


Engineering for the Ocean – Education, Training & Learning



Contents

BACKROUND
- Big Picture – Technology begets Civilization
- Technology & Engineering in the pre Scientific era

TODAY'S SITUATION
- Today's general public perception – Science "good" – Engineering "bad".
- Importance of dealing with this erroneous perception.
- Current issues with University education of engineers

FUTURE ACTIONS with resect to Engineering for the Oceans
- Educate the public at large and the younger generations in particular
- Attract young people into the profession
- Educate, train and pass knowledge to students and young professionals
- Include a strong "hands-on" component – not only theory but practice also.
- Develop ways to link academic research more directly to benefits for society.

THE BIG PICTURE

Planet Earth or Planet Ocean?

- ~ 70% of the earth's surface is covered by water
- ~ 80% of the world's population lives within 200 km of the coast
- ~ 90% of the world's trade volume moves by sea
- ~ 100% of life as we know it depends on water

Technology & Human Civilization

- Today, based on media reports and "green" organizations, it is becoming increasing difficult for engineers to articulate the critical importance of our work. We often seem to be on the defensive, with engineering seen as "*grubby and unimaginative*" while science seems to be championed as "*pure and creative*".
- But the reality is that in the developed world we live generally, safe comfortable and rewarding lives due to the availability of engineering and technology.
- And even in earlier times technology, pre-scientific age technology, played an important role in advancing civilization.
- The Egyptians built great pyramids to honor their Pharaohs, the Romans developed water supply and sewage infrastructure, central heating and an impressive network of roads and the Vikings designed and built ships which carried them across the stormy N. Atlantic to N. America
- All these engineering feats were accomplished centuries or even millennia before science was part of our regular lexicon.

Pre-Scientific Age Engineering

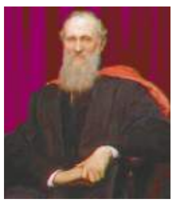

Egyptian Pyramids, 2560 BC


Aqua Appia, 322 BC


Viking Long ships circa 800 AD

Technology often precedes Science

James Watt 1736-1819



William Thompson,
Baron Kelvin of Largs 1824-1907

James Watt developed the working steam engine in 1775, which brought us the industrial revolution, well before the laws of thermodynamics were postulated by Lord Kelvin in 1850.

It has been said that;

"the science of thermodynamics owes more to the steam engine, that the steam engine owes to science"

Some indigenous technologies from Canada in global use today

Kayak

Trampoline

Sun Shades

- Note that all these indigenous technologies were created to meet identified needs within the societies that developed them.

CURRENT SITUATION

What is Engineering?

- Dictionary Definition:
  - the art or science of making practical application of the knowledge of pure sciences, as physics or chemistry, as in the construction of engines, bridges, buildings, mines, ships, and chemical plants.

Definition - Engineering

- Engineering:
  - The process of utilizing creativity, ingenuity and knowledge to design, build, and analyze objects.
  - Identifying problems and creating solutions – often creating something completely new in the process.

Definition - Technology

- Technology:
  - the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment, drawing upon such subjects as industrial arts, engineering, and science.
  - the sum of the ways in which social groups provide themselves with the material objects of their civilization

Definition - Science

- Science:
  – the intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment.

Recent Quote from a Prominent Fellow - Canadian Academy of Engineering

- *"A number of years ago I went on a 21 city speaking tour from Victoria to St. John's, sponsored by NSERC, to promote the fact that Canada's Innovation Strategy was absolutely silent on the role that engineers play in innovation.*
- *Despite a great deal of personal exposure and the fact that the then President of NSERC was promoting the same message, I never was able to get a hearing with any politician.*
- *In fact, I couldn't even get the NSERC Council to hear the talk. This cause was later taken up by the NSERC Chairs in Design Engineering who generated what came to be known as the "Montreal Manifesto". This was widely communicated to politicians to a resounding silence!"*

The difference between Technology and Science

– ***"Design & Invention*** *cause things to come into existence from ideas; they* ***make the world conform to thought****;*

– *whereas* ***Science****, by deriving ideas from observation and analysis;* ***makes thought conform to existence****."*

