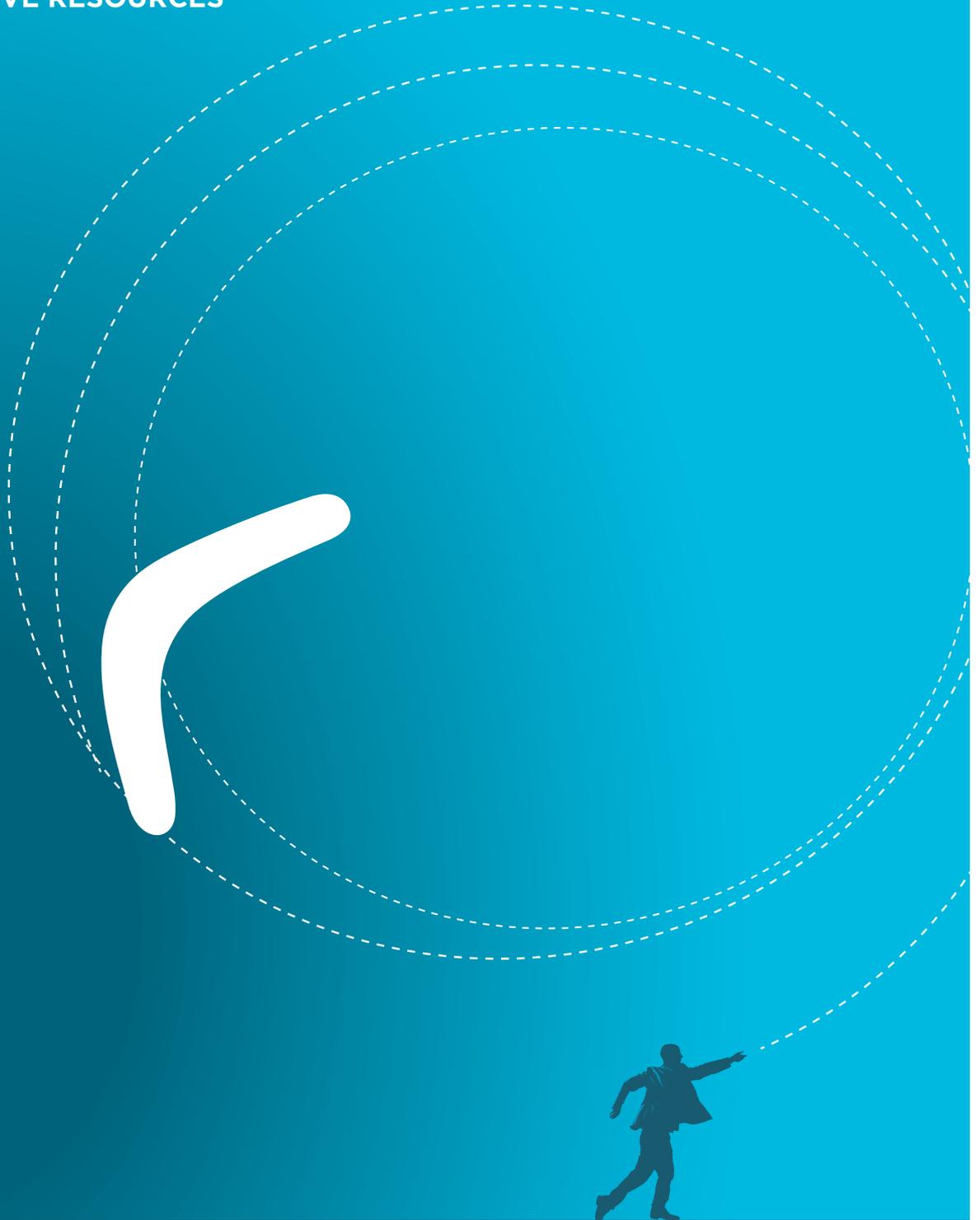


CIRCULAR ECONOMY AND CURRICULUM DEVELOPMENT IN HIGHER EDUCATION

VERSION 2

BRIEFING NOTES, SUPPORT
& ILLUSTRATIVE RESOURCES



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SECTION 1

SOME INTRODUCTORY NOTES

THIS DOCUMENT'S CONTEXT

The Ellen MacArthur Foundation was established in 2010 with the mission to accelerate the transition to a circular economy. We work with business, government and academia to build a framework for an economy which is restorative and regenerative by design. We do this by: inspiring learners to rethink the future through a circular economy framework; catalysing business innovation and creating the conditions for this to happen at scale; providing robust evidence about the benefits and implications of the transition; transforming key material flows and engaging a global audience around the circular economy.

