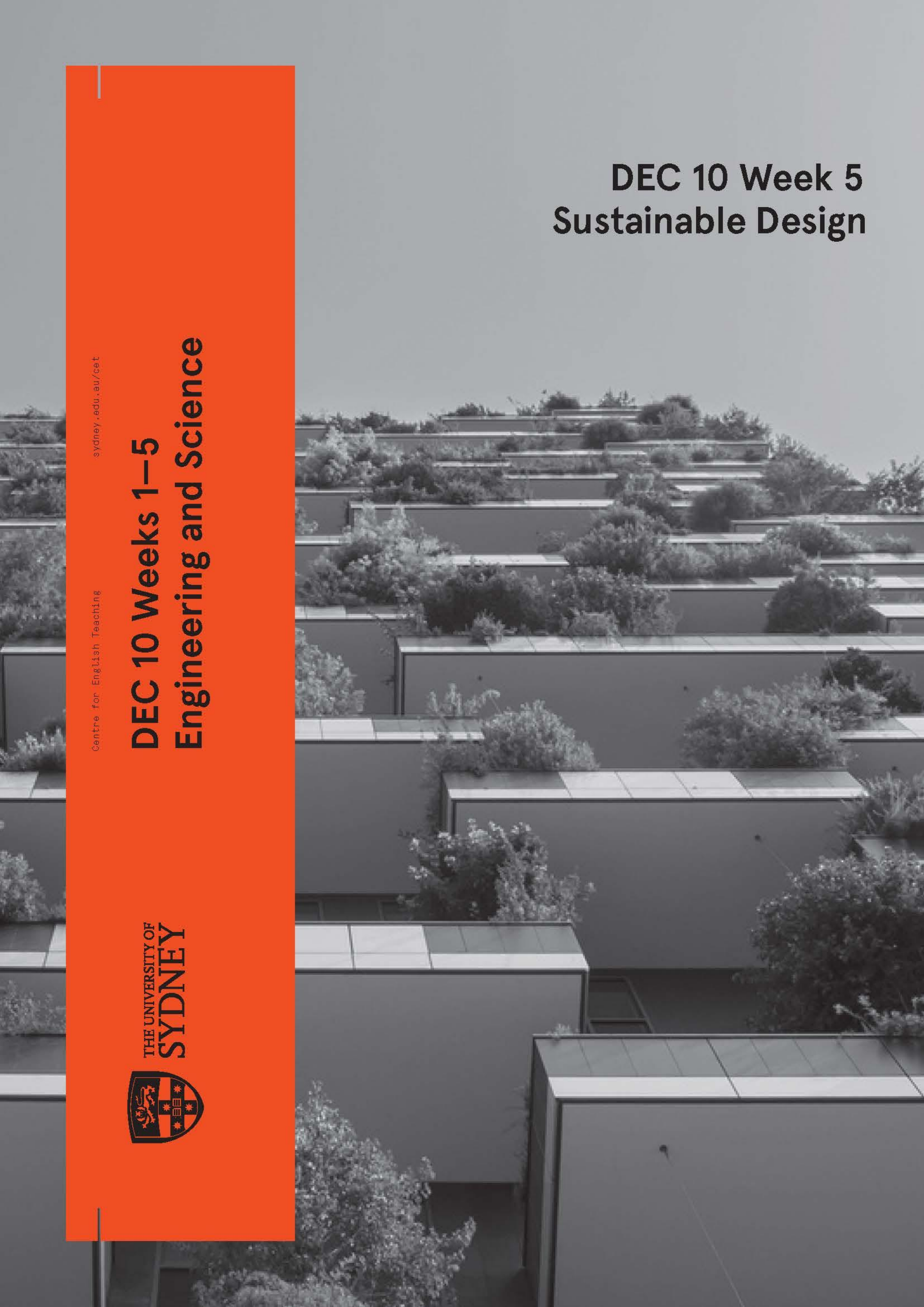

DEC 10 Week 5
Sustainable Design

Centre for English Teaching

sydney.edu.au/cet

DEC 10 Weeks 1—5
Engineering and Science

THE UNIVERSITY OF SYDNEY

DEC 10 Week 5
Sustainable Design

Contents

Reading

Listening

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Reading

Wk 5 Reading 1: The systemic correlation between mental models and sustainable design

Lesson Objectives
• Identify connections between the text and previous reading • Use existing knowledge from previous reading to predict text development • Identify the author's position • Identify cohesive links

You will find the activities for Reading 1: *Using systems thinking to understand and enlarge mental models: Helping the transition to a sustainable world* on Canvas.

The text is included here for you to annotate and take notes.

Edited extract from:

Vanasupa, L., Burton, R. Stolk, J. Zimmerman, J. B. Leifer, L. J. & Anastas, P. T. (2010). The systemic correlation between mental models and sustainable design: Implications for engineering educators. *International Journal of Engineering Education, 26* (2), 438 - 450.

Introduction

GIVEN THE MAGNITUDE of twenty-first century challenges, it is increasingly clear that effective engineers will need to be capable of designing for sustainability; that is, they must be able to engage in 'sustainable design.' Unfortunately, 'sustainable' and 'design' are terms that share an ambiguous heritage that is not clarified by combining them into 'sustainable design.'

Sustainability, which is being approached by some as an emerging science [1], is viewed by some engineers as a design constraint [2]. However, it is a constraint that defies simple evaluation. Its indicators, which engineers may view as measures analogous to design specifications, can include qualitative measures such as 'Reducing the gap between rich and poor,' 'Conserving and enhancing the natural environment,' and 'Enhancing community participation.' [3, 4]. These measures highlight the fact that sustainability encompasses societal, environmental and economic dimensions as well as the interactions between them. These measures also represent a degree of dynamic complexity not encountered in traditional engineering performance criteria. Along with the (U.S.) National Academy of Engineering's Committee on Grand Challenges for Engineering, who identified four categories of engineering challenges (sustainability, health, safety, and the joy of living), these indicators underscore the shifting identity of engineers in society from 'designers of widgets' to 'codesigners of a healthy, thriving, global future.' This shift to a more systemic design process that must consider the global complexities of the proposed design is itself a paradigmatic shift. As such, it is likely to involve the human dynamics described by Thomas Kuhn in his seminal book, The Structure of Scientific Revolutions [5]. This includes vehement resistance to the new paradigm. It also results in counterproductive actions. For instance, if your assumptions about growth are producing the consequences that are viewed as unsustainable, more growth cannot produce a different result.

