades the number of stair-related injuries in the USA grew by a factor of two—a greater growth than of population.

At the same time, fire-related injuries were reduced by half.

What Designers, Builders & Code Officials Should Learn About Stairways & Falls The trend is not explained by age effects.

Nearly \$200 billion excess total injury cost.



What Designers, Builders & Code Officials Should Learn About Stairways & Falls Comprehensive Costs of Stair-related,
Nonfatal Injuries for the Year 1995 in the United States (in 1997 US dollars)

Medical costs
Productivity losses
Quality of Life losses
Total Costs

4.7 billion
7.1 billion
38.1 billion

49.9 billion ← **Factor of ten**



Source: Ted Miller and colleagues
National Public Services Research Institute
Landover, Maryland, USA

50-year Benefit-Cost Analysis by Pauls For New Homes Built in USA in 2000

Cost of new home stairways

US\$800

Added cost if "7-11" stair geometry used

\$250-980

Medical care cost for new-stair related injuries

\$3000

Comprehensive cost of new-stair related injuries \$30000

Usability benefit for all new-stair users (@\$0.002 per use)

\$2000

Total usability benefit for certain elderly users of new stairs with "7-11" step geometry

\$7000

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Goals of Presentations and Discussions

By the end of the session you will have

B. A detailed understanding of three key sets of environmental factors contributing to reasonably safe, usable stairways.

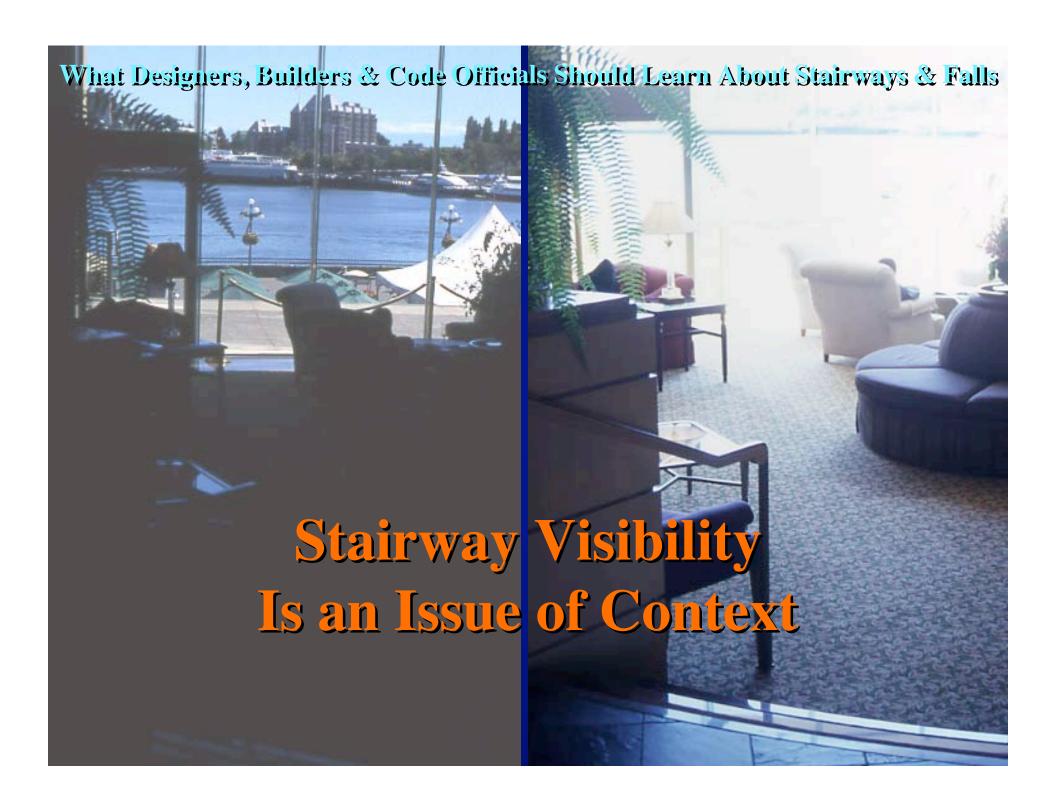
Sections dealing with this: 6, Key Factor of <u>Visibility</u>; 7, Key Factor of <u>Geometry</u>; & 8, Key Factor of <u>Handrails</u>

Visibility of Stairway

Steps that can be reliably seen when approaching and using the stair

Stairway Visibility







Air Step Site at Two Steps in Hotel Lobby

Handrail, marking and sign might not be sufficient mitigation.