Within teaching and learning we are working with the academic community to design educational programmes that develop insights and understanding about a circular economy transition. This document forms part of our Higher Education Programme.

WHO THIS DOCUMENT IS FOR

Developed by the Ellen MacArthur Foundation and our key higher education contacts, this document provides guidance, resources, insights and relevant links to support higher education institutions that look to develop circular economy teaching and learning capacity.

Whilst this document is primarily for university academic staff developing new curricula, policymakers, senior managers and support staff who want to know more about circular economy may also find it helpful. The document focus is specifically about teaching and learning in higher education institutions and does not cover other areas where circular economy is relevant such as research, campus management and organisational change.

The initial version of this document was the outcome of a workshop held with higher education practitioners at the Foundation's Rethinking Progress conference in April 2015.

It is a living resource that is updated by the Foundation and our HE partners annually. We encourage you to make this document more useful and relevant by giving us your feedback and ideas for further development. This will help us make improvements that will benefit everyone in the Foundation's universities network.

HOW TO USE THE DOCUMENT

This document is not designed as a cover to cover read. The format - short texts, boxes, resources, case studies, links etc - is intended to allow easy accessibility and facilitate use of the material in a way that is appropriate to your needs. The concepts, ideas, models and resources presented are indicative, and not in any way intended to be prescriptive or comprehensive. So the material here, and in the sister online resource hub, is meant as a resource, to be used, tried out, interpreted, amended, critically discussed and, if useful to you, adapted for use in your curriculum development work: from feeding into one-off extra curricular sessions, to existing courses, through to the development of new modules and courses; or perhaps as a stimulus for reflection in your staff development work.

THE NATURE OF EFFECTIVE SUPPORT AT HIGHER EDUCATION

What is the nature of effective support for higher education which reflects the emerging interest around circular economy based on a better understanding of complex dynamic living systems?

We suggest that what is most needed is support that enables learners to develop a clear sense of the narrative of a putative circular economy, its coherence (hopefully it has one), and what this implies for, say, teaching and learning methodologies. On one level, this may be easy enough:

1. develop learners' insights about real-world systems which are typically non-linear, complex and dynamic systems. Apply systems thinking foci: know what being a feedback-rich system means; identify positive and balancing feedback; homeostasis and homeorhesis; understand effectiveness and scale; diversity and its role in creativity and resilience; capital stocks and related flows. This is not circular economy per se, just the core 'framework for thinking'

2. develop learners' insights on how a circular economy might be understood, including the role of business, government and citizen. Enable learners to apply a complex, living systems framework for thinking to an economy through using appropriate modelling - say a model in which finance is endogenous - and one where the economy is embedded in energy and materials flows and also has a workable circularity to its income flows

3. develop learners' insights about 1 and 2 above, using participatory learning approaches, as an example of feedback-rich learning

In other words, same basic model, different applications: **real world systems + economy + learning**. If it was one diagram it might look like this...



Figure 1

SECTION 1
SOME INTRODUCTORY NOTES

However, at a deeper level, developing support for learners may be more challenging ... a note of caution. In mainstream economics a huge literature and experience exists around its particular heuristic:

In brief

... humans are self-interested, acting rationally in their own interests to maximise 'utility', as do businesses;

... the invisible hand of supply and demand - markets - whose participants are aware of all relevant information - creates a mechanism for the most efficient allocation of resources possible;

... the sum of this activity leads to increasing prosperity through economic growth, rewarding the various actors according to their value;

... banks and finance are intermediaries, resources are always substitutable (through innovation) and waste sinks are endless or capable of being cleaned up

In contrast to the mainstream economic heuristic, the circular economy heuristic is still being developed. But it takes its cue from seeing the world as metabolism and from the interplay in decision-making between competition and cooperation, self and other. Whilst not a new approach, the notion of an economy which is embedded in materials, energy and information flows behaving as a complex adaptive system has far less in the way of literature, development and reflection around it. The circular economy in practice is focussed on product and service design, engineering and business models.