Unsustainable design as a systemic consequence of our historically valid mental models

There now exists substantive scientific evidence from a range of disciplines that points to global human activity as the source of rising concentrations of atmospheric carbon dioxide (CO2) [6]. The higher CO2 content directly increases CO2 absorbed by the ocean, increases its acidity, and kills the oceanic foundation of the global food chain [7]. Aside from the debated impact of rising temperatures, it is clear that destroying the basis of the global food chain threatens the system of biological services that support human and nonhuman life on earth. Simply put, our fossil fuel intensive state is not sustainable if we intend to sustain the human species.

It is hard to imagine that the global-scale, negative impacts are by design. Clearly, they must be unintended consequences of designers. While the exact cause of our collective, global unsustainability is not solely the fault of engineers, engineering advances have inadvertently contributed to the current state. William Perry, chair of the Committee on Engineering's Grand Challenges (National Academy of Science, U.S.) says that 'engineers must save the world, in some cases, from the harm that technology enabled.' [8]. Because public safety is at the core of an engineer's goal, we must ask, 'Why are we as engineers currently and collectively engaged in unsustainable design?'

For example, consider plastic bags. Grocery store patrons are confronted with the choice of paper disposable bags or plastic disposable bags for their purchases. However, any benefits of the material choice of paper of plastic are made irrelevant by the systemically damaging effect of the design of the system. The system requires a constant supply of energy, materials and resultant pollutants to manufacture packaging that will be used once and disposed of. What is the intent of such a system? It may be something like, 'Serve the economy by creating a disposable bag market,' This purpose does not consider the finite nature of energy and materials from the environment nor the infinite sink required for resultant waste with respect to the product life cycle.

Within the conversation about sustainability, many often refer to the 'triple bottom line' mental model–net gains in social, economic and environment considerations as a design or decision-making criteria. This is depicted with a set of separate but overlapping circles as shown in Fig. 4. In the language of Venn diagrams, these three circles imply three separate systems that have overlapping regions. Sustainable design is characterized as the region where all three systems overlap. While some may view this model as simply a convenient way of presenting the challenge of sustainable design, we contend that the consequences of this mental model are unsustainable design decisions. The reason is that it misrepresents the physical or thermodynamic relationships of the economic, societal or environmental systems. The consequences are design decisions that are misaligned with the natural order of things. For example, the economy has no meaning outside the confines of society, nor can either exist outside of the physical confines of the environment. However, if one holds a mental model like Fig. 4 that depicts an economic system wholly separate from both society and the environment, they may make decisions that are inconsistent with nature. For example, they may choose to create a product in service of the economic system while simultaneously externalizing the harm of serving the economy to the social and environmental system.

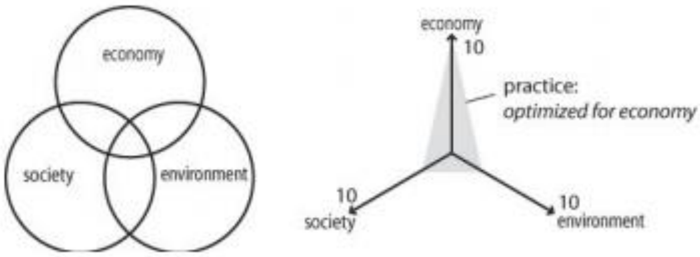

Fig. 4. Separate economic, societal and environmental systems.

The model in Fig. 4 also implies an accounting system where one can weigh and trade-off the gains in between these three categories, resulting in three ‘bottom lines.’ It implicitly treats the environment, society and the economy as separate, competing and substitutable for one another. In practice, the often-unstated mental model is a set of three axes (Fig. 4, above) along which designers must optimize and balance. To illustrate, consider axes that go from zero to 10. Optimizing the trade-offs in the triple bottom line is much like distributing an insufficient number of points (e.g., 17) across the three axes. Companies frequently defer to the economic ‘bottom line’ at the expense of societal and environmental concerns within the product or system life cycle. The consequence is short-term economic gain with long-term damage to the social and environmental systems required to create and ‘consume’ the product—eventually destructive to the economic system and thus counterproductive to the original purpose. This phenomenon illustrates one of the active questions around sustainable design: Where should we place the economic, environment, societal and temporal system boundaries?

An embedded systems model of reality as paradigm

A model that more accurately reflects the natural relationships between society, economy and environment is one that views these three systems as embedded systems: the environment is the system in which society entirely resides; the economy is a wholly-owned system within society. The United Kingdom was among the early proponents of this model through their primary and secondary education campaigns in early 2000. In Fig. 5, we illustrate how the model is built by beginning with the entire earth as the physical equivalent of the environmental system. As shown in Fig. 5, this model derives its validity from the physical reality that society lives on the environmental system we call earth. Additionally, it visually implies the fact that the economic system is a human-made system of trading goods and services that only has meaning within the social system.

Fig. 5. Embedded systems model of reality.

By using this embedded systems model as the starting point, sustainability of the parts of reality that are constrained by thermodynamics (e.g., material and energy) can take on a simple meaning that is connected to the laws of thermodynamics. For example, the environment is essentially a closed thermodynamic system (i.e., it can exchange energy with its surroundings, but it cannot exchange a significant mass to affects its own thermodynamic state). The law of mass balance implies that all material resources used in the economy for products or processes must come from the environment; additionally, the environment must act as a sink for all material wastes that result from the economy. It is also clear that society, on the whole, can be exposed to all that is within the environment. (It may not be that all are equally exposed and this fact leads to a further opportunity to discuss the fairness of who is and is not exposed to toxins in the environment.) Herman Daly's criteria [20] to sustain the integrity of the environmental system become quite logical: .

- For renewable resources, the consumption rate must not exceed the regeneration rate (promotes continual availability of renewable resources); .
- For non-renewable resources, the consumption rate must not exceed the rate of substitution by renewable resources (avoids depletion of nonrenewable resources); .
- For pollutants, the rate of emissions must not exceed the rate at which they can be either detoxified or absorbed by natural systems (averts accumulation of toxins in the environment).

There are also parallel principles that guide design decisions for the social and economic dimensions of sustainability [21]. The model in Fig. 5 also illuminates the common-sense basis of the first of the 12 Principles of Green Engineering: Design inherently benign systems [22]. Any designed system will be physically situated in a shared social and environmental commons, so inherently benign systems serve to preserve the larger environmental system on which the other two systems depend. The strength in the embedded systems model is its resonance with the thermodynamic and societal realities of our social, economic and environmental systems. It also promotes design decisions based on the true relationship and interaction between these systems.