– Carl Mitcham, Philosopher, Prof of Liberal Arts and International Studies, Colorado School of Mines

The Roles of Science and Engineering

- *Scientists seeks to understand what is, engineers seek to create what has not yet been."*

  – Theodore Von Karman 1881-1963

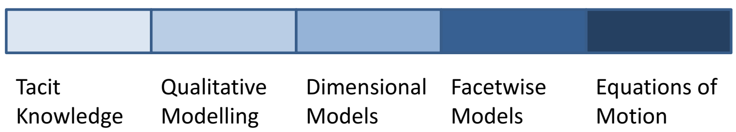
- There is also a fundamental difference in the work of Engineers and Scientists which should be understood

- *Scientist seek certainty while Engineers deal with uncertainty*

Modelling

- Engineers create and use models, both physical and numerical, to advance technology, while scientists build ever more accurate models to observe phenomena.

- Range of Modelling



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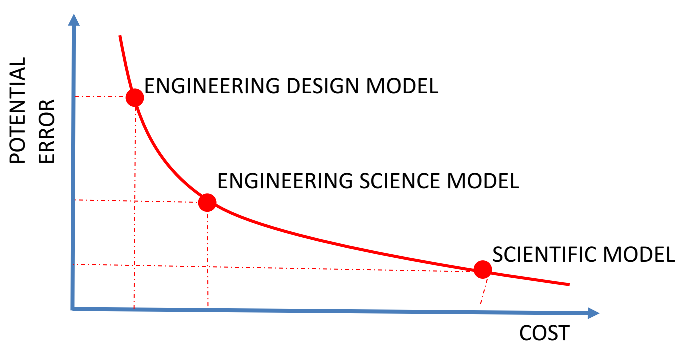
Engineering and Science Model

- These models lie in the same plane, but with different attributes



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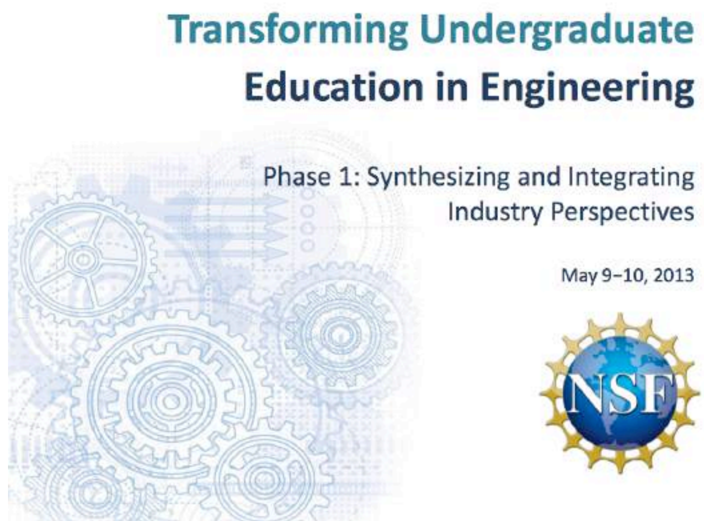
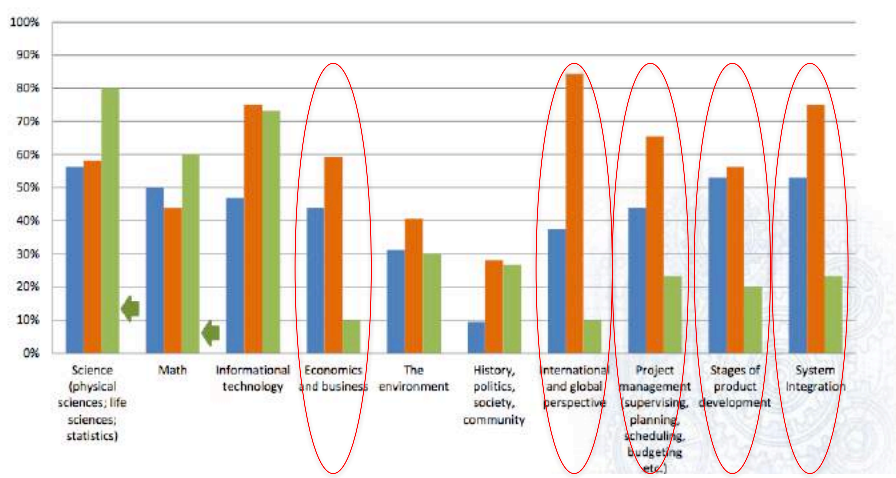
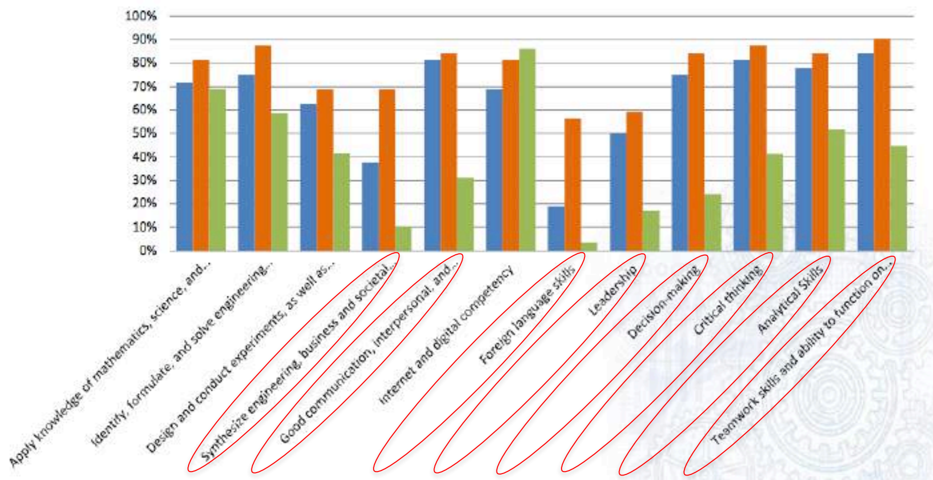