THE CENTRAL CIRCULAR ECONOMY 'HEURISTIC'

As the name suggests, a 'circular economy' is a feedback-rich approach, (often described as 'circularity') with its subject matter the choices we make around resources - the economy. It rests in contradistinction to a linear economy. A linear economy is a 'take-make-and-dispose' throughput approach and is rooted in the insights coming from a scientific worldview in the 19th and 20th centuries which is often described as 'mechanistic'. This is the worldview which underlies much of modernism, the idea that we can understand, predict and control our world as we would wish. A circular economy uses insights into real world systems which are complex, adaptive systems. These systems are open to modelling and influence where we emphasise participation, connections and understanding consequences rather than the identification of parts and their manipulation. 'In the Foundation's view, the circular flows are by intention or design regenerative (to rebuild and then enhance stocks) - not degenerative (to use up stocks of materials and energy).

The combination of effective flows and enhancing capital stocks marks out the circular economy from what we have today.

The diagram (Figure 2 below) characterises how materials are designed to flow within two pathways: either biological (capable of decomposition) or technical (kept at high quality for as long as appropriate and separate from the biological). Stocks are maintained or enhanced. The economy requires a surplus of energy to do this work.

All products and materials are therefore intended to be 'food' for other processes and the very idea of waste is eliminated. Energetic flows are crucial and for long term operation a shift from using fuel stocks (fossil fuels) towards renewables (current income) is anticipated.

To conclude this briefing note: the one-liner is that circularity is essentially exploring the impact of feedback - within a system which has effective flows and enhances capital stocks. And here is the central heuristic in one diagram (overleaf)...

