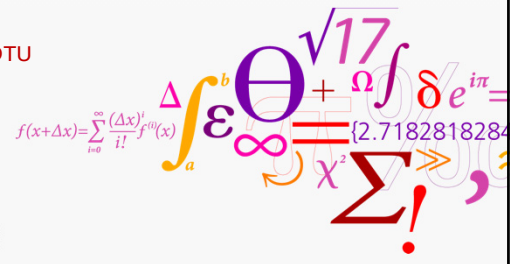
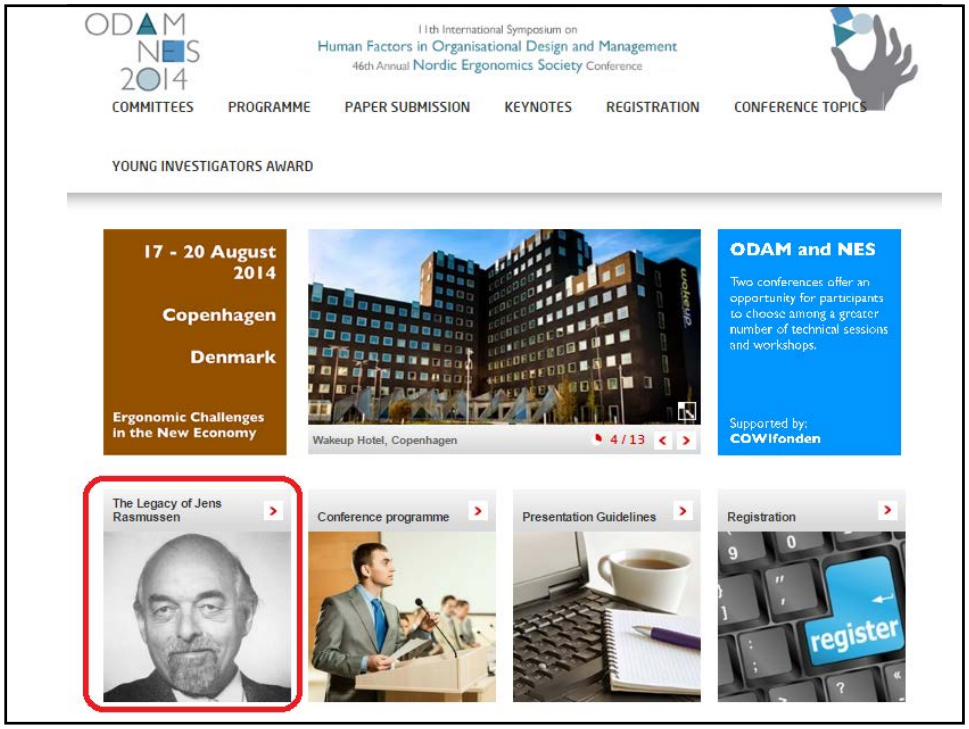
Human Factors Themes from the Legacy of Jens Rasmussen

HFC Forum meeting
15-16 October, Oslo

Henning Boje Andersen
Professor
Management Engineering Inst.
Technical University of Denmark / DTU



DTU Management Engineering
Department of Management Engineering



ODAM NES 2014

11th International Symposium on
Human Factors in Organisational Design and Management
46th Annual Nordic Ergonomics Society Conference

