EBM Systems Level Issues I

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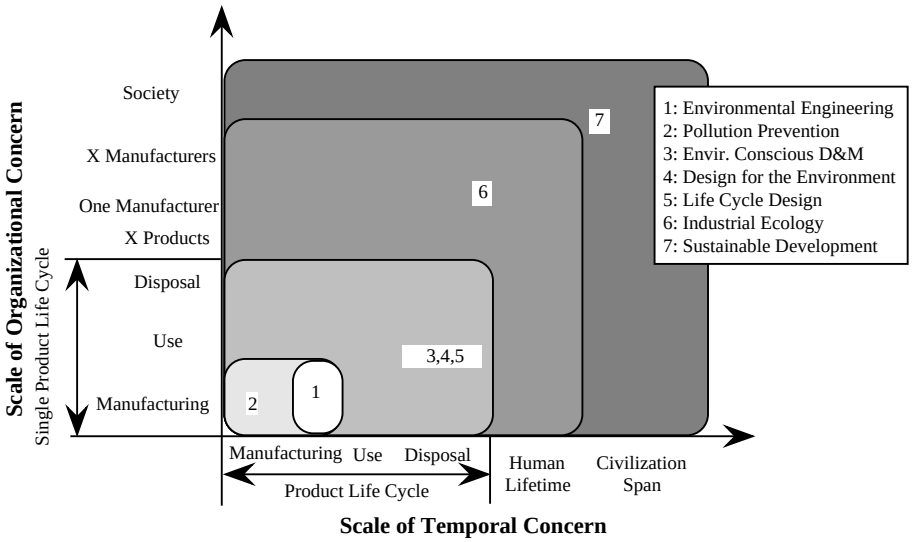
Potential Scope of EBM and Systems Issues



So where and what is EBM?

Findings in Some Specific Areas

- **Societal/Culture**
- **Education**
- **End-of-life (reuse & recycling)**
- **Design for Environment**
- **Assessments**
- **Integration**
- **Summary**
- **Needs**

Society/Culture

- **The difference and importance of culture was striking.**
- **Japan:**
  - **Avoiding waste and saving resources is culturally ingrained.**
  - **Japanese are on a "small ship in the pacific"**
  - **Environmental stewardship is part of "being a good citizen"**
  - **Criticism on US**
- **Europe:**
  - **Green space is scarce and thus precious.**
  - **Environmental stewardship and associated action groups are very strong and sometimes reinforced by religion (mankind is custodian of the Earth).**
  - **High degree of cooperation between governments and industry.**
  - **Recycling is culturally ingrained from bottle recycling - consumer goods is just a logical next step.**
  - **Resource/material based tax system (rather than labor/income based) is being introduced in The Netherlands - has bilateral support.**
  - **Still, average citizen is not overly environmentally conscious at all (traffic problems).**
  - **Criticism on US**

University Education

- **Japan:**
  - **EBM related education was limited to electives**
- **Europe:**
  - **EBM related education is part of core curriculum at many universities, but again mostly restricted to students taking a few courses in the area.**
- **Integration into core subjects still lacking.**
  - **Some European universities realize this problem, but falling enrollments has shifted their attention at the moment.**
  - **The broadness of EBM does not help - teaching from a systems perspective is difficult.**
- **The US lags Europe, but not too far, given the many initiatives at the K-12 level.**
  - **However, arguably the average US student lags his/her European and Japanese counterparts in the level of education in general when entering entering university.**

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End-of-Life

- **End-of-Life issues are considered to be very important.**
- **Both Europe and Japan are developing and implementing product take-back legislation as we speak.**
- **These cannot and will not be turned back.**
- **Take-back and recycling process issues affect manufacturing**
  - **Types of materials**
  - **Product configuration design**
- **Recycling also causes environmental impact.**
  - **Transportation, facilities construction and operation, etc.**
- **Incineration considered to be a viable option in Japan and Europe (new problem: Europe has over-capacity)**

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Material Recycling

- **US:**
  - **Recycling efforts either self-motivated or in response to European initiatives.**
- **Japan:**
  - **Avoidance of waste and saving of resources is culturally ingrained.**
  - **Take-back laws considered are derived from European initiatives.**
- **Europe:**
  - **High emphasis on take-back for recycling - due to legislation.**
  - **Working take-back system in place in The Netherlands.**
  - **Reprocessing still highly dependent on manual labor (for sorting, disassembly, inspection). US may lead in mechanical separation technologies.**
  - **Recycling/reuse is seen as new job opportunities, especially in Germany.**
  - **No magic silver bullets.**
- **Take-Back Legislation:**
  - **No objection from population to pay extra for disposal fee on consumer goods.**
  - **European laws to be implemented are stricter than Dutch law.**
  - **Experience from Dutch recyclers:**
    - » **should be economically viable to be self-sustaining;**
    - » **find market for materials first, then recycle.**

Reuse & Remanufacture

- **US:**
  - **Reuse is pursued primarily when it makes business sense.**
  - **Most reuse is done by third party remanufacturers.**
  - **Automobile parts, manufacturing equipment are well established remanufacturing infrastructures.**
- **Japan:**
  - **"Inverse Manufacturing" seems to be well known phrase in many companies.**
  - **Electronic companies are thinking about using "inverse manufacturing" and service industry paradigm (rather than being product sales oriented) to their advantage.**
  - **Still, "classical" remanufacture and reuse problems persist**
    - » **set-up of reverse logistics network is challenging**
    - » **need for better reprocessing technologies**
    - » **products not designed for reuse - designers need re-education**
    - » **radical new concepts still in laboratory stage**
    - » **Profitability can still be a problem**
- **Europe:**
  - **Slightly different situation due to emphasis of take-back legislation.**
  - **High interests in "selling-use" from academia and governments.**