The circular economy - an industrial system that is restorative by design

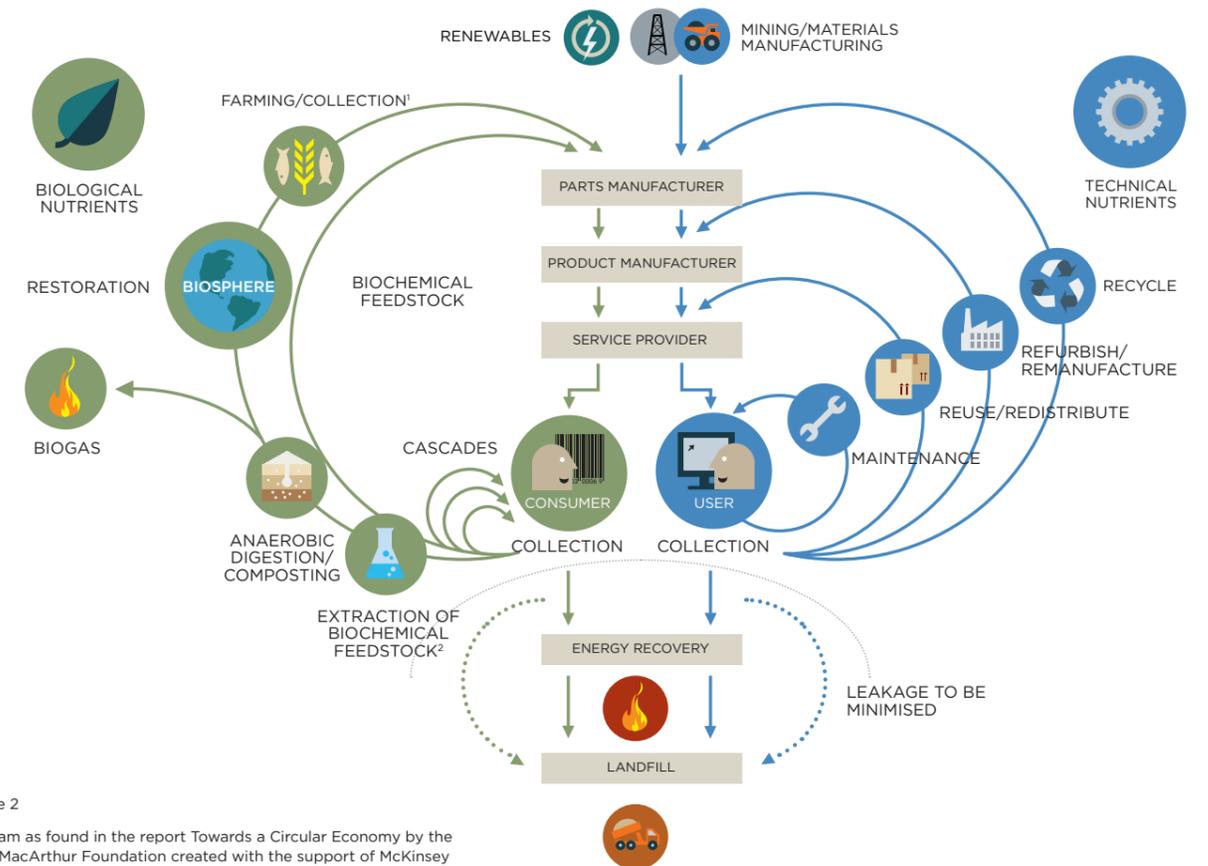


Figure 2

Diagram as found in the report Towards a Circular Economy by the Ellen MacArthur Foundation created with the support of McKinsey and Company.

1 Hunting and fishing

2 Can take both post-harvest and post-consumer waste as an input
SOURCE: Ellen MacArthur Foundation - Adapted from the Cradle to Cradle Design Protocol by Braungart & McDonough

A REGENERATIVE CIRCULAR ECONOMY

can be seen as the effective flow of materials, energy and information in relation to maintenance or increase of stocks of capital: ECONOMIC, SOCIAL, HUMAN AND NATURAL.

- It uses insights from the functioning of non-linear systems – feedback-rich systems, and especially living systems – as a framework for thinking.
- Its study is likely to have in mind nested systems (fractal scale, diverse periodicities) with histories and entrainment but also emergent properties and the possibility of evolution.
- Characterisation: the bigger picture, the longer term and by intention (design).

WASTE = FOOD
SHIFT > RENEWABLES
PRICES = FULL COSTS
MONEY = MEDIUM OF EXCHANGE
DIVERSITY = STRENGTH

- The circular economy can be explored through a number of identities and one related shift. In a circular (feedback-rich) system the endless transformation means that one side of the equation has an intimate relationship with the other if it is to ‘work’ optimally as a system.
- Using the three categories of materials, energy and information and informed by systems thinking, the four identities fall into place.