COMMITTEES PROGRAMME PAPER SUBMISSION KEYNOTES REGISTRATION

YOUNG INVESTIGATORS AWARD

ODAM-NES 2014 › Legacy

The Legacy of Jens Rasmussen

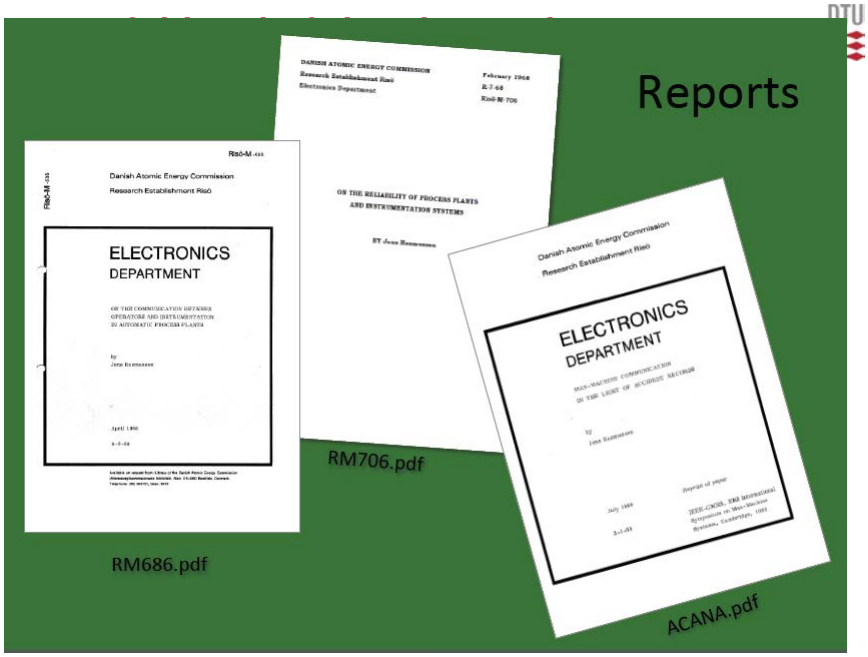
Adjunct ODAM 2014 Symposium

August 20th noon – August 21st noon, 2014

Call for Papers

The work of Jens Rasmussen over the contributions to the field of safety scie practitioners in a number of fields incl a large amount of research has been i models of the boundaries of safe oper graphical support for accident investig Management Framework has been cit was elected a member of the National

Jens Rasmussen (b. 1926)



5 **DTU Management Engineering, Technical University of Denmark**

6 **DTU Management Engineering, Technical University of Denmark**

The work of Jens Rasmussen over the course of the last half century represents some of the most influential contributions to the field of human factors, safety science, human error and accident research.

His work has influenced researchers and practitioners in a number of fields including psychology, engineering, sociology and human factors .

In more recent years, a large amount of research has been inspired by theoretical and practical aspects of Rasmussen's work including his models of the boundaries of safe operation and performance and methods such as Cognitive Work Analysis and graphical support for accident investigation such as AcciMaps.

E.g., his work on the Risk Management Framework has been cited over 1000 times since its original publication in 1997.

In 2013, Jens Rasmussen was elected a member of the US National Academy of Engineering

Adapted from call text of the Legacy conference:

DENMARK

Dr. Per V. Bruel
President
Bruel Acoustics
Holte, Denmark

Member Type: Foreign Member
Election Year: 1979
Section: 07. Electronics

Dr. Niels Hansen
Technical University of Denmark
Roskilde, Denmark

Member Type: Foreign Member
Election Year: 1995
Section: 09. Materials

Dr. Jens Rasmussen
Emeritus Research Professor
RISO National Laboratory
Smorum, Denmark

Member Type: Foreign Member
Election Year: 2013
Section: 08. Industrial Systems

Dr. Henrik Topsoe
Executive Vice President
Haldor Topsoe A/S
Kgs. Lyngby, Denmark

Member Type: Foreign Member
Election Year: 2013
Section: 03. Chemical

Dr. Viggo Tvergaard
Professor Emeritus
Technical University of Denmark
Kgs. Lyngby, Denmark

Member Type: Foreign Member
Election Year: 2001
Section: 10. Mechanical

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Member Type: Foreign Member
Election Year: 2013
Section: 03. Chemical

Dr. Viggo Tvergaard
Professor Emeritus
Technical University of Denmark
Kgs. Lyngby, Denmark
Member Type: Foreign Member
Election Year: 2001
Section: 10. Mechanical

NORWAY

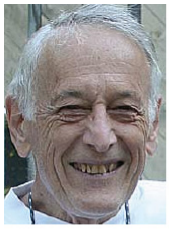
Dr. Egil Abrahamsen
Retired President
Det Norske Veritas, Inc. (Retired)
Oslo, Norway
Member Type: Foreign Member
Election Year: 1978
Section: 08. Industrial Systems

Dr. Odd M. Faltinsen
Professor
Norwegian University of Science and Technology
Trondheim, Norway
Member Type: Foreign Member
Election Year: 1991
Section: 12. Special & Interdisciplinary