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Listening

Wk 5 Listening 1: Designing a sustainable future

Lesson Objectives
• Practise predicting, monitoring and reflecting strategies to improve listening • Raise awareness of how speakers use intonation, stress, and chunking to structure speech • Use language to describe problems and solutions

Part 1: Listening strategies check-in

Last week, you practised the following Listening and Note-taking strategies. Fill in the right-hand column to review the skills you have been practising at home since last week. Then discuss with a partner.

LISTENING & NOTE-TAKING STRATEGIES Week 4		✓ / X / ?
PLANNING Before I listen, I….	7. predict key words in the listening AND think of abbreviations for them.	
	8. prepare to concentrate.	
	9. encourage myself to relax.	
MONITORING While I listen, I…..	18. use symbols & abbreviations in my notes.	
	19. maintain concentration.	
	20. continue to be relaxed.	
REFLECTING After I listen several times, I…..	28. evaluate my notes	
	30. evaluate if I was able to maintain concentration	
	31. evaluate if I was able to stay relaxed throughout	

This week, let's review the Listening strategies we have already looked at and reflect on the development of your Listening skills over the last five weeks.

Take a look at the full Listening strategies check list that we introduced to you in week 1. Complete the right-hand column. Put a ☺ if you feel you now use the strategy well. Put a 😐 if you feel you are on your way to using this strategy well. Put a ☹ if you feel you don't understand this strategy.

LISTENING & NOTE-TAKING STRATEGIES CHECKLIST		☺ /😐 /☹
PLANNING Before I listen, I….	1. think about what I know about the general topic.	
	2. predict the content of the listening.	
	3. decide what information I need to listen for (that will be relevant to the task I have been assigned), e.g. main ideas, specific information or author's opinion.	
	4. predict key words in the listening AND check their pronunciation.	
	5. predict the structure of the listening.	
	6. plan how I want to organise my notes.	
	7. predict key words in the listening AND think of abbreviations for them.	
	8. prepare to concentrate.	
	9. encourage myself to relax.	
	10. decide what listening strategies I will focus on.	
MONITORING While I listen, I…..	11. compare what I hear with what I already knew.	
	12. compare what I hear with my predictions.	
	13. listen for the information that is relevant to the task I have been assigned.	
	14. guess the meaning of words I don't know.	
	15. listen for the structure of the listening & compare with my prediction.	
	16. listen for connections between ideas.	
	17. write well-organised notes.	

	18. use symbols & abbreviations in my notes.	
	19. maintain concentration.	
	20. continue to be relaxed.	
	21. continue to focus on specific listening strategies.	
REFLECTING After I listen several times, I…..	22. compare what I heard with what I already knew.	
	23. compare what I heard with my predictions.	
	24. summarise what I heard.	
	25. evaluate the relevance of what I heard to the task I was assigned.	
	26. review the vocabulary I didn't know and check if I guessed the correct meaning.	
	27. identify the structure of the listening and compare with my prediction.	
	28. evaluate my notes	
	29. read the transcript (in order to learn new vocabulary, identify the structure of the text and identify the difficulties I had etc.)	
	30. evaluate if I was able to maintain concentration	
	31. evaluate if I was able to stay relaxed throughout	
	32. think about what **listening strategies** I used well.	
	33. decide what **listening strategies** I need to focus on next time.	
	34. complete extra reading & listening on the topic to expand my general knowledge.	

Overall, I….	35. regularly complete self-study to improve my listening & note-taking skills.	
	36. listen to each recording at least twice before I listen again with the transcript.	

Based on your reflection above, decide on three strategies that you will focus on during this final listening session. Write them down:

1. ____

____

2. ____

____

3. ____

____

Part 2: Before you listen

Vocabulary: Word Families

1. Remember that many words in English can have word families where the prefix or the suffix change to create a new part of speech

2. Match the part of speech to the function in the table below:

Part of speech	Function	Example:
1. Noun 2.Verb 3.Adjective 4.Adverb	A. used to describe a noun or a pronoun B. describe adjectives, verbs, or another adverb C. refers to words that are used to name persons, things, animals, places, ideas, or events. D. shows an action (physical or mental) or state of being of the subject in a sentence	*sustainaBILity (n)*

http://partofspeech.org/

1. Now put these words with the correct part of speech: sustain, sustainably, sustainability, sustainable
2. Mark the stress in each example. The first one has been done
3. Select the correct form of the word to fill in the gaps in these sentences.
   a. The Earth needs more ___________________ solutions.
   b. The design would be able to ______________ the industry in the future.
   c. Resources need to be________________ sourced.
   d. __________________ is a common theme in design today.
4. Now think about a sustainable solution that you have heard of before. Describe the design to your partner using the correct part of speech and stress.

Designing a sustainable future

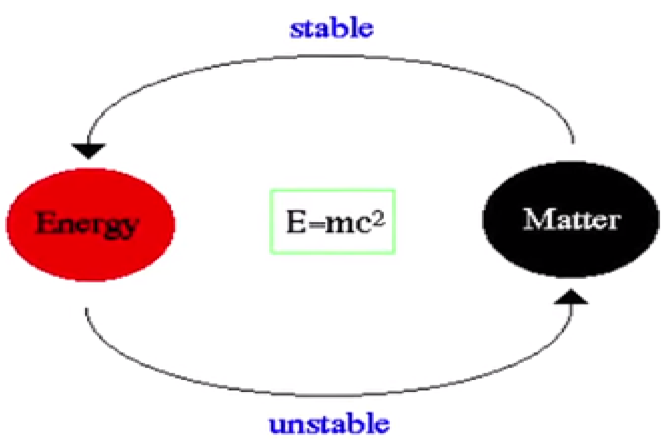


Figure 1

You are going to listen to a talk about sustainable design.

Task 1 Turn to your partner and discuss the following questions:

1. Do you recognize the equation in Figure 1? Where does it come from?
2. Why do you think Dr Anastas is referring to this equation to discuss sustainability?

Part 3: Watch and listen

Extract 1 Prediction

- What do you imagine will be the themes of a lecture called Designing a Sustainable Future? What have you already learned about sustainable design?

- Write down 3-5 words that you would expect to hear.

____

Listen to Dr Anastas' explanation of why he became a chemist. Can you predict his answer?.