This is not a good place to have steps.



Evidence for Environment-Based Fall Prevention Mis-marked stair step nosings

• The often seen recommendation to mark the top and bottom steps in a stair flight does not go far enough <u>and is dangerous</u>.



Side view

View by descending person

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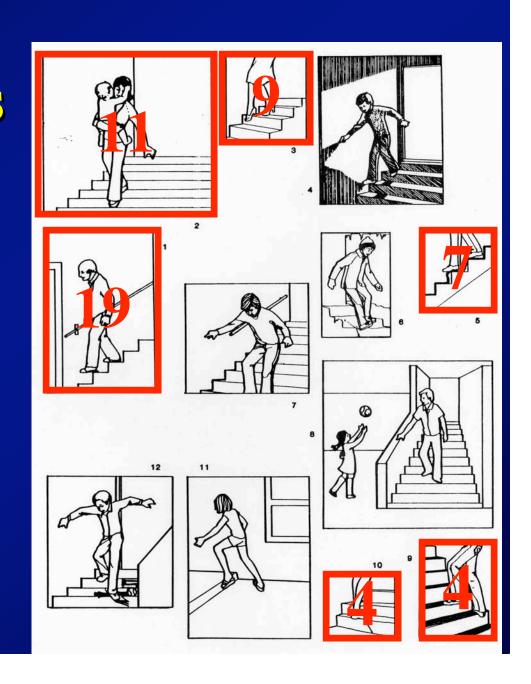
C. Rationale to prioritize inspection goals in relation to stairways.

Sections dealing with this: 4, Economics and Ergonomics; 6, Key Factor of Visibility; 7, Key Factor of Geometry; & 8, Key Factor of Handrails.

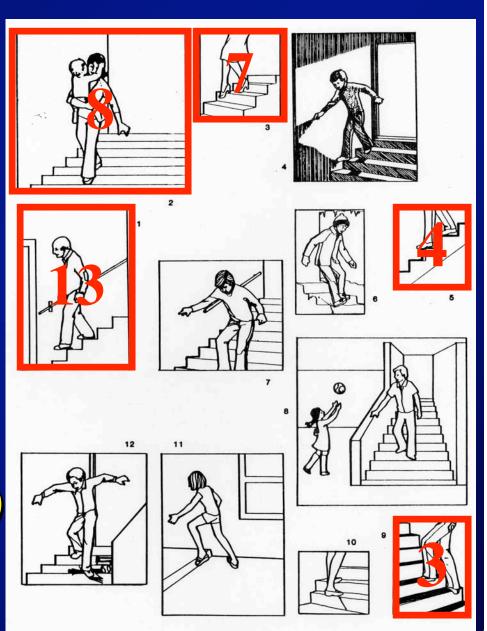
How do stair-related injuries occur?

What are the scenarios?

Step geometryrelated scenarios accounted for about 54% of the million or so estimated falls occurring each year in the United States.



Researchers estimated that about 35% of all of the million falls would be preventable with "7-11" (180 mm rise, 280 mm run) step geometry.



Many Falls Due to Step Geometry: Increased Risk with Smaller Runs

Risk of falls on home stairs with various run or going sizes

Risk estimates derived from Wright and Roys (2008) Figure 4

Run or Going dimension	Relative risk of falls	Used for home stairs by
255 mm (10.0")	0.03	ICC Codes in USA
250 mm (9.8")	0.05	BS5395-1:2010 in UK
245 mm (9.6")	0.07	
235 mm (9.3")	0.11	
225 mm (8.9")	0.12	NAHB in USA
215 mm (8.5")	0.13	
205 mm (8.1")	0.14	NBCC in Canada
195 mm (7.7")	0.21	

ICC—International Code Council; NAHB—National Association of Home Builders; NBCC—National Building Code of Canada

This is excerpted from Johnson, D. and Pauls, J., Systemic stair step geometry defects, increased injuries, and public health plus regulatory responses. *Contemporary Ergonomics and Human Factors* 2010, Anderson, M. (ed.), CRC Press, pp. 43-461.