Prof. Emeritus Kaare Hoeg
Expert Advisor
Norwegian Geotechnical Institute
Oslo, Norway
Member Type: Foreign Member
Election Year: 1993
Section: 04. Civil

Dr. Suzanne Lacasse
Managing Director
Norwegian Geotechnical Institute
Oslo, Norway
Member Type: Foreign Member
Election Year: 2001
Section: 04. Civil

Dr. Johannes Moe
Advisor Emeritus
SINTEF
Trondheim, Norway
Member Type: Foreign Member
Election Year: 1977
Section: 04. Civil



Tom Sheridan (MIT)

"Jens has always been one of my heroes … I wish I could be at the symposium"

"We have had numerous exchanges, ever since Gunnar Johannsen and I organized that first NATO Human Factors Symposium "Monitoring Behavior and Supervisory Control" in 1976 in Berchtesgaden, where Jens more or less 'first' impressed the international HF community with several of his general models.

I have discussed Jens' skill-rule-knowledge hierarchy tree and decision ladder in several of my books, and I think those ideas are as fresh and applicable today as they have ever been."

From Sanderson 2014

Colin Drury (SUNY/Buffalo)

"Jens' early ideas have become part of the very fabric of human factors"

"Is there any student who does not know the SRK framework or CWA?

Is there any process-oriented human factors practitioner who was not delighted to see the EID framework linking the underlying process physics to human perceptual needs?

Jens' more recent ideas on the basis for what we call 'human error' and his very practical theories of accident investigation are referenced by a new generation of authors and practitioners.

I am fortunate and happy to be practicing at a time when such ideas are current."

DTU

1950: M.Sc. degree with honors, Technical University of Denmark (DTU) 1950

1956: Atomic Energy Commission's Research Establishment Risø (later Risø National Laboratory).

1962-1987: head of the Electronics Department.

1962: elected member of the Danish Academy of Technical Sciences;

1979-1981: chairman of group of experts on human error analysis under CSNI, the Committee on Safety of Nuclear Installations of OECD.

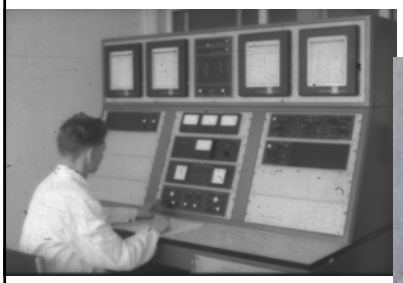
1981-1983: member of NATO Special Program Panel on Human Factors;

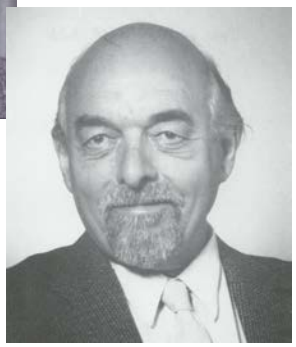
1982-1983: visiting professor at "Center for Man-Machine Systems Research", Department of Industrial Engineering, Georgia Institute of Technology;

From 1983, expert panels on human-machine interaction and human error issues under National Research Council Washington

1987-1992: professor of cognitive engineering at Risø National Laboratory and the Technical University of Denmark.

Powerful head of the Electronics Department Atomenergikomissionens Forsøgsanlæg Risø / Risø National Laboratory





Major themes and insights

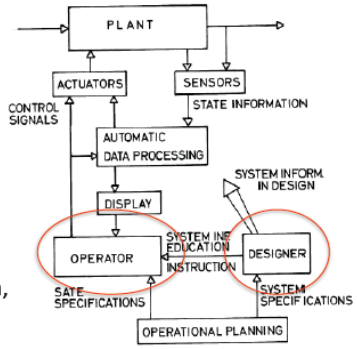
- Human operator performance results from behaviour-shaping constraints that we can identify and model
- The human operator is a flexible and adaptive element who ”completes the design of the technical system (and compensates for its shortcomings)
- Human operators cope with complexity by applying mental models and modes of performance (eg SKR …)
- Risk management requires an understanding of the socio-technical context of work
- Strong graphical modeling approach

[after Sanderson 2014; Cook 2014]

Instrumentation and control

"...the designer is thus faced with the choice of counteracting an abnormal operational situation by incorporating automatic protective intervention in the instrumentation system or by ensuring correct intervention on the part of the operators through training and instruction.