Ranking of the **quality of engineering education** in the following **KNOWLEDGE** areas, as well as their importance for the engineer workforce **today** and **10 years from now**



Ranking of the **quality of engineering education** in the following **SKILLS**, as well as their importance for the engineer workforce **today** and **10 years from now**



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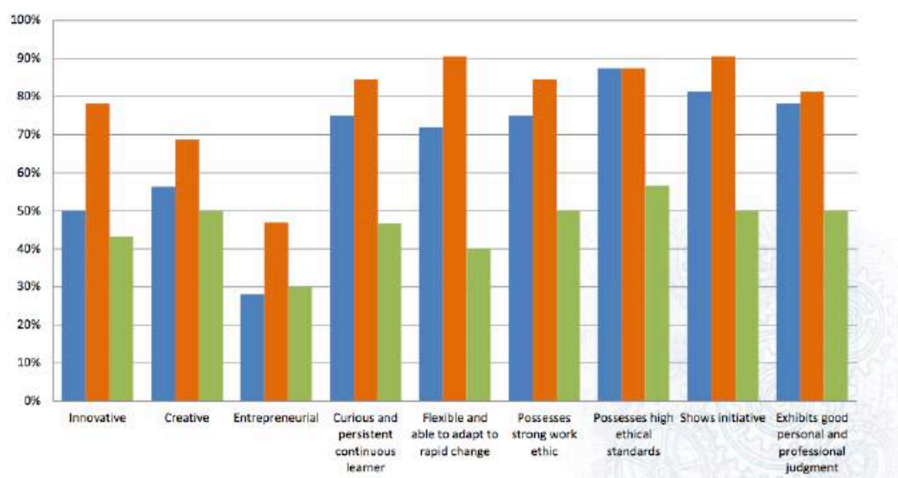
Ranking of the **quality of engineering education** regarding the listed **ABILITIES/QUALITIES**, as well as their importance for the engineer workforce **today** and **10 years from now**



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National University of Singapore Design-Centric Programme (DCP)

A unique learning pathway, offering multi-year duration projects that students can define:

- solving problems which have societal impact
  - e.g.: *new ways of recycling*; *medical technology*; *energy supply*
- developing "cool" technologies
  - e.g.: *next generation aircraft*; *future phones*; *intelligent household devices*
- offering projects with 5 broad themes (or tracks)
  - *Aerospace Systems Initiative*
  - *Future Transportation Systems*
  - *Engineering in Medicine*
  - *Smart, Sustainable Cities*
  - *Innovative Systems*

c

National University of Singapore Design-Centric Programme (DCP)

Immersion within a culture that emphasizes:

- personal ownership of project direction
- challenging of convention
- innovative design
- multi-disciplinary teamwork
- formulation of holistic solutions

Living & learning together:

- residential learning at DCP Cluster within the new UTown Residences

Photo by Darren Soh

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DENMARK - EDUCATING MARITIME ENGINEERS FOR A GLOBALISED INDUSTRY - BRIDGING THE GAP BETWEEN INDUSTRY AND UNIVERSITIES

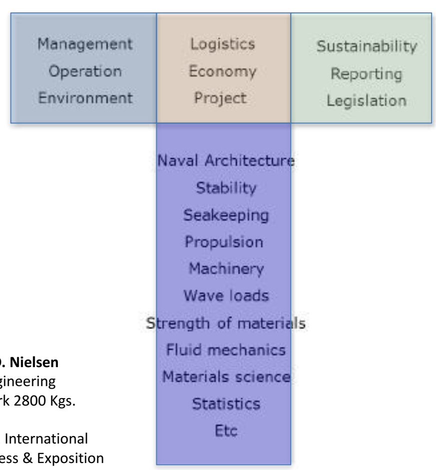
Operation

- Operation management.
- Operation optimization.
- Operation economy.
- Performance management and performance monitoring.
- Operation of ships and offshore structures.
- Environmental management.
- Environmental reporting.
- Understanding of national and international environmental legislation.
- Sustainability and life cycle analysis.
- Creativity, innovation and change management.

Competences for projects

- Naval architecture.
- Stability, seakeeping and propulsion.
- Structural assessment of ships and marine structures.
- Fluid mechanics, hydrodynamics and CFD.
- Wave loads.
- Thermal energy systems, machinery and combustion engines.
- Combustion processes, combustion chemistry and air emissions.
- Material science (metals and composite materials).
- Statistics.
- Electric control and automation systems.
- Alternative marine fuels, particularly the use of liquefied natural gas.
- Understanding of complex machinery systems.
- Acoustics and vibrations.

Denmark - Proposed "Tee" Shaped Education



Ingrid M.V. Andersen 7 Ulrik D. Nielsen
Department of Mechanical Engineering
Technical University of Denmark 2800 Kgs.
Lyngby, Denmark
Proceedings of the ASME 2012 International
Mechanical Engineering Congress & Exposition

Canadian Situation

- Based on experience with US, UK, Europe, Singapore and China, the two Canadian universities that teach naval architecture, ocean engineering and shipbuilding engineering, MUN and UBC are above average in graduating work-ready engineers.
- One attribute of these schools is that many of their alumni have left Canada for work for periods of time and gained valuable experience internationally.

FUTURE ACTIONS

How to Influence the Future

- Required :
  - A society that appreciates engineering & technology
  - People who are enthusiastic, creative, smart, committed, well educated well trained and with a desire for life long learning.
  - Readily accessible and usable knowledge base.
  - Good ideas and the ability to implement them.

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CCA Study

"The Value of Commercial Marine Shipping to Canada"

EXECUTIVE SUMMARY

The report, produced by the Council of Canadian Academies, examines the value that Canadians receive from marine shipping.

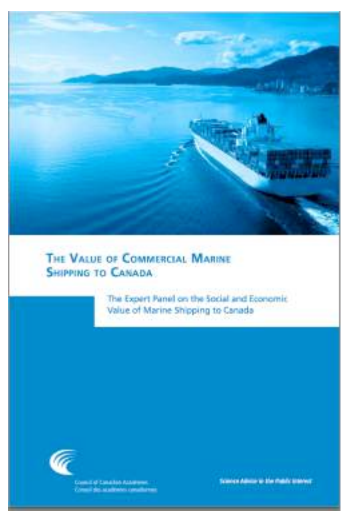
The study examines a scope that extends beyond economic impacts and draws conclusions about how marine shipping contributes much to Canadians' daily lives – whether or not they live in coastal communities.

