

SUSTAINABILITY ON ENGINEERING PROGRAMMES THE NEED FOR A HOLISTIC APPROACH

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“The human species is on a **brutal collision course** with its natural environment”
Periera, 2009

“I don't think the American public has **gripped in its gut** what could happen. We're looking at a scenario where there's **no more agriculture** in California.”
Chu, 2009

*The world in which we are practicing engineering is not only one where we are exhausting and plundering the resources of the earth at unsustainable rates but we are on the **threshold of unimaginable devastation** that climate change is likely to bring”*
ICEE, 2007

Where do we stand today?
“We have got to deal with increased demand for energy, increased demand for food, increased demand for water, and we've got to do that while mitigating and adapting to climate change.
..And **we have but 21 years** to do it.”
Beddington, 2009

There is ‘a significant risk that many of the trends will **accelerate**’
Copenhagen, 2009



The problem with accelerating climate change (ACC)

severe weather events

water shortages

drought

food shortages

famine



sea level rise

flooding

habitat extinction

species extinction

is that, like an accelerating vehicle, it is destined to eventually go out of control with devastating consequences,

...unless a brake is applied in timely fashion.



Parallels with current global economic recession:





Parallels with current global economic recession:

Economist (5/31/2003, Vol. 367, Issue 8326)
Special Section: A survey of property

*“The rapid house-price inflation in many countries over the past few years is clearly **unsustainable**. Alan Greenspan dismisses the idea of a national housing bubble that could harm the whole economy if it bursts. ..He needs to exercise his imagination.”*

*“Given the fragile state of many economies, the bursting of a housing bubble could easily drag them into **recession** ..Sooner or later it will **burst**”*



Economic

Environmental

2003: Growing Property Bubble

Growing environmentally related Economic Bubble (Brown 2003)

pre 2007: Soft Landing?

2007: 'Sub-prime' correction

2008: 'Credit crunch'

"global economy might be at some kind of tipping point" BIS, 2008

2009: 'Great Recession'

post 2010: ?

Can we engineer a *soft landing* via the creation of a sustainable society??



Is féidir linn!

But, first of all we must begin to appreciate the scale of the issue on a global and collective basis. Then we must work together to find a sustainable pathway; to do this we must have leaders who can chart a way forward. Engineers are well placed on all these fronts and therefore are potential and obvious key players.



A new Engineering Paradigm

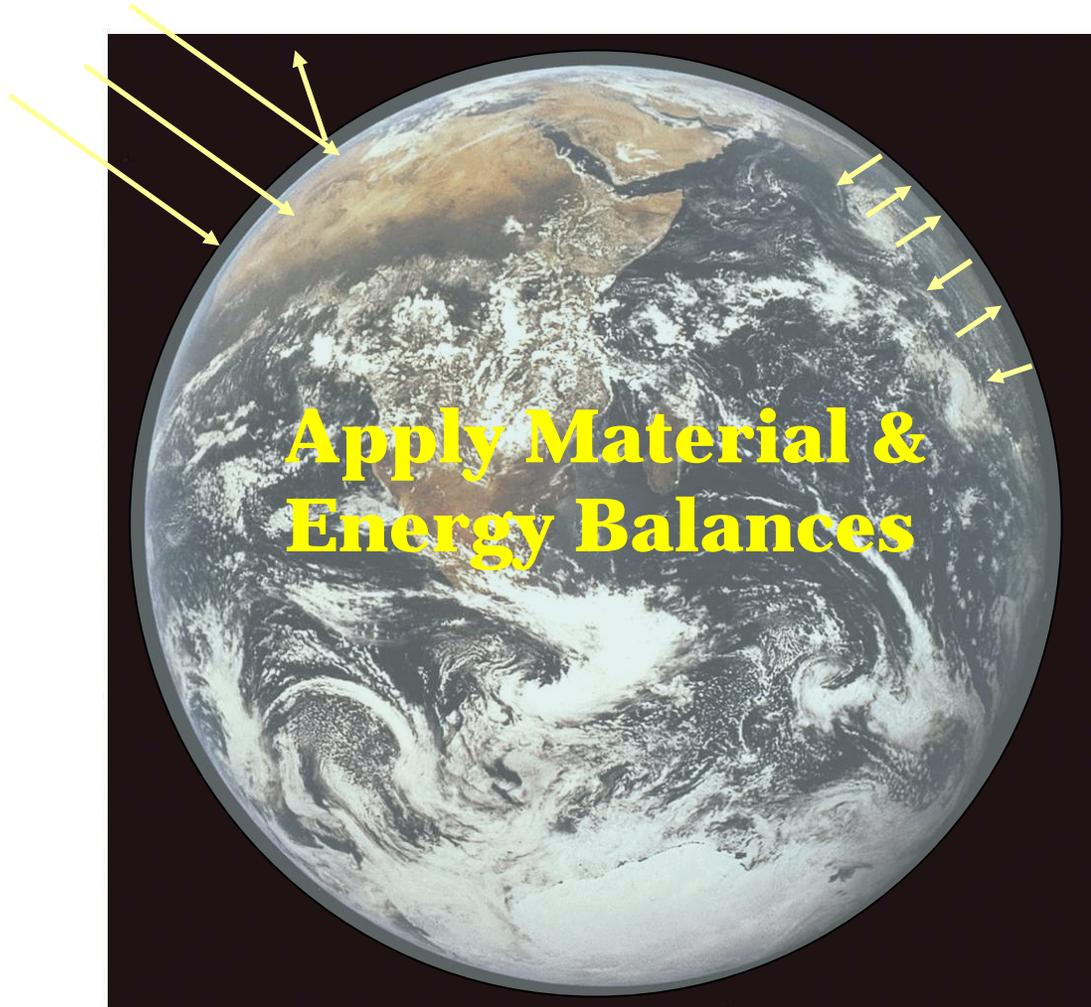
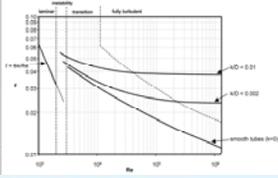
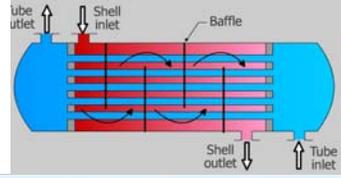
From ‘**design with constraints**’