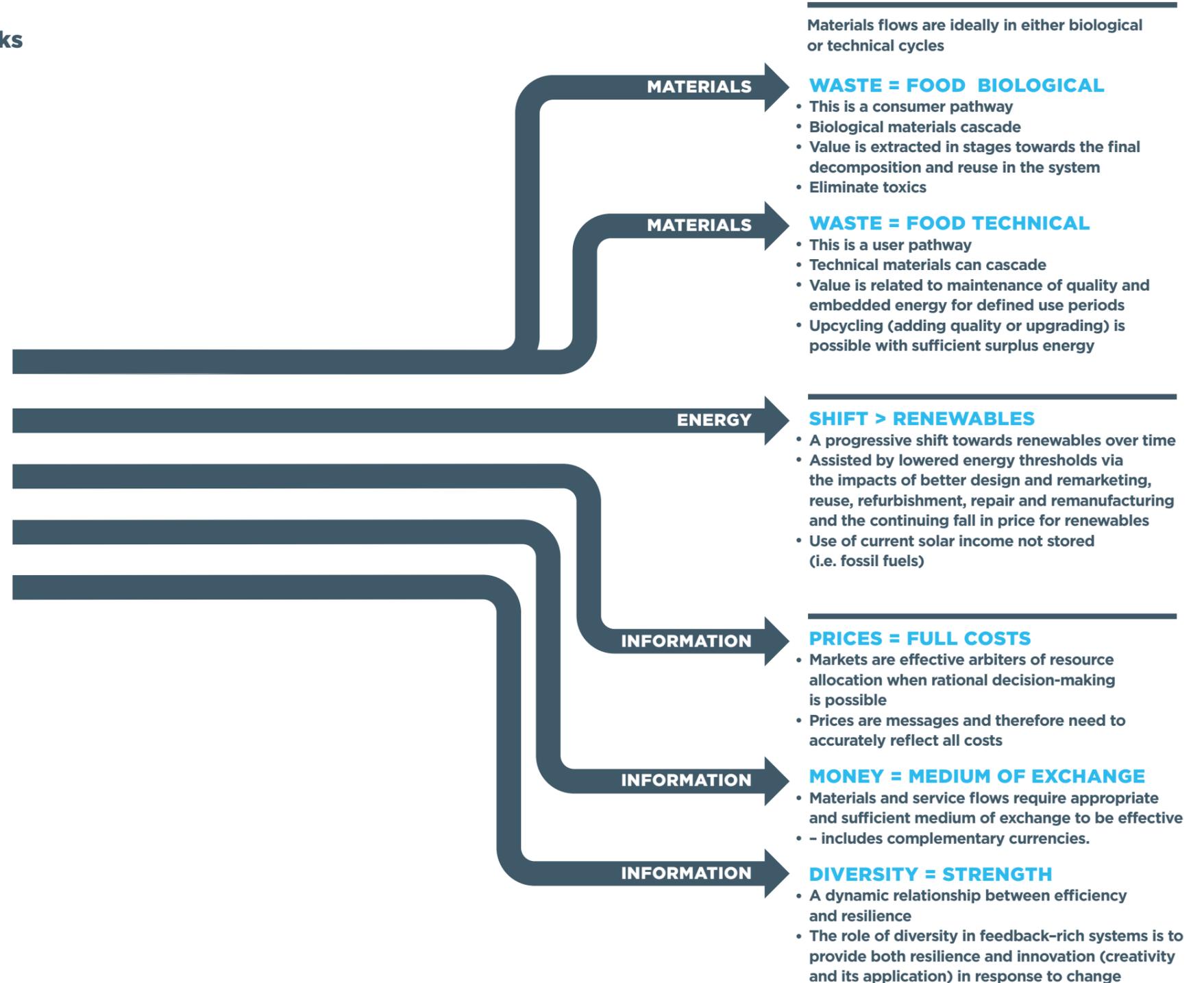


Figure 3
Sources: Synthesised by Ken Webster from McDonough and Braungart, Stahel, Lovins, Hawken, Anderson, Holling, Boulding, Webster and Fuller.

SECTION 1

SOME INTRODUCTORY NOTES

A LONGER CIRCULAR ECONOMY DEFINITION FOR DISCUSSION WITH LEARNERS!?

“Built increasingly on the endless flow of energy from the sun (**energy in surplus**) is an economy which transforms materials into useful goods and services endlessly (**waste = food**). It **builds capital** and maintains it. Money is information which stimulates and coordinates the exchange of all things at all levels and so material is transformed (**money as primarily a medium of exchange**). To do this **prices act as messages** and like the need for materials to flow cleanly, uncontaminated for them to become food, for new cycles prices need to **reflect the full costs** to do their job. Like all living systems a circular economy is dynamic but adaptive and if enduring, it will be **effective**, neither courting disaster by over-extending efficiency (**brittleness**) or too resistant to change (**stagnation**). It **celebrates diversity** – of scale, culture, place, connection and time because a dynamic system is full of change, by definition, and thriving in such an environment requires diversity – a fount of **creative adaption**, a means of **resilience**, a source of redundancy or back up. A circular economy is led by **business for a profit** within the ‘rules of the game’ decided by **an active citizenship in a flourishing democracy.**”

SOME QUESTIONS AND QUOTES... FOR REFLECTION

Does understanding the basics of a circular economy help us look at the ‘wicked’ problems of a complex world in a more systemic way and advance our potential for improving that world?

In a curriculum context, what we have is a partial model (the role of money and finance does not appear for example) but a model is a way of testing ideas and experience.

If we understand it, what can we do with it? Some pointers...

“Data without models are just numbers.” Unknown

“Remember, always, that everything you know, and everything everyone knows, is only a model. Get your model out there where it can be viewed. Invite others to challenge your assumptions and add their own.” Donella Meadows

See if it is useful, because...

“All models are wrong but some are useful.” Box and Draper

“There is nothing more practical than a good theory.” Lewin

SECTION 2

RESOURCES AND SUPPORT

HE RESOURCES ONLINE

The Foundation has developed an extensive online HE Resources area which carries videos, audio, text, presentations, professional development workshop activities etc. Further development of the HE resources collection will be carried out following feedback, advice and comments from higher education colleagues.