Extract 1:0.00-1.31

Extract 1 Listen & Monitor

- Were your predictions correct? How might this viewpoint influence the rest of this lecture?

- For instance, what tenses do you think Dr Anastas will be using?

- What language is useful for discussing problems, change, and outcomes?

Extract 2 Listen & Monitor

Listen to the next extract. Dr Anastas will be saying that today's situation is different than it was in the past.

Try to write down some of the words that describe the changes in the examples that he gives.

Extract 2 1.32-2.29

Extract 3 Prediction

In the next extract Dr Anastas introduces his opinion about the future.

What is the difference between optimism and pessimism? Tell your partner about how you would describe your own feelings about the future of this planet.

Extract 3 Listen & Monitor

Listen to Dr Anastas' opinion and compare with your own.

Extract 3: 2.30-3.15

What reasons does he give for his opinion?

Extract 4 Note-taking

Listen to the section on resource consumption in the United States and take notes. Focus on

- noting key ideas only
- using abbreviations and symbols wherever possible
- using numbers (1, 2, 3, etc.) where the speaker lists reasons or figures

Extract 4: 3.16-4.30

Notes:

Now, compare your notes with those of others around you.

1. What point is Dr Anastas trying to make by showing these examples?

2. How do you think these figures compare to resource consumption in your own country?

Complete this table with the figures from your notes.

Product	**Disposed Quantity**
plastic bags	
cell phones	
plastic beverage bottles	

Extract 5 Comprehension Evaluation

The next extract introduces some considerations around design. Continue taking notes, and then answer the questions.

Extract 5 4.31–5.19

Notes

Compare your notes with those of others around you.

Use your notes to try and answer these questions:

1. Which opinion most closely matches that of the speaker?
    a. Problems should be looked at independently
    b. Good design is easy to accomplish
    c. Issues are interrelated and have to be addressed together

2. What point is Professor Anastas making about biofuels?
    a. Biofuels have been an example of good design
    b. Biofuels can be used as an example of design failure
    c. Biofuels will be useful in the future

Extract 6

In the next section, Dr Anastas outlines four examples of having good intentions around design solutions, but executing those solutions in the wrong way.

Listen carefully to know when Dr Anastas is finished talking about one example and is discussing another.

Extract 6 5.20-6.21

- Renewable fuels:
- Purifying water:
- Renewable energy:
- Crop efficiency:

Compare your notes with your partner. What problem does Dr Anastas give with the solution currently being used for each?

What kind of language does he use when he begins each new example?

Extract 7 Prediction

Look at the cartoon that Dr Anastas is going to discuss in the next extract. Talk to your partner about what idea this cartoon is trying to convey.

Image credit: https://www.youtube.com/watch?v=xXbZ4MKRK9U

Extract 7 6.22-7.40

1. What does the boat in this cartoon represent? The planet
2. With your partner, explain what point Prof. Anastas is making when he describes this cartoon.
3. At the end of this section, Prof. Anastas quotes Einstein and says : "*problems can't be solved at the same level of awareness that created them*".
4. Why does the professor use this quote here? What do you understand from this story?

Extract 8 Selective Attention

Listen to the next extract and try to focus your attention on what Dr Anastas says is the main goal of green chemistry.

Extract 8 7.41–8.58

Talk to your partner. Did you understand his point? Ask your teacher to play this section again if you are still unsure.

Extract 9 Prediction

Write THREE words that you think you may hear in the next section about adhesives. Check with your partner if you are unsure about this word.

Dr Anastas is going to talk about the performance of products like adhesives. What do you think he might say about the performance of these products?

Extract 9 Listen & Monitor

Extract 9 8.59-11:32

1. What is Professor Anastas saying about the performance of objects found in nature?
2. What two criticisms of "greeny products" does he give? \
3. What is his point about performance?

Extract 10 Directed Attention

Extract10 11.33-12.03

With your partner, discuss the definition Prof. Anastas gives for ideality.

Listen again to this section and fill in the missing words.

So we might want to think about, how do you engage in ___________________? There's a concept called ideality. How do you get all ___________________ of a product, without the product _____________________ itself? What? What did you say? It's not that crazy. Most of us of a certain age grew up with _____________________wires stringing along the streets and most of us have these phones in our pockets; getting all the performance of the telephone wires without the telephone wires ______________________ to exist. Right, so that's ______________________.

Extract 11 Comprehension monitoring

Take notes then compare them, as you have been doing.

Extract 11 12.04-12.54

Coffee   Dyes   Waterproofing

Use your notes to answer these questions (Check the transcript for answers and listen again if necessary

)

1. What is the desired outcome from each product?
2. What is the problem with the current method?
3. What alternative does Prof. Anastas suggest?

Evaluate your notes. Were they helpful in answering these questions? How could your listening strategies be improved?

Part 4: Pronunciation

Recognition of meaning and overall tone

This is the conclusion of the lecture today.

Before your teacher plays this extract, work with a partner to mark all the pronunciation features that we have learned over the past four weeks.

Prediction

1. Look at the speaker's choice of vocabulary: ***exciting, astounding collectively***

    How do these choices of words set the tone for the conclusion?

    Are you able to infer this speaker's view about the future based on his vocabulary?

2. Dr Anastas uses Jamie Edwards as an example of what?

3. Why do you suppose that Professor Anastas chose this specific quote from Kennedy?

4. What do you predict Dr Anastas will sound like?

5. What types of intonation patterns do you expect to hear in a conclusion like this?

6. Practice saying and recording this section using **linking**.

7. Now listen to the extract and follow along in the transcript. Mark any areas of difficulty.

Extract 13 12.55-15.02

So, what does the future look like? I have no idea, and neither do you, and that's why it's so exciting. That's why it's so astounding, because the future is going to look like: what you did, what you design it to look like, what we design it to look like collectively. Let me introduce you to Jamie Edwards. Jamie Edwards build a nuclear fusion reactor for his science fair project at the age of 13. He built it at the age of 13, becoming the youngest person ever to build a functioning nuclear fusion reactor. He beat out Taylor Wilson, who a year or two before, had built it at the age of 14, and went on to, or a few years before, he went on to build a prototype nuclear fission reactor. A reactor prototype that is being funded by the Department of Energy to the tune of millions of dollars. So you might be sitting there saying, "you know, maybe someday." No, not someday, these days. These days, every one of you is getting the tools. You're getting the toolbox that you need in order to design tomorrow. It's not some day. We are the leaders we've been waiting for. At the beginning of this talk, I told you that I know as a chemist that all we have is matter and energy, and all of you know that. I lied. The reason that I am the most optimistic person in any room is because I know that it's not just about matter and energy; it's about spirit, it's about commitment, it's about creativity, it's about innovation, it's about the human things that we bring to this equation of matter and energy that's going to design tomorrow to be different than today. Robert F. Kennedy Jr. used to like to say, "Some see the world as it is and ask why? Others dream of a world as it could be and ask why not?" Why not? Thank you very much.