This choice is rendered difficult especially by the very limited general knowledge of the reliability of operators' decisions and the possibility of improving it by advanced data processing in the instrument system, and further by the shortage of generally formulated knowledge of the reliability of instruction systems.



Model of control system.

After the training period the designer's instruction ... will therefore be of negligible importance and be replaced by the operator's experience ... his properties may be established on the basis of experiments and experience from other plants with human operators..."

After Sanderson 2014

Rasmussen (1968) RM706.pdf

"The initial experiments will attempt to evaluate the difference between conventional meter panels and integrated displays in detection and identification tasks ...

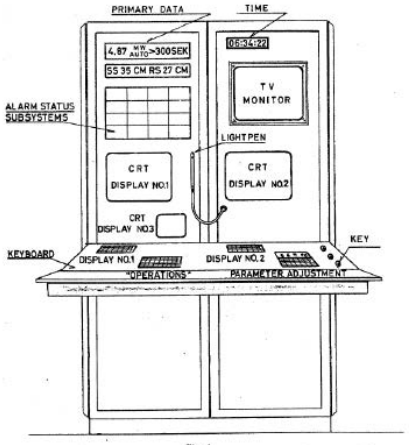


Fig. 1
Preliminary layout of experimental control console of the DR2 reactor, a 5 MW pool type research reactor.

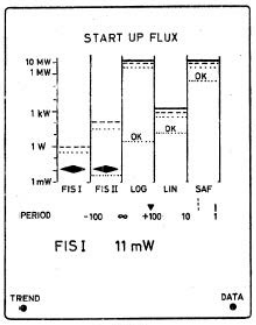


Fig. 3
Survey display allowing the operator to compare measurements of neutron flux in all start-up channels. Interlock and alarm limits are indicated by ····· , power set-back by – – – – and automatic shut-down by ——— . Channels that are "alive", but have too high a measuring range, show "OK"; this signature is replaced by ◂▸ when the flux reaches the measuring range. In the data field the data from fission chamber channel 1 have been chosen by the light pen.

Sanderson 2014

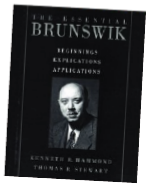
Goodstein (1968)
Rasmussen (1968) EXPER.pdf

"Generalisations can be made only in reference to precisely-formulated behaviour-shaping constraints"

Rasmussen et al. (1994)

"This apparently requires a new direction within experimental psychology to include complex experiments in the laboratory repertoire, and it requires that psychologists not only focus their interest upon the human but include detailed analysis of the human's task environment.
This development was foreseen by Brunswik in 1952 when he advocated equal attention by psychologists to the real life task content and to the psychological processes of the performer..."

Rasmussen (1986)



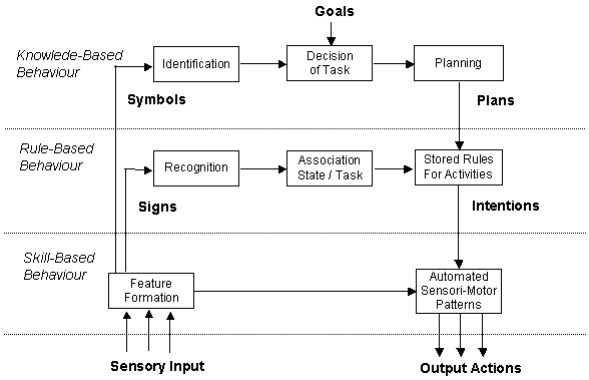
From Sanderson: 2014

Names of major contributions (often coauthored, sometimes inspirator)