You can view our collection of HE resources [here](#).

The following list highlights the sort of resources that feature in the online HE Resources area:

VIDEOS

A selection of Ellen MacArthur Foundation videos

GRAPHICS AND INFOGRAPHICS

A full range of Ellen MacArthur Foundation graphics from our publications. Includes the Circular Economy Central Heuristic diagram shown in Figure 3 of this document

BACKGROUND READER ON CIRCULAR ECONOMY

This background reader entitled ‘The Circular Economy-an economy in mind and four images’ is sourced from the University of Bradford/EMF executive education introductory course series 2017 (attached in appendix)

PROFESSIONAL DEVELOPMENT WORKSHOP RESOURCES

A collection that has been designed to encourage discussion, clarification and reflection within the context of a circular economy. The various downloadable stimulus resources are prompts and scaffolding for thinking and learning within professional development environments. They have been developed out of the

experience of the Ellen MacArthur Foundation and the Technical University of Delft, Cranfield University and the University of São Paulo (extract attached in appendix).

BIBLIOGRAPHY OF SELECTED BOOKS, ARTICLES AND WEBSITES

BOOK EXTRACTS

Eg extract from chapter 1 and 2 of *A New Dynamic* - these two chapters develop the central heuristic outlined in this document (extract attached in appendix)

REPORTS AND PUBLICATIONS

Links to relevant Foundation reports and publications.

BUSINESS CASE STUDIES - From November 2017 a selection of case studies will feature a variety of business case studies including examples of the work of the Foundation’s CE100 business programme.

The resources in the online HE Resources area are available for use and/or adaptation in your lectures, seminars, student assignments and staff development work. The resources include examples of the Foundation’s videos, publications and graphics which are available for use in HE institutions on a free, open-access basis. We do hope these resources will be of value in your teaching and learning programmes. Acknowledgement would be appreciated where possible and please keep us updated on the progress of your circular economy-focused curriculum development work so we can share emerging practice across the higher education network.

SECTION 2 RESOURCES AND SUPPORT

ELLEN MACARTHUR FOUNDATION SUPPORT PROGRAMME

To support curriculum development work in higher education institutions, the following resources and opportunities are available to all universities internationally:

- this document which is entitled *Circular economy and curriculum development in higher education*

- the online HE Resources area, as described above

- Places at our regular face-to-face education conferences and symposia where there is an opportunity to meet other like minded academics and staff from the Foundation to see what's new, what's changing and share concerns or progress, or just to catch up

- the opportunity to develop programmes as part of our online Disruptive Innovation Festival which brings together thought leaders, entrepreneurs, businesses and learners to catalyse systems-level change for a future economy (see www.thinkdif.co for details)

Additional support for curriculum development work is available to universities working in formal partnership with the Ellen MacArthur Foundation - Our partner universities can request specific input from the Foundation, which is considered on a case-by-case basis. This is a non-commercial work stream for the Foundation although travel and resource fees are usually required for team members to cover costs for the following support examples:

- Speaker input to conferences, seminars and staff development sessions – in person and through online conferencing
- Curriculum feedback – reviewing course frameworks to provide recommendations and feedback
- Speaker recommendations – drawing from our circular economy network

To keep up to date with the Foundation's Higher Education work you can sign up to receive our HE newsletter here and our Google+ forum [here](#).

APPENDIX THREE EXAMPLE RESOURCES FROM OUR ONLINE HE RESOURCES AREA

EXAMPLE 1 FROM THE HE RESOURCES AREA

SAMPLE READER FROM THE CIRCULAR ECONOMY EXECUTIVE EDUCATION INTRODUCTORY COURSE THE CIRCULAR ECONOMY: AN ECONOMY IN MIND AND FOUR IMAGES

Week 1 synopsis - The circular economy framework

In this opening week of the course we will provide an introductory characterisation of the circular economy framework as characterised by the EMF. This will include an overview of the key grounding concepts and principles and the drivers for change from a linear to circular economy. Some of the key complementary schools of thought will be described together with the importance of some of the common root metaphors and ideas around our greatly enhanced scientific understanding of the ways in which systems are able to adapt and achieve vitality. New times, new circumstances, new models as an innovative business response to our current linear modes.