Step Geometry Uniformity Defects

• Especially top-of-flight defect due to inconsistent nosing projection



Step Geometry Uniformity at Top Steps of Flights with Nonuniform Nosing Projections

The single most important, easily implemented act to improve the safety of existing stairs is to find and retrofit landing nosings that do not project the same as other nosings of the stair flight!

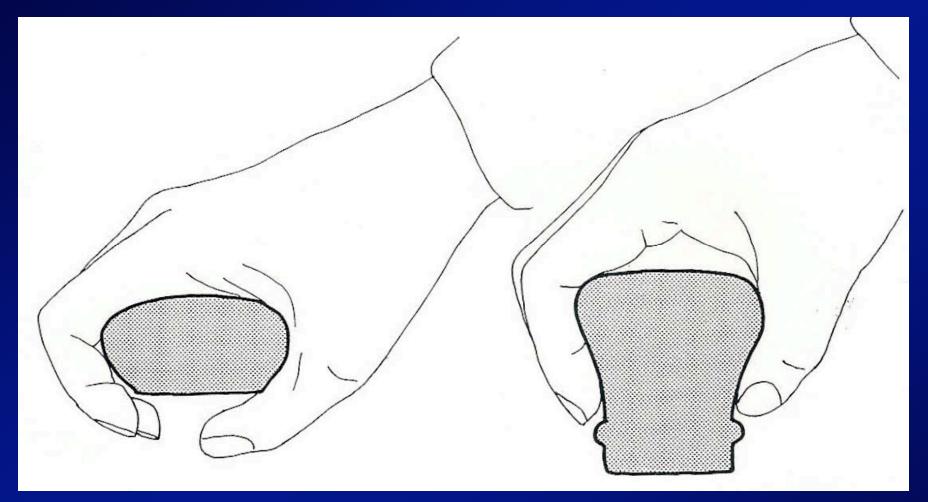
Generally, the top-of-flight, run non-uniformity defect is only one of several recently suggested factors that could be contributing to the dramatic recent increase in stair-related injuries in US CPSC statistics.

Potential Contributing Factors for Recent Growth of Injuries

- (1) Relatively steep stair step geometry permitted traditionally only for homes.
- (2) A systemic top-of-flight dimensional non-uniformity on many home stairs, due to flawed code requirements and/or flawed construction and inspection practices.
- (3) An apparent reduction—generally—in the code enforcement process for new home construction.
- (4) the potential deterioration of movement performance in the US population (among others), stemming from reduced physical activity and increasing prevalence of obesity and overweight.
- (5) Increased use of 'Type II' handrails for new home stairs.
- (6) Increasing differential between public and home stairways.

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- (6) Increasing differential between public and home stairways.



Power Grip with Type I Handrail

Pinch Grip with Type II Handrail

These standard industry profiles are examples of the two types that share the same upper width and shape





Power Grip with Type I Handrail

Pinch Grip with Type II Handrail

 Much of the current debate about handrail graspability centers on the paper published in Applied Ergonomics in July 2009.

Applied Ergonomics 40 (2009) 657-669



Contents lists available at ScienceDirect

Applied Ergonomics

journal homepage: www.elsevier.com/locate/apergo



Effect of handrail shape on graspability

Donald O. Dusenberry*, Howard Simpson, Steven J. DelloRusso

Simpson Gumpertz & Heger Inc., 41 Seyon Street, Building 1, Suite 500, Waltham, MA 02453, United States

ARTICLE INFO

Article history: Received 2 October 2007 Accepted 26 May 2008

Keywords: Handrail graspability Stairway falls Handrail profiles Handrail research

ABSTRACT

This paper summarizes research performed to evaluate the impact of handrail profile dimensions on graspability. It reports on research performed to determine the forces that stairway users exert on handrails when they fall, tests demonstrating the forces persons with various hand sizes can exert on handrails with different profiles, and comparisons of the probability of loss of grip by stairway users when they attempt to arrest a fall by grasping a handrail. The recommendations based on this work include specific definitions of the shapes of handrails that are deemed to be sufficiently graspable to constitute functional handrails.