Evaluation

1. Re-record yourself making any necessary pronunciation adjustments Use the language learned in today's listening to help you clearly explain the concepts.
2. Watch your video and self-asses your speaking performance.
   e. What words or sounds are unclear?
   f. Does your intonation rise and fall or is it flat?
   g. How well did you stress syllables and content words?
   h. Are you chunking without having to write it down?
   i. Are you able to use linking?

3. Make any necessary adjustments to improve the delivery of your explanation and re-record yourself.

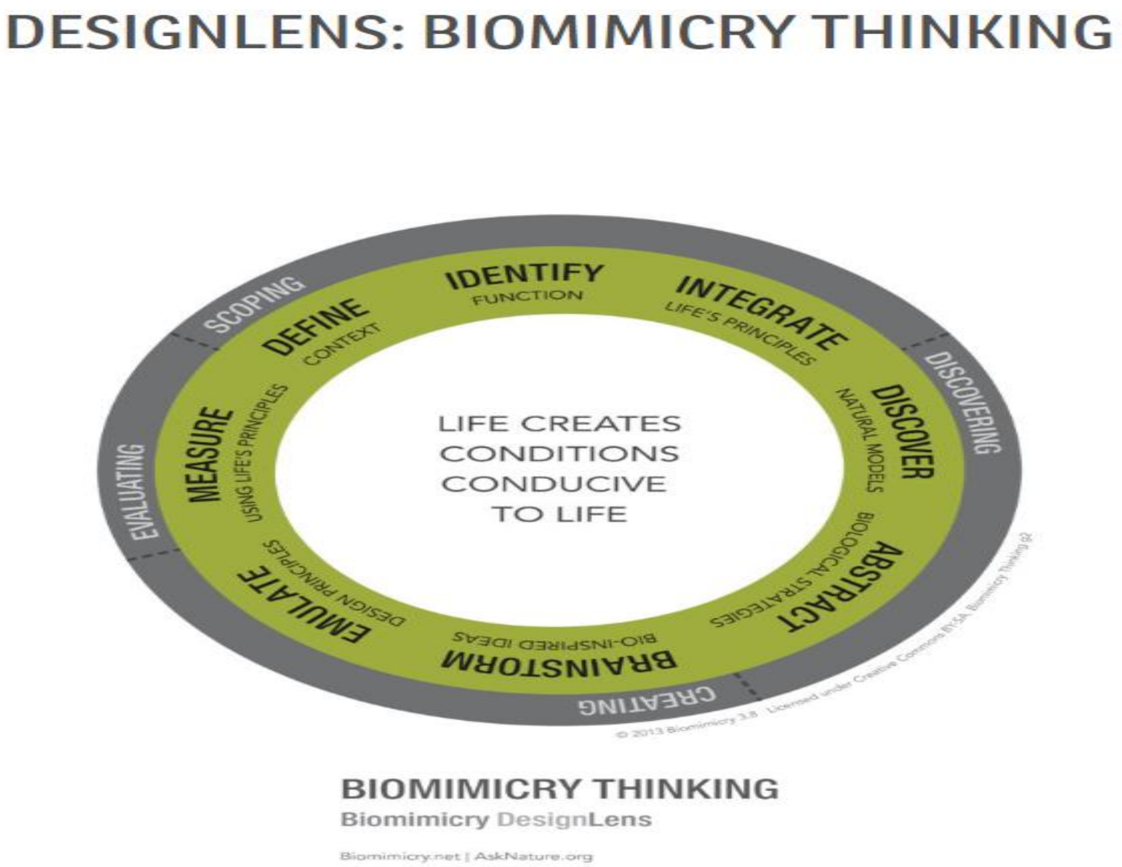
4. Compare videos and evaluate.

    a. What areas have improved?

    b. What still needs practice?

Function word	Contracted form	Pronunciation	Examples
not	n't	/nt/	I haven't got any.
Is, has	's	/s/ after /p, t, k, f & θ/ /z/ after other sounds.	It's interesting. She's left.
are	're	/ə/	We're all right.
will	'll	/l/	I'll get it.
have	've	/v/ after vowels /əv/ after consonants	You've got a letter. I could've gone.
Had, would	'd	/d/ after vowels /əd/ after consonants	I'd already seen it. It'd be wonderful.

Part 5: Restructuring



BIOMIMICRY THINKING

Biomimicry Design Lens

Biomimicry Thinking provides context to where, how, what, and why biomimicry fits into the process of any discipline or any scale of design. While akin to a methodology, Biomimicry Thinking is a framework that is intended to help people practice biomimicry while designing anything. There are four areas in which a biomimicry lens provides the greatest value to the design process (independent of the discipline in which it is integrated): scoping, discovering, creating, and evaluating. Following the specific steps within each phase helps ensure the successful integration of life's strategies into human designs.

https://biomimicry.net/the-buzz/resources/designlens-biomimicry-thinking/

Procedure

1. Your teacher will assign you to one of three groups: transportation, packaging, or chemistry
2. With your group go to https://biomimicry.net/what-we-do/innovation-services/sustainable-innovation-solutions/
3. Download the PDF that is on your topic
4. Read through each product that was designed to solve a specific problem
5. Discuss with your partners the key concepts of each problem and solution
6. Choose one product to take notes on
7. Your teacher will give you a number
8. You are now responsible for explaining the design problem, the solution, and the outcome to your new group
9. Before you tell your new group the information, record your explanation
10. Evaluate your description and make adjustments to improve clarity
11. Try to incorporate the language and vocabulary that you heard in this lesson
12. Listen to your partners' descriptions and take notes.
13. Ask questions about anything that you did not understand

Example

Product:

- *Superior Packaging*

Company:

- *Natura, Sao Paulo, Brazil*

Design Inspiration:

- *Beetle wings*
- *Poppy flower buds*

Outcome:

- *reduced material and logistics cost*
- *customers able to get more product out of packaging*