From the End to the Front - Design for Environment

- **Interest in DFE is growing world-wide**
- **Japan (general):**
  - **Avoidance of waste is culturally ingrained - lean thinking.**
  - **Growing necessity due to limited natural resources available (incl. space)**
- **Japanese Industry**
  - **Strong focus on tools:**
    - » **Design for Disassembly**
    - » **Design for Recycling**
    - » **LCA**
  - **Many tools are developed in-house. One reason: language barrier.**
  - **Integration with other design and management tools and practices still not resolved.**
  - **Cooperation between government and industry not strong.**
- **Japanese Universities:**
  - **Ongoing work and several major initiatives and conferences.**
  - **However, DFE is not integrated in curricula.**
  - **Mainly elective course and driven by individual faculty interest.**

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DFE - Europe

- **Arguably leading this area**
  - **At least historically.**
- **Most larger companies all seem to have some expertise in it**
  - **Seen now by many as "just another Design for X" to be done, but (still) lower in priority to technical and economical concerns.**
  - **Fits in concept of lean manufacture → avoid waste.**
  - **Low hanging fruits can easily be identified using existing DFE tools/practices.**
- **Even in Europe's large companies, getting practicing engineers to do DFE can be a problem.**
- **Trade-off and detailed analyses are still difficult to do.**
- **Trials with implementing DFE in Small & Medium-Size Enterprises have been conducted in Netherlands and Sweden.**
  - **Current tools are good enough to get them started.**
  - **Self-motivation and sustaining of effort is difficult → SME may not see business advantage or simply has no time.**

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What is Better?

- **Typical questions:**
  - **What is the environmental impact?**
  - **Where does it occur most?**
  - **What should we do about it?**
  - **What is it going to cost us?**
- **"Quantify → Qualify → Symbiosis"**
- **Assessment tools are crucial.**
- **Ideally, these need to be valid, easy, objective, reproducible, enhance understanding, etc.**
- **Generally agreed that one should not focus on one life-cycle aspect solely, but take a systems and life-cycle perspective.**

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Life-Cycle Analysis (ISO 14040-14043)

- **LCA = Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life (ISO 14040)**
- **Findings:**
  - **Wide variety of packages available.**
  - **Widely used in Europe, slightly less in Japan.**
  - **Mostly done by experts, either internal or (hired) external consultants.**
  - **Not integrated with other analyses yet**
- **Problem: No general consensus on "standard" for measuring environmental impact - thus wide variety of interpretation possible (and allowed).**
- **Other criticisms: Not tied to business perspectives, too academic, too vague, data lacking, difficult to do, does not capture "value".**

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Integration with Business

- **EBM is seen by many in Europe and Japan as a natural extension of lean manufacturing and/or concurrent engineering.**
  - **In the US, it is still often viewed as a separate and special activity.**
- **European EBM/DFE support strategies seem to have evolved to**
  - **a) have a group of experts at corporate R&D level, but**
  - **b) definitely have a few dedicated DFE/EBM persons at the business unit/manufacturing plant level.**
- **Integration with company wide information systems (and beyond to suppliers) is being pursued.**
- **Interestingly, few (if any) have really linked environmental assessments closely with business/economic assessments.**
  - **Mostly on a case-by-case basis.**
  - **Not systematically.**
  - **In some cases, governmental bid packages include request for environmental analysis in addition to financial budget.**
  - **Financial and environmental accounting systems not linked (yet).**

Symbiotic Thinking

- **Next frontier: integrate manufacturing and industry with Nature.**
- **Noticeable was the interest of several companies in natural fibers.**
- **Also, "waste" is a relative term: a waste may be a food for something/somebody else. Key is to find that thing or person.**
- **If symbiotic, closed-loop, links can be established, then impact reduction could be significant.**
  - **Within the industrial system by teaming with diverse partners → Industrial ecology**
  - **With Nature by using renewable and (bio)degradable materials → Natural ecology**

Summarizing

- **System thinking is extremely important, but equally difficult.**
- **Use-economy thinking will increase emphasis on manufacturing-remanufacturing cycle.**
- **More and more LCAs are performed, but validity, repeatability, comparability, and even usefulness are still a huge problem.**
- **Integration of environmental assessments with "regular" business and engineering tools still not achieved.**
- **Emerging "out-of-the-box" thinking in terms of using natural materials and symbiotic relationships.**
- **All this affects DFE, which needs better tools, exposure, and integration itself (across supply-chain/value-chain/life-cycle).**
- **No magic silver bullets (software or hardware).**
- **Collaboration is key!**

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Needs

- **Fundamental understanding and dissemination of "true" environmental impact.**
  - **Link Earth & Atmospheric Sciences with engineering.**
- **Improved linking and understanding of environment and economics.**
- **Industry support:**
  - **Help/team with/support industry with assessments.**
  - **Design tools with different level of specificity.**
  - **Focused study and help for SMEs**
- **Cross-industry collaboration and roadmapping to facilitate symbiotic thinking.**
- **Engineering education modules that fit in engineering core subjects.**
- **Collaboration between Industry, University, and EPA, in a positive trusting manner.**
  - **Change to materials and energy based tax/reward system rather than penalties**

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