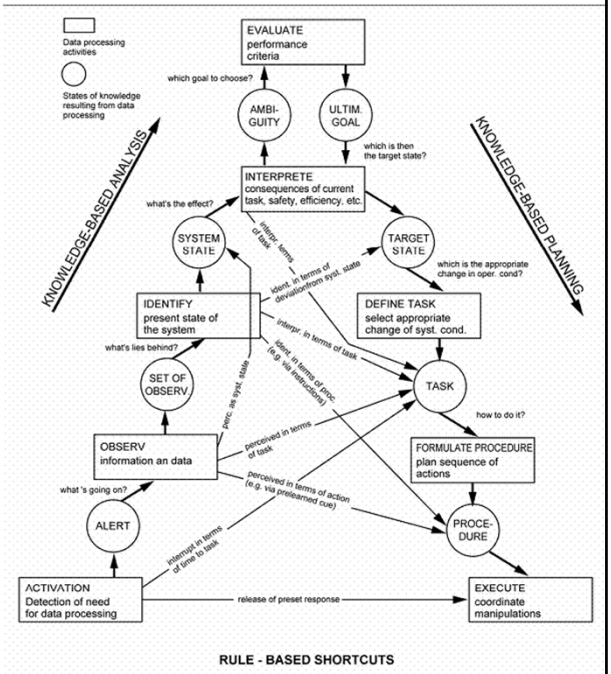
- Skills-Rule-Knowledge model of human performance
- Means-End Hierarchy – Cognitive Work Analysis
- Intergrated interface displays
- Ecological Interface Design (with Kim Vicente)
- Boundaries of human performance
- AcciMaps

[Contributors at Legacy conference]

Models, representations, diagrams …. SKR framework



Models, representations, diagrams: Decision ladder



Models, representations, diagrams: Abstraction hierarchy

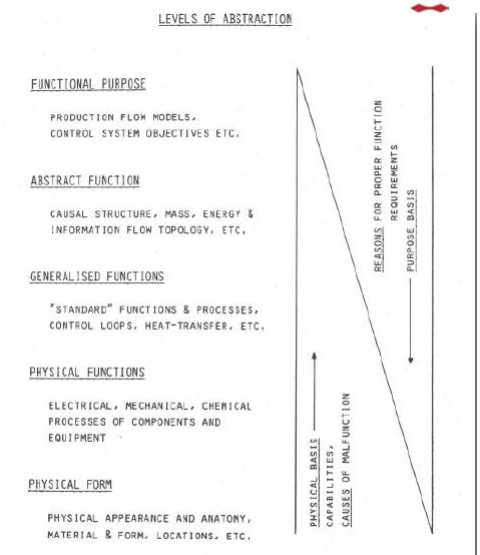


Figure 4. The abstraction hierarchy used for representation of functional properties of- a technical system.

Models, representations, diagrams: Boundary of safe performance

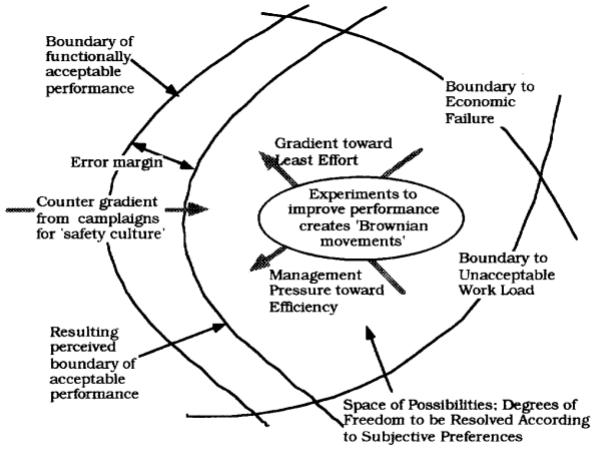
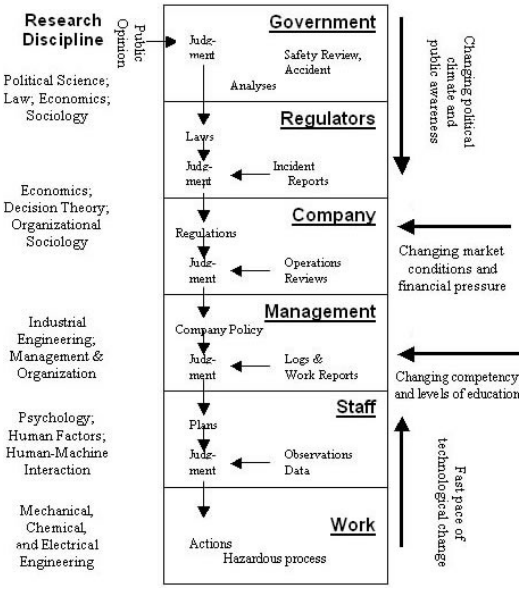


Fig. 3. Under the presence of strong gradients behaviour will very likely migrate toward the boundary of acceptable performance.