Group A

Transportation

https://biomimicry.net/what-we-do/innovation-services/sustainable-innovation-solutions/

Product:

Company:

Design Inspiration:

Outcome:

Group B

Sustainable Packaging

https://biomimicry.net/what-we-do/innovation-services/sustainable-innovation-solutions/

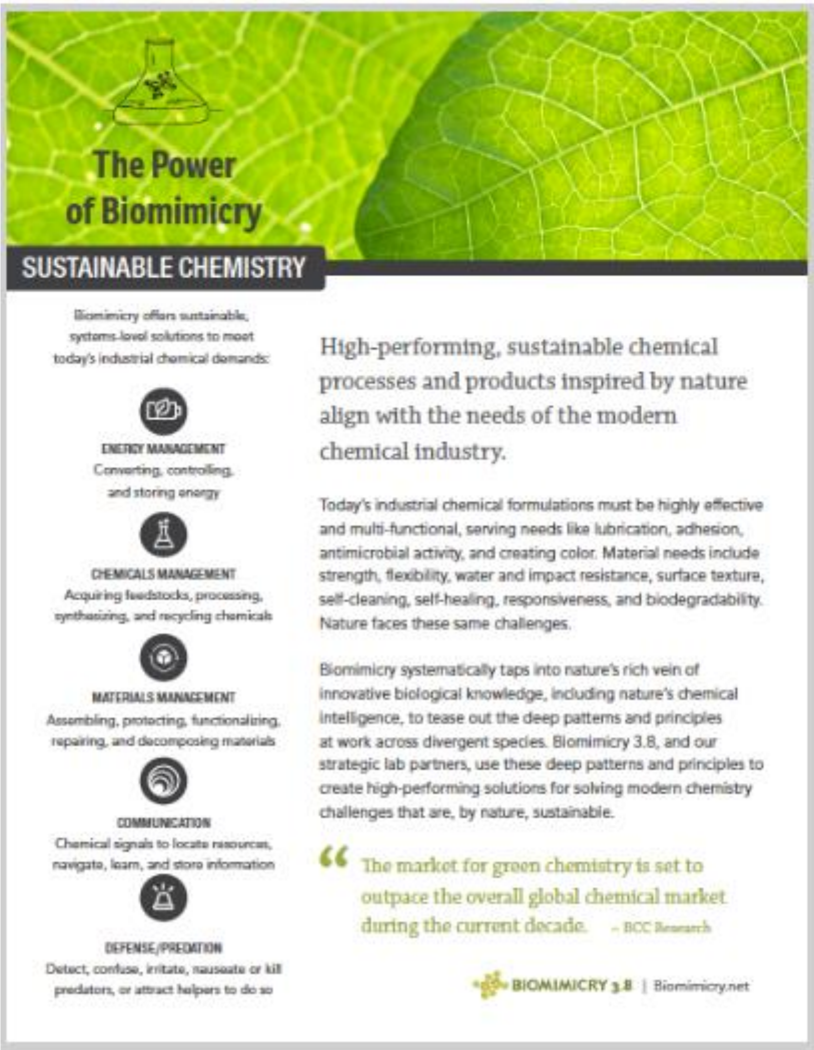
Product:

Company:

Design Inspiration:

Outcome:

Group C



Chemistry

https://biomimicry.net/what-we-do/innovation-services/sustainable-innovation-solutions/

Product:

Company:

Design Inspiration:

Outcome:

Part 6: Post task extension

Go to https://biomimicry.net/resource-categories/biomimicry-case-examples/

1. Read through the case examples and select one.
2. Record yourself speaking to a camera (phone/computer) about the example.
3. Provide information about all aspects such as: the company, the product, and the inspiration from the biological world.

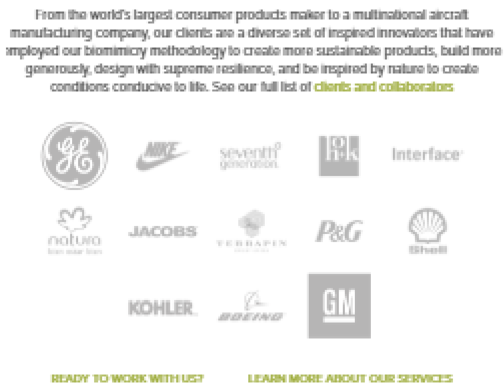


Image retrieved https://biomimicry.net/our-effect/

4. Try and think of other possible uses for such technology.
5. Use the language learned in today's listening to help you clearly explain the concepts.
6. Watch your video and self-asses your speaking performance.
   a. What words or sounds are unclear?
   b. Does your intonation rise and fall or is it flat?
   c. How well did you stress syllables and content words?
   d. Are you chunking without having to write it down?

7. Make any necessary adjustments to improve the delivery of your explanation and re-record yourself.
8. Compare videos and evaluate.
    a. What areas have improved?
    b. What still needs practice?

Reflection Task

REVIEW FORM			
	objective achieved? ☺ 😐 ☹	Examples of good use	Examples for improvement
Strength of ideas (Were the ideas logical?)			
Use of engineering related vocabulary			
Participation in the discussion			
Use of chunking & pausing			
Use of stress & intonation			
Use of connected speech			
One Suggestion:			

Transcript

Designing a sustainable future

USA Science & Engineering Festival (2014) Designing a sustainable future with Prof Anastas. Retrieved from https://www.youtube.com/watch?v=xXbZ4MKRK9U

I love being a scientist, because I love being astounded. I love being astounded by discoveries and realizations and new things that have never been seen by people, but that's not why I went into chemistry. So, why did you go into chemistry, you say. Because I didn't like the way things were. 1.31

So, when I was sitting in the same chairs that you are, the air wasn't too easy to breathe. They used to say there's this old saying about you know back when the Environmental Protection Agency was founded it was so polluted that the people of Denver wanted to see the mountains again. The people of Los Angeles wanted to see each other again. It's not unlike China is today, and the reason that today is different from how it was years ago, is because people designed it to be different. People didn't accept things the way they were. The reason that you can go outside and breathe the air without coughing and gagging and the reasons you can swim in your beach, is because people designed things to be different. People designed a sustainable future that is today. 2.29