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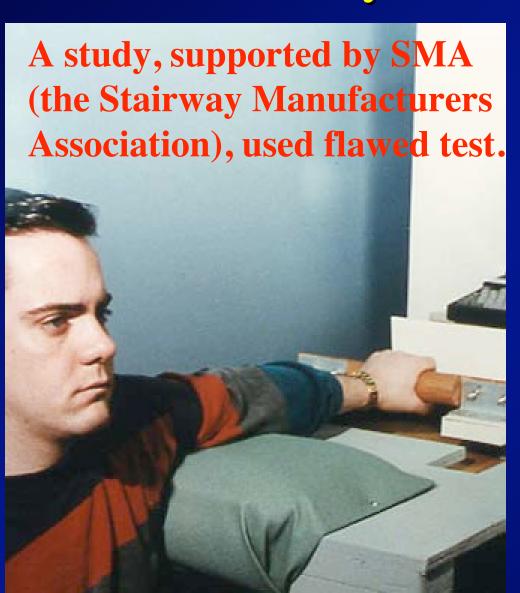
1. Introduction

Falls on stairs constitute a major cause of accidental injury in the United States. While various stairway design parameters have significant influences on the number and severity of accidents, there is no available statistical information that establishes a correlation between the cross sectional shape of stair handrails and the

In addition to allowing users to develop adequate pulling forces, the grasping surface must be uninterrupted along the length of the handrail, be sufficiently distant from adjacent walls to allow for free grasping action, and be of appropriate height.

The research described herein addresses the performance of handrail shape as it relates to the last two of the four functions described above. The results also are applicable to the evaluation of

Handrail industry and Maki's test protocols





The SMA-controlled study tested the worst of the Type I handrails versus the best of the Type II handrails — modified for better performance



Modified Profile # 6010

Power Grip with Type I Handrail

Enhanced Pinch Grip with *Modified* Type II Handrail

Type II handrail, the 6010 profile, as marketed versus as modified for testing



Allow

This Profile





Code Requirements Justified by Results of Tests Using This Modified Profile

Type II handrail, the 6010 profile, as marketed versus as modified for testing



Pinch Grip with 6010 Profile Handrail



Enhanced Pinch Grip with Modified 6010
Profile Handrail

• The situation warrants publication of critical comments on the *Applied Ergonomics* paper — perhaps even formal withdrawal of the paper.

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1. Introduction

Goals of Presentations and Discussions

By the end of the session you will have

D. Knowledge of techniques for stairway inspection relevant to assessing safety and usability.

Section 13: Liability-related and other inspection techniques.

Two-second handrail grasp test





10-second Crouch-andSight Test

Crouch down at the top of the flight, sighting along nosings, to confirm that nosings line up exactly.

If they do <u>not</u> line up exactly, the stair is non-uniform in rise and/or run dimensions.

If the nosings appear to line up exactly, perform the follow up test to check for equal inter -nosing distance.





This appeared to pass the crouch-and-sight test, but internosing distance was not uniform (353 mm versus 315 mm)

Failure of either test, crouch-and-sight or inter-nosing distance test, should lead to full measurements of step rise and run.



using trigonometry

(i.e., sine and cosine).

What Designers, Builders & Code Officials Should Learn About Stairways & Falls Typical Set of Small Tools for a Qualified Stairway Inspector



What Designers, Builders & Code Officials Should Learn About Stairways & Falls Additional, Larger Tools for a More-capable Stairway Inspector



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E. Awareness of current and potential impacts of litigation related to stairways.

Section 13: Liability-related and other inspection techniques.

Elements of Liability:

- Duty
- Breach
 - Violation of a building code requirement is neither a necessary nor sufficient basis for for being found liable by a court of law.
- Cause
- Harm

Building officials in the US have a double responsibility for the condition of buildings.

They create the rules as well as enforce them. Should they then not share liability, including for flawed stairways, particularly if official behavior is unethical?

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F. An improved basis for meaningful participation in model code development, adoption and enforcement activities nationally and locally.

Section 12: Home design codes and the double, lower standard.

Knowledge, presence and participation in code development are all important to achieving better stairways—and built environment generally including improved safety and usability.

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Goals of Presentations and Discussions

By the end of the session you will have

G. Greater enthusiasm for building safety activities that significantly impact public health generally and the wellbeing of people in your community.

Section 12: Home design codes and the double, lower standard.