Models, representations, diagrams: Socio-technical system



AcciMaps

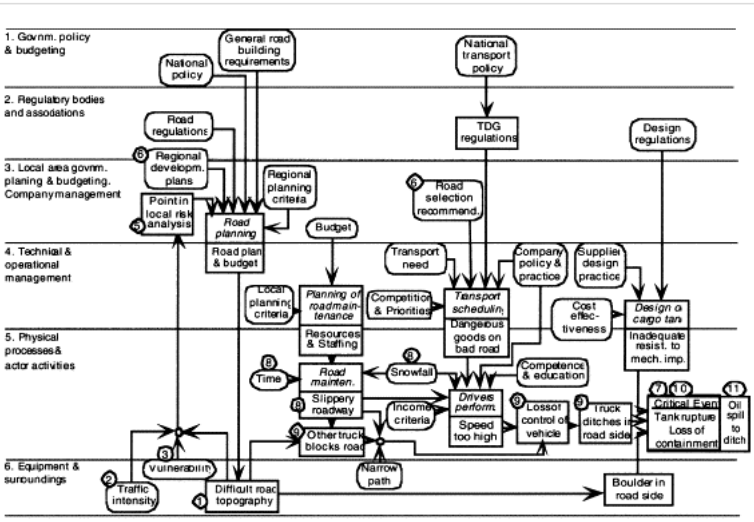
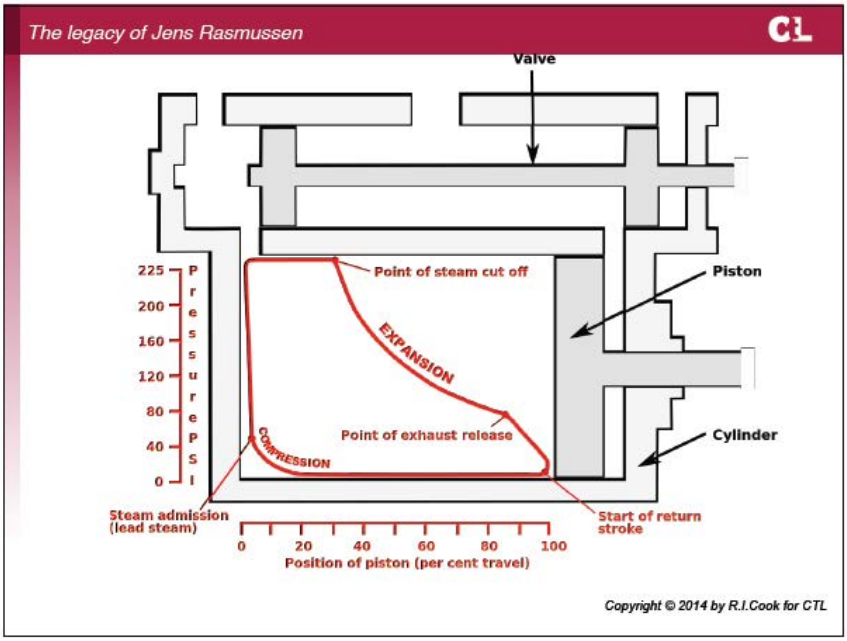


Fig. 5.

An "AcciMap" showing the results of the analysis of a transport of dangerous goods accident involving oil spill into a ditch that via a stream is connected to a municipal drinking water supply. The physical accident process prior to the critical event is represented at levels 5 and 6. Also shown are decisions or activities important in conditioning the accident and performed at all levels of society together with related information sources. Numbers in circles refer to notations (see Appendix) based on the accident report.



Colleagues and collaborators

- Morten Lind
- Erik Hollnagel
- Berndt Brehmer
- Keith Duncan
- James Reason
- Jacque Leplat
- .....