Now, is today where we need to be? I'm going to tell you I don't think so, but I'm also going to tell you that I'm the most optimistic person in almost any room that I go in, because I recognize that we can design things to be different; we have designed things to be different, and as a chemist I know one thing to be true. I know that all we have in this world is energy and matter, energy and material. In green chemistry, designing those molecules to be more sustainable, is all about not just redesigning all of that matter, but all of the matter that's used to generate, store, and transport our energy. 3.15

So let's step back now, I have very little patience for pessimism, I have very little patience for people who talk about the negative, and say things are impossible, and this is bad and that's bad, but I'm going to give you just a little glimpse of where we are. This might look to you like an abstract painting, maybe it's in the National Museum, but if we zoom in; we realize that hmm no, that's the 60,000 plastic bags that are used every five seconds in the US. What about this then? Is that a rocky beach, sandy beach, now definitely rocky, now hold on, that's actually 426 thousand cell phones that are disposed of every day in the US. And I lose so many cell phones, those of you who know me, that those six in the middle, those are mine, that's terrible. Ok, let's see: landscape, moonscape, let's zoom in. Those would be the two million plastic beverage bottles that are disposed of every five minutes in the U.S. 4.30

So people dedicated their lives to making the air land and water clean or over the decades. But sometimes, and this is important to remember, because we're talking about design: that you have to be thoughtful about how your design, or you, could do the right things, yet do them wrong. What do I mean by that? How many people here have played the game whack a mole at a carnival? Don't lie, you all have, you all have, we all know it. I have, you have. So, but if you look at the issues around pollution, the planet, and you look at them in a fragmented way: water, toxics, energy, climate, biodiversity, then it's playing whack a mole. You're dealing with one problem while another one pops up, and you need to understand that all of these things are interconnected, otherwise you wind up doing things like inventing biofuels.5.19

Wonderful! We want to get fuels from renewable resources and wind up doing it in a way that competes with food, feed, and land-use options. Doing the right thing, making renewable fuels, doing it in the wrong way, perhaps. Purifying water with acutely lethal substances like chlorine. Purifying our water yes, using acutely lethal deadly substances, probably not so good. Renewable energy through capturing the power of the Sun, but if those photovoltaic cells are made from acutely toxic, persistent, rare metals, you're doing the right thing, but doing it in an unsustainable way. Increasing our crop efficiency, but using pesticides that are persistent, bioaccumulative, and get into our groundwater. Getting energy saving lights, but you do it with mercury, which is a neurotoxin, and it's used in the manufacturing at the end of life. Doing the right things, but maybe doing them wrong. 6.21

So, how did we get here? Was it some kind of conspiracy, say haha I'll get those environmentalists people? No, of course not, these were urgent and necessary goals. People by the millions die from infected water. People by the millions starve because of inadequate food. The energy crisis and the energy prices are real challenges. People with noble goals, best of intentions, brought to bear creativity, but they did it in a fragmented way; without understanding that all of these things are interconnected and we need to think about things in terms of systems in order to get the right answers. So, this is one of my favorite cartoons: people bailing out the boat, the folks at the other end saying I'm sure glad the hole isn't in our end of the boat. So the message from this is twofold. One, we only have one boat and two, we're all in the same boat. So, thinking in terms of interconnected systems, and it all comes back to Einstein, doesn't it always come back to Einstein; problems can't be solved at the same level of awareness that created them, you have to think differently, you have to think inventively, you have to take a new pair of eyes, and so some of this is about green chemistry. 7.40

I'm not going to go down into the specifics of green chemistry, because quite frankly, it would take me probably a whole academic semester to do that; but it's about designing things so you don't use or generate hazardous substances. Now this is not an eye chart and I will not read this to you, but it's a design framework for how you design everything: from the clothes you're wearing, to the way that we go about generating our energy, our transportation, our computers, and on and on. Everything that we see touch and feel, so that's actually not toxic, not degrading, it's healthy. So when we make adhesives, things to glue things together, how do we do that? We have these very reactive, very toxic, starving materials. We put all kinds of additives into these things, that's really not how nature does it. How many people have gone down to the ocean and ever tried to pull like a muscle or a clam off of a rock? Anybody? Is it easy? No, no it's not, and that is not using the same types of materials that we use industrially. It uses very low concentrations, it's doing this at room temperatures, and with benign starting materials. 8.58

So, I was redoing a bathroom recently. I was redoing a bathroom, and scraping up the tiles, and when you scrape up the tiles, I'm scraping my knuckles, and my knuckles are bleeding, and I'm very upset. And then I started to, right before I started feeling woozy, and when I woke up, I read this little label on that can that said, "only use in a well-ventilated area. If you don't, it will be bad." And I started thinking, this isn't the way nature goes about making glues and adhesives. Now that slide's not upside down, that's the gecko. Now who wants to tell me how, what glue, what chemical glue, that gecko stuck on its feet in order to, any glue? No glue. It uses millions of submicron, keratin fibres to create weak force interactions so it can stick there. Does it have to scrape its feet up? No. It picks them up and walks and walks a lot. So, is this one of these greenie products? Now take the lessons from nature and make something called gecko tape. That's a spider-man model, at the square centimetre of gecko tape, 3m made it. It can go on and off, and on and off. This isn't one of those greeny products that costs more and doesn't work as well. This is about superior performance, as nature often gives us. 10.26

So, this is how we make high tech ceramics in an industry: it's called heat, beat, and treat. You beat the clay to the proper consistency, heat at 3,000 degrees for about 50 hours. How many people in the audience have bones? Okay, I do too, yep. I have bones, mine are pretty hard. Okay how many people here have been heated in an oven at 3,000 degrees for 50 hours? Yeah what's my point? My point is, getting the performance that you want doesn't require these environmentally ridiculous steps. Instead, you learn from nature. How do you set down protein templates in order to get molecular self-assembly to get this? Because this is the way that the abalone does it. It's as good as our high-tech ceramics, but he's like a metal under stress, and that's the abalone ceramics factory. Ambient temperatures and pressures dilute feedstocks, non-toxic, and it does it under water just to show off. 11.32

So we might want to think about, how do you engage in innovation? There's a concept called ideality. How do you get all performance of a product, without the product existing itself? What? What did you say? It's not that crazy. Most of us of a certain age grew up with telephone wires stringing along the streets and most of us have these phones in our pockets; getting all the performance of the telephone wires without the telephone wires needing to exist. Right, so that's ideality. 12.03

What does that mean for us? Instead of decaffeinatating coffee by using methylene chloride, which is a cancer suspect agent, instead of doing that, we decaffeinate with liquid carbon dioxide. That's an incremental improvement. What's the transformative innovation? Coffee beans growing without caffeine. These are natural hybrids in Hawaii. That's the leapfrog innovation. 12.27