Summing up the situation of the model building code development, adoption and enforcement situation affecting public safety

- —especially stairways in homes and elsewhere:
 It is a Colossal Failure in:
 - Policy
 - Process
 - Product
 - Outcome
 - Response

And this is just the situation in the USA.

In Canada it is worse than in the USA!

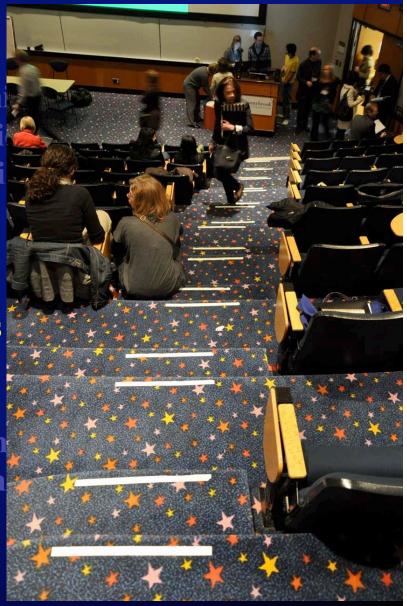
At the Centennial Conference of the Canadian Public Health Association, CPHA, on June 15, 2010, in Toronto, Jake Pauls is presenting a progress report on this topic:

Progress on Making the National Building Code of Canada More Responsive to Public Health Problems

In Canada is it worse than in the USA?

Outline for OAA Contidiangesearch. 1Basedjon Canadiangesearch 1Basedjon Canadiangesearch 1Basedjon Canadiangesearch **Session:**

- 2. this aisle stair has long been
- 3. prohibited by angus model building codes but it is still
- 5. not addressed by the 6. National Building Code of
- Canada factor of geometry
- 8. **Key factor of handrails**
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Those who control the process, control the product or outcome.

Code development, adoption and enforcement must have more oversight and participation by public health professionals including design professionals

- Responsibilities of public health professionals for solving (or at least mitigating) problems of stairway safety and usability are not restricted to designers, builders and code officials.
- A meeting is being proposed, mostly for leaders in the field of fall biomechanics and stairway ergonomics to address two sets of priorities:
 - How better to apply what we already know.
 - How to improve our knowledge through additional research on stairways.

The two priorities come from two recent meetings.

• One-day meeting on stairway safety, usability and research at the UK Health and Safety Laboratory on April 16, 2010.



- This drew participants from EU, CA, US, JP and NZ.
- One recommendation was for a longer, more detailed follow up meeting in 2011 with more US & CA participation.

The two priorities come from two recent meetings.

• A small, follow up meeting to discuss and plan a larger meeting on stairways in 2011 in North America, occurred at the UK Building Research Establishment, April 23, 2010.



Present: Mike Roys (UK), Wen Chang (US) Jake Pauls (CA & US)

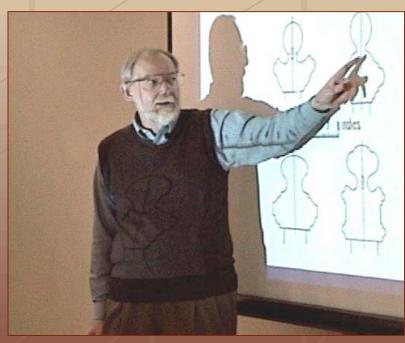
- With a current hourly, societal cost on the order of ten million dollars—growing as much as ten percent per year, it is imperative that a major research and technology transfer effort be made to mitigate, if not solve, the problems of stairway safety and usability, especially in homes.
- Responsibilities are not only with designers, builders and code officials; they are with the highly skilled professionals present in this room today.
- 2011 could be a seminal year for stairway usability and safety, especially in homes.



Announcing the Availability of a 3-DVD, 1-CD Set of a One-day Workshop

Stairway Usability and Safety

Use by individuals in homes and other buildings



Jake Pauls, CPE

Educational Presentation at *Measuring Up the North* Conference in Prince George, BC, Canada, April 2009

Email: bldguse@aol.com Website: http://web.me.com/bldguse Disc 1

Introduction

Acknowledgements

Terminology and epidemiology

Economics and ergonomics

Introduction to model building code grading

Key factor of visibility

Disc 2

Key factor of geometry

Key factor of handrails

Disc 3

Special stairs

Home stair geometry

Home stair railings

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Litigation Summary

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