ABET, 2007: “*an ability to design a system, component, or process to meet desired needs within realistic **constraints** such as economic, environmental, social, political, ethical, health and safety, manufacturability, and **sustainability**.*”

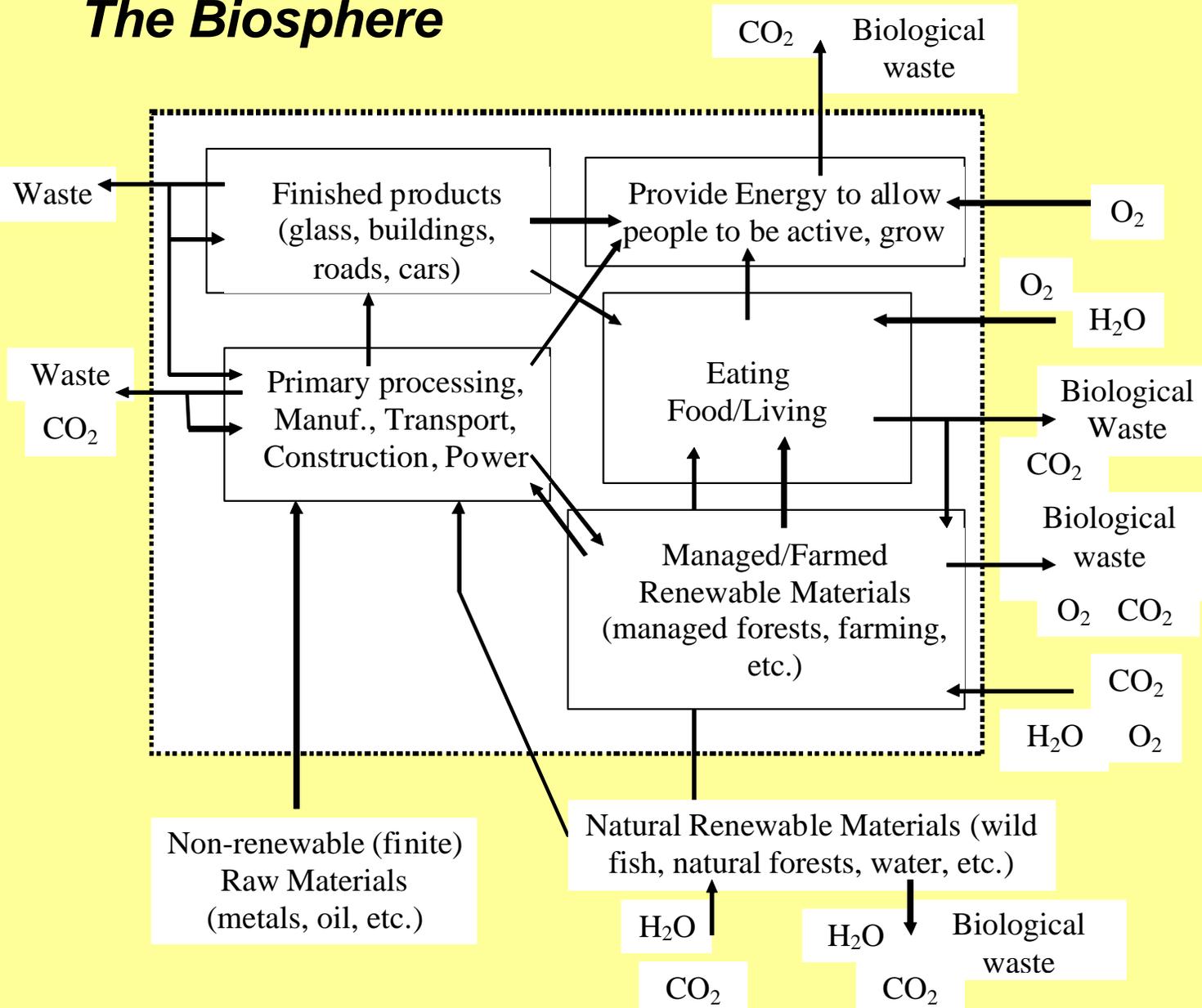
..to **sustainability** being the **context** of engineering practice

1997 Joint Conference on Engineering Education and Training for Sustainable Development in Paris: Sustainability should be “*integrated into engineering education, at all levels from foundation courses to ongoing projects and research*”

Professional engineering institutions need to “*adopt accreditation policies that require the integration of sustainability in engineering teaching*”.