What about dyes? We know that some dyes, the manufacturing, the dyes themselves can be toxic. What about having cotton that's naturally coloured without any dyes? 12.36

Instead of waterproofing things by putting a whole bunch of chemicals, water-resistant perfluorinated things, we look at the lotus leaf. And the lotus leaf tells us hmmm, we can do this, not with, not with chemical applications, but with geometry to repel the water. 12.54

So what does the future look like? I have no idea, and neither do you, and that's why it's so exciting. That's why it's so astounding, because the future is going to look like: what you did, what you design it to look like, what we design it to look like collectively. Let me introduce you to Jamie Edwards. Jamie Edwards build a nuclear fusion reactor for his science fair project at the age of 13. He built it at the age of 13, becoming the youngest person ever to build a functioning nuclear fusion reactor. He beat out Taylor Wilson, who a year or two before, had built it at the age of 14, and went on to, or a few years before, he went on to build a prototype nuclear fission reactor. A reactor prototype that is being funded by the Department of Energy to the tune of millions of dollars. So you might be sitting there saying, "you know, maybe someday." No, not someday, these days. These days, every one of you is getting the tools. You're getting the toolbox that you need in order to design tomorrow. It's not some day. We are the leaders we've been waiting for. At the beginning of this talk, I told you that I know as a chemist that all we have is matter and energy, and all of you know that. I lied. The reason that I am the most optimistic person in any room is because I know that it's not just about matter and energy; it's about spirit, it's about commitment, it's about creativity, it's about innovation, it's about the human things that we bring to this equation of matter and energy that's going to design tomorrow to be different than today. Robert F. Kennedy Jr. used to like to say, "Some see the world as it is and ask why? Others dream of a world as it could be and ask why not?" Why not? Thank you very much.15.02

Wk 5 Note-taking practice

Below you will find space for note-taking and sample notes for this week's in-class listening.

- At home, listen to the talk again after you have done it in class and understood the organisation and main points. Make notes as you listen again.
- This is good practice for you to take notes from a talk you are already familiar with and to practise listening for the signals of organisation in that talk.
- Try to organise your notes in a way that shows the organisation. You can compare your notes to the sample notes.

Space for note-taking

Space for note-taking

Space for note-taking

Sample notes

Designing a sustainable future

USA Science & Engineering Festival (2014) Designing a sustainable future with Prof Anastas. Retrieved from https://www.youtube.com/watch?v=xXbZ4MKRK9U

Love science
    chemist b.c. wanted change

EPA founded b.c. pollution
    Ex: Denver- couldn't see mountains / L.A.-couldn't see people/ China- today
    Different today b.c. D= sus future
    Today not enough/ but optimistic ↔ different D
    Chemistry= E +M
        green chem= D sus molecules
            redesigning matter + matter to generate, store trans energy

No pessimism, but current pic:
    -abstract painting/ +60,000 p bags used 5 sec US
        -rocky beach, sandy beach/ +426, 000 cell phones disposed day US
        -landscape, moonscape/ +2 mill p bev bottles disposed 5 min U.S

D: needs thought or → do right things, but wrong way
    Ex: carnival game/ pollution looked at fragmented = dealing w 1 prob + another pops up
    + recognize all probs interconnected, otherwise - inventing biofuels.
    + want fuels renewable resources - way competes w food, feed, land-use options. Doing - purifying water w acutely lethal substances (chlorine) + purifying water
    +renw energy ↔power Sun - photovoltaic cells ↔ acutely toxic, persistent, rare metals,
        *doing +thing, but unsus way
    +↑crop eff -using pesticides persistent, bioaccumulative, get into groundwater

+ energy saving lights -mercury, neurotoxin, used manuf end of life

Conspiracy/ no b.c urgent and necessary goals

-mill die from infected water/ mill starve b.c. -food/ energy crisis+ energy $ =real chall

-ppl noble goals, best of intentions→ creativity, but fragmented way

-no understanding interconnected

-need to think in terms of systems↔ +answers

Cartoon: 2 msgs

1. Only 1 boat
2. All in same boat

*Einstein= interconnected systems→probs not sol same lvl awareness that created need think diff/ inventively/ new pair eyes → green chem

Green Chem= D↔ don't use/generate hazardous subs

D framework: clothes/ generating energy/ trans/ comp

touch + feel = not toxic, not degrading, it's healthy

Ex: adhesives =very reactive, very toxic, starving materials b.c. additives

-not natural

-natural= muscle/ clam not using industrial material, low concent, room temp, benign mat

redoing bathroom/ scraping up tiles = upset b.c. not way nature makes glue/ adhes

Ex: gecko = no glue/ uses mill submicron, keratin fibres↔ create weak force interactions

Product= gecko tape/ can go on + off

+superior performance = nature often gives

high tech ceramics = heat, beat, treat↔ 3,000 deg 50 hrs

vs. bones no heat

=perf doesn't require environmentally ridic steps↔ learn from nat

-set down protein templates→ molecular self-assembly = abalone

+as good as high-tech ceramics

- ambient temp + press dilute feedstocks, non-toxic, under water

How engage in innovation? Ideality = all perf prod w/o prod existing itself?

- not crazy
- Ex: phone wires past/ now performance w.o. wires

(-) decaffeinating coffee w methylene chloride, cancer suspect agent,
(+) decaf w liquid carbon dioxide = incremental improve
* transformative innov = coffee beans growing w/o caffeine natural hybrids Hawaii= leapfrog innov

dyes
(-) manuf dyes toxic
(+) cotton naturally coloured w/o dyes
Waterproofing
(-) chemicals, water-resistant perfluorinated
(+) lotus leaf ↔ geometry repel water

Future?
-no idea =exciting/ astounding b.c. future= design it collectively

- Jamie Edwards - built nuclear fusion reactor
- 13 = youngest ever
- beat Taylor Wilson 14
- built prototype nuclear fission reactor
- funded Dep Energy mill $$

- maybe someday + these days b.c. getting toolbox to D tom
-we/leaders we've been waiting for
-most optim b.c. know not just about M+E/ +spirit, commitment, creativity, innovation
-what we bring to equation M=E↔ D tomorrow = diff than today

- R. F. K. Jr. "Some see the world as it is and ask why? Others dream of a world as it could be and ask why not?" *Why not?

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