Colleagues and collaborators









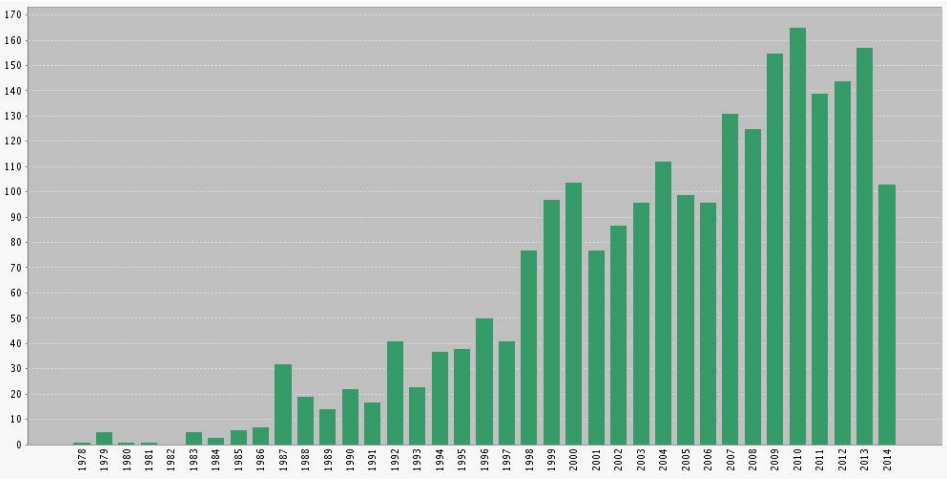


Impact and collaborations

Bob Wears and Shawna J Perry: Citation analysis

- Google scholar
  - limit to > 3 citations
  - eliminate same name papers, combine report → paper
- 197 works with 17,226 citations
  - 51 papers with ≥ 51 citations (h index)

Web of Science (Wears & Perry 2014)



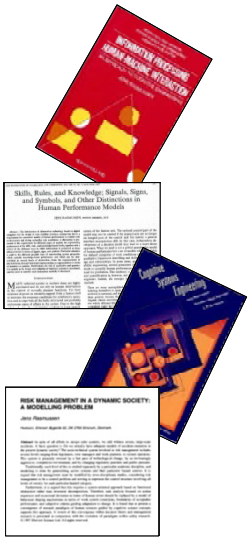
> 1,000 citations

Rasmussen, J. (1986). *Information Processing and Human-Machine Interaction: An Approach to Cognitive Engineering. Amsterdam: North Holland.*

Rasmussen, J. (1983). Skills, rules and knowledge; signals, signs and symbols and other distinctions in human performance models. *IEEE Transactions on Systems, Man, and Cybernetics, 13(3), 257 - 266.*

Rasmussen, J., Pejtersen, A. M., & Goodstein, L. P. (1994). *Cognitive Systems Engineering. New York: John Wiley & Sons, Inc.*

Rasmussen, J. (1997). Risk management in a dynamic society: a modelling problem. *Safety Science, 27(2/3), 183 - 213.*



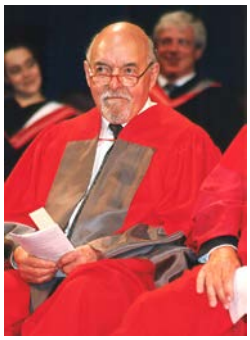
2,952

2,435

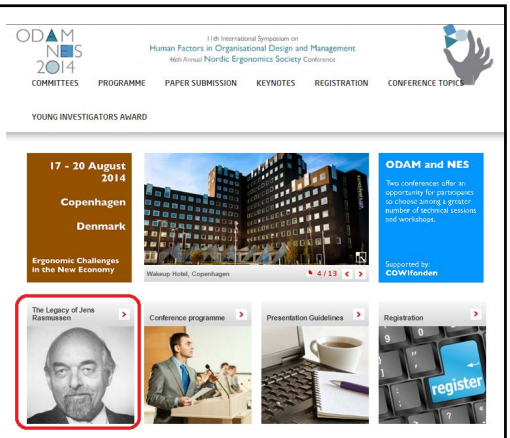
1,430

1,116

Jens awarded an honorary doctorate at University of Toronto (1999)



Jens at the terrace of his nursing romm flat where he moved in in 2014 after prolonged illness



More information on www.odam2014.org/legacy and more to follow, including all published works by Jens Rasmussen