The report was developed by a multidisciplinary and multi-sectoral panel of ten experts. The Panel examined the best available evidence on marine shipping and its value for more than a year.

Overall, this study confirms how marine shipping's contribution to the lives of Canadians and the Canadian economy is frequently underestimated.

Key economic findings of the report include:

- The national economic impact of marine shipping is equal to approximately 1.8% of the Canadian economy or about $30 billion.
- Marine shipping transports about 20% of Canadian exports and imports by dollar value
- The GDP of Canada's marine shipping industry is $3 billion
- The marine shipping industry in Canada is a direct and indirect source of income for nearly 100,000 jobs accounting for $4.6 billion in labour income



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STEM is not the perfect answer

- Today STEM, in reality, is Science & Mathematics.
- Currently, school teachers are not well trained in Technology & Engineering, especially not early years educators.
- Science and Mathematics can be considered as using analytical skills, while Technology and Engineering require the synthesis of creative ideas.
- We need new approaches to teaching T&E.

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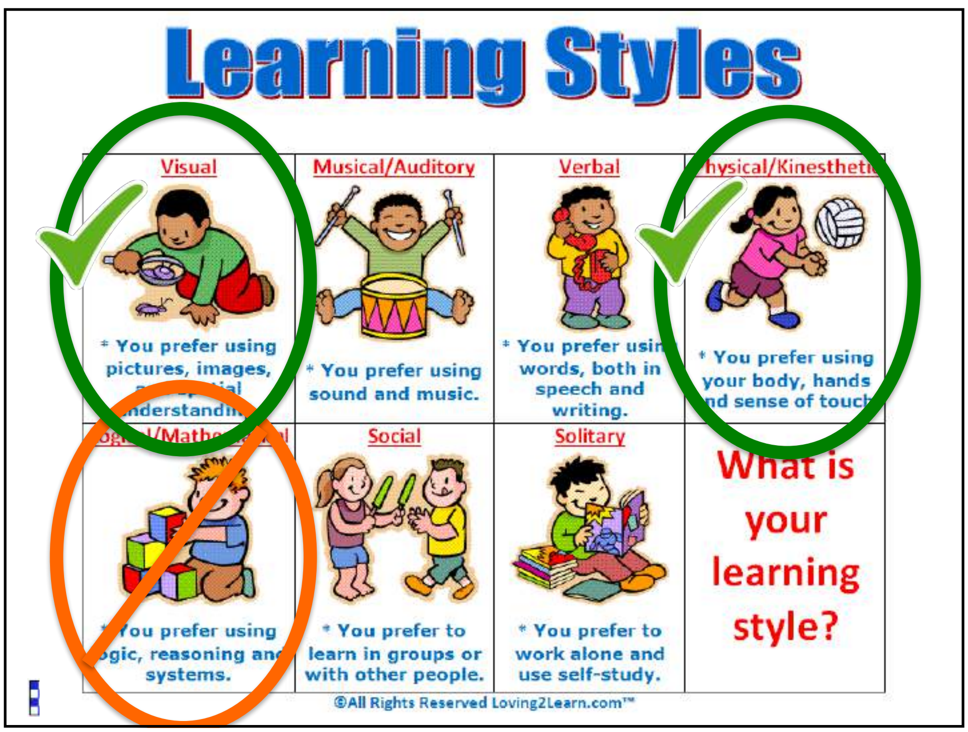

Engineering Education

(based primarily on N. American and European models)

- Undergraduate programs do a good job on teaching engineering analysis and a poor job on teaching design synthesis.
- Post-graduate engineering education is largely focused on producing more researchers and professors.
- Most engineering schools put significantly more emphasis on professors being good researchers and publishing papers, rather than on being good teachers and producing work-ready engineers.
- William John MacQuorn Rankine, had a reputation as an excellent teacher, emphasized the ***"mutual dependence and harmony between sound theory and good practice",***