Each week on the course we will provide a slightly longer note about some of the key ideas covered. This is intended to aid understanding and give an opportunity to download and read off-line. In week 1 we present a little more background on the origins and characterisation of a circular economy.

The rationale for a circular economy

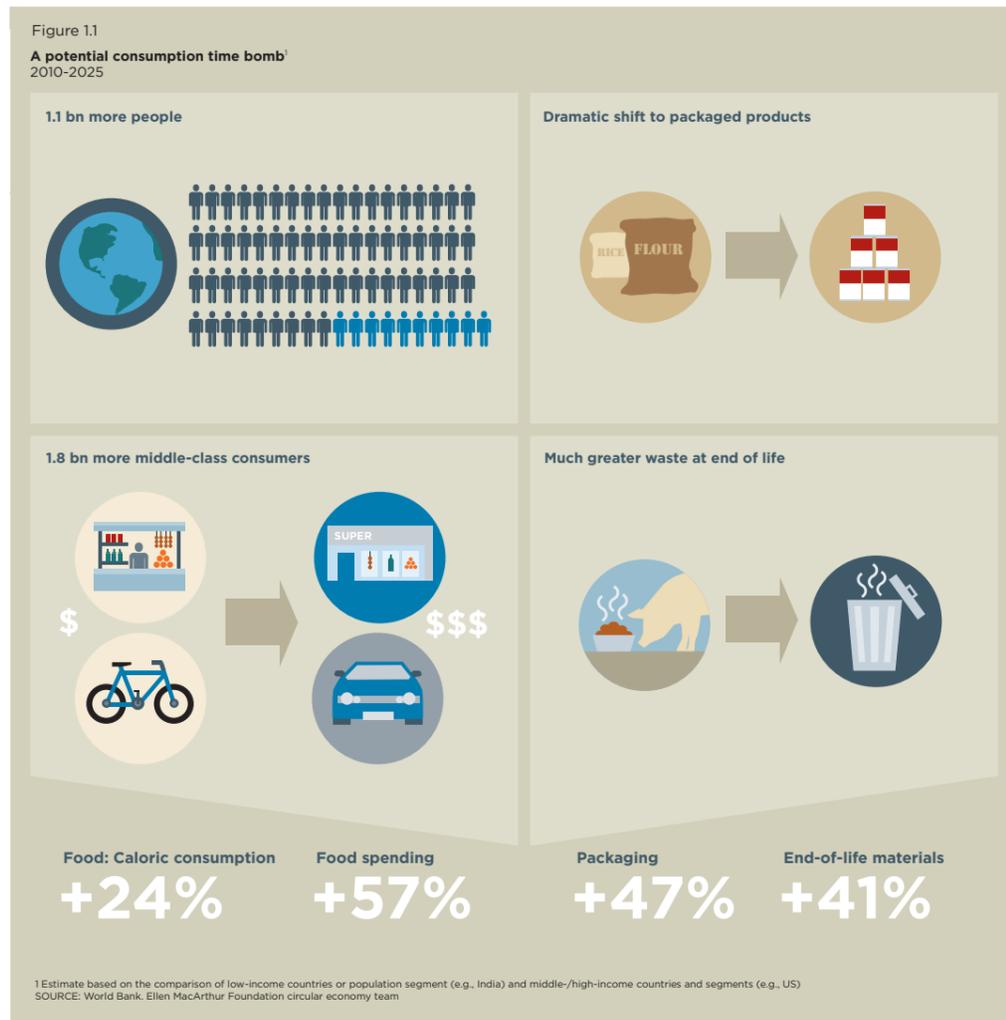
The rationale for a circular economy comes from a number of quarters. A surprising number: it comes from the facts on the ground, the state of the world; it comes from changing perceptions in science about 'how the world works', our 'worldview'; it comes from a Western Enlightenment concept of the role of the individual and the freedom to make meaningful choices; it emerges from our desire to continue the endeavour we have created under the heading 'civilisation' and the belief that civilisation is worth the description, or qualification 'in the long term.'

As a business perspective is important throughout this course, it is also possible to say from the start that the circular economy is 'at home with the modern world', with markets and with capital. Except that this is no longer about changing all capital into financial capital but rather building and