The Biosphere





Easter Island



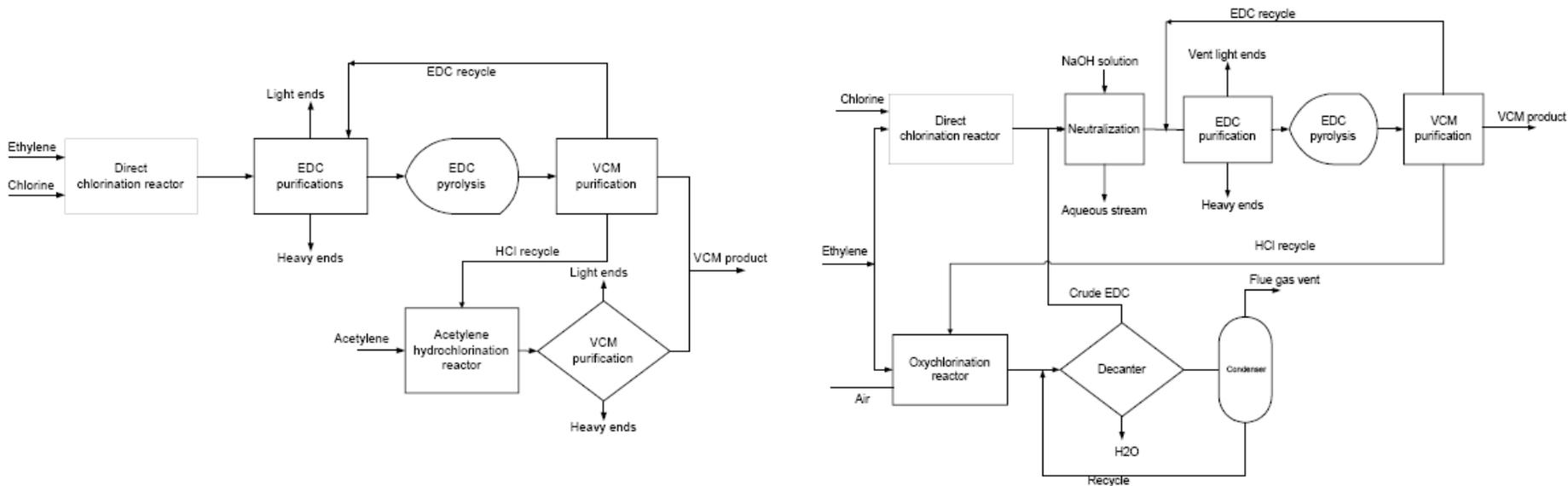
17th Century construction & population boom



..18th Century collapse of society & population; 10,000 → 750 (est.) & long term subsistence living



Alternative processes to produce Vinyl Chloride (VCM) (Bi, 2005)



Question asked: *What is the best way to produce vinyl chloride?*

Questions that could/should be asked: *What do we do with vinyl chloride?*

Does this entity really need to be produced?

Are there other (less unsustainable) materials that could be produced instead? PLA?

How feasible is it to produce plastics from renewable materials as opposed to oil?

What are the technical and economic barriers to this?



'The entropy of the universe increases with any spontaneous process'

..Second Law of Thermodynamics



time



Concentrated
Energy

2nd Law

Diffuse Energy

Useful Work?

Increased
Entropy



High Entropy
(Dispersed/Less useful Energy)



Spontaneous ↑ - with E_{act}



(Concentrated/Organised Energy)
Low Entropy



Engineering Ethics

Case studies – artificial, oversimplified, well defined problems, often neglect *“the social complexities of engineering practice”* *Bucciarelli, 2008*

Don't appeal to students' **better instincts** to *“to ‘do good’, to better the environment, conserve energy...”* *Bucciarelli, 2008*

The engineering programme should be **reformed** *“to enable student (and faculty) understanding of the social as well as instrumental challenges of contemporary professional practice.”* *Bucciarelli, 2008*

“Engineers need to consider how they intervene in the public policy arena and whether these interventions enable or constrain the move towards a sustainable and just world.” *Conlon, 2008*



In conclusion..

Sustainability should be a **common threadline** running throughout engineering programmes.



This will enable it to:

- become the **context** for all **engineering practice**
- equip engineers to better **comprehend** the **very significant challenges** ahead & work with others to address these challenges
- **take the lead** in our most important endeavour yet.



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