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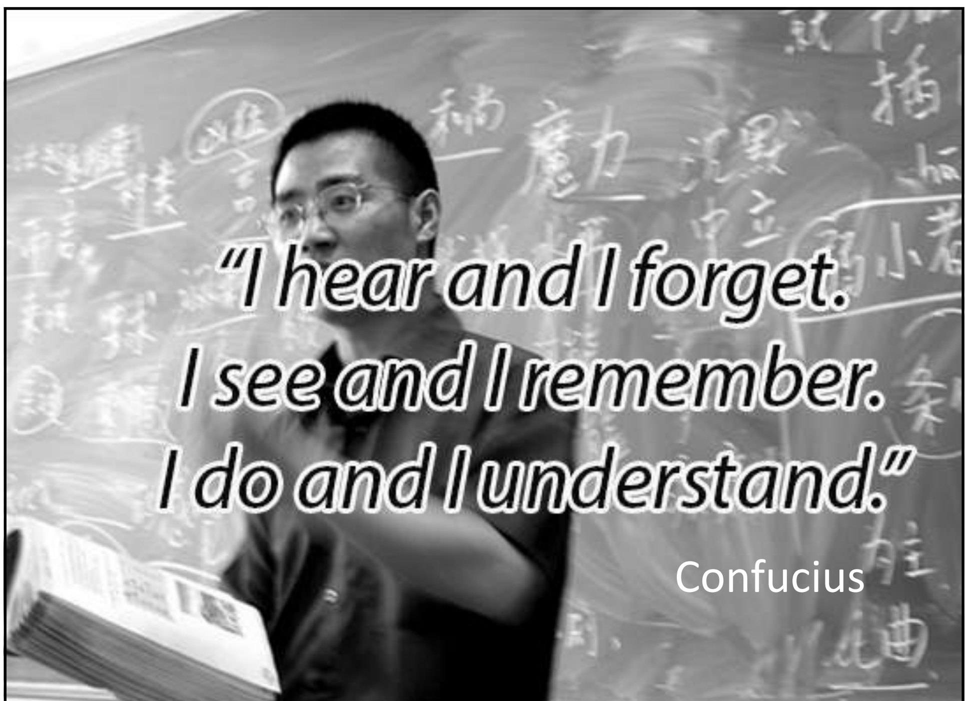

There is value for students in hands-on extracurricular activities

- Autonomous Sailboat development
- Human Powered Submarine races
- Footy Yacht Design and Racing
- Etc.

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The Naval Architect

- *"A naval architect should be able to design, draw, calculate, lay down, cut out, set up, fasten, fit, finish, equip, launch and send to sea a ship out of his own head.*
- *He should be able to tell beforehand at what speed she will go, what freight she will carry, what qualities she will show in a sea, - before it, athwart it, against it, - on a wind, close hauled, going free, - what she will stow, and carry, and earn and expend.*
- *On his word you should be able to rely, that what he says, that his ship will infallibly do."*

  – John Scott Russell's (engineer and naval architect), "The Modern System of Naval Architecture", 1865

IKIGAI

A Japanese concept meaning "reason for being".

Current Issues

- We need to
  - Educate the public on the importance of engineering and technology in sustaining civilized life.
  - Encourage young people to seek a career in engineering and technology development.
  - Explore university education, college training and apprenticeships models and combinations thereof
  - Look for ways to expose young engineers to practical experience
  - Develop improved ways to enable Transfer Knowledge and retain Lessons Learned.
  - Reinforce the importance of Hand & Brain connections
- Universities, Technical Colleges, Professional Societies, Government Agencies and Industry Associations all have key roles in addressing these issues through increased collaboration.

An Idea for a Better Way to Demonstrate the Value of Academic Technology & Engineering R&D

The Current Role of Universities

- Engineering Schools currently perform 3 concurrent functions:
  - Teaching– class room lectures, lab work and in a few cases formal work-terms and internships.
  - Testing & Certifying a certain level of knowledge – awarding of degrees
  - Conducting Research – carrying out engineering research and publishing results

Initiating Event

- I recently gave a Technical Talk in Singapore and a question was asked that stimulated the following slides.
- It was asked by an "enlightened" academic who wanted some measure of the usefulness of her work outside the ivory tower world of academics peer reviewing each other.

Background

- One common approach for measuring success in R&D in academia is through the "citation record", i.e. how many other researchers reference a paper when publishing their own work. This is part of the "publish or perish" paradigm that now dominates much of academic R&D.
- This has two problems
  - This can become an bit incestuous with a spiral of citations building in a relatively small and specialized community with little or no reference to the usefulness of the research in adding value to society at large.
  - Users of useful knowledge generated in published work, infrequently write and publish papers on their work and when they do may not follow the rigorous citation standard of academia., so there is no feed-back from end users. This results in R&D funders and performers having no ability to judge the true value of their work.
- This following slides explore a potentially better way to determine the societal value of such R&D

The Internet Shopping Model

- When one shops for a book (or anything else) on Amazon or similar sites, one get access to a scoring system and user comment data base.
- At SNAME we have an excellent collection of technical material from our Journals, Section Meeting, Annual Meetings, OTC, Specialized Symposia etc.
- We might set up our system to capture the address of the member downloading a papers from our system, and then send an automatic email to the member a regular intervals until a response is received.

Sample Message

"Dear SNAME Member,

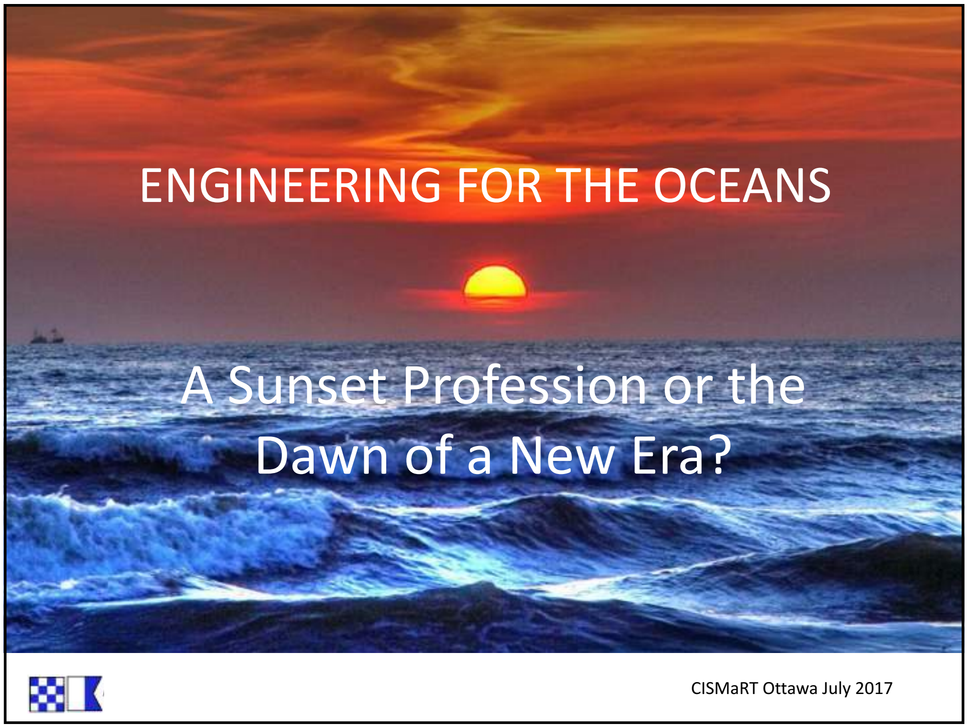
We noted that you have recently down-loaded the paper " Better Banana Boat Design", by Frank Bacon

We value your feed-back which we will share with the author and our members.

Please rate the value of this paper to you and provide any comments"

Improved "Citation" Record

Title:	***Better Banana Boat Design*** by Frank Bacon
Rating:	★★★★☆ 4 stars
Area:	Design ■ Research ☐ Operations ☐ Other ☐
Review:	*Patrick Macintosh, Associate Member*
	Best paper on specialized fruit carriers I have read and am now using to design a new class of such ships which will be unmanned to reduce cargo loss from crew consumption of bananas.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Dawn of a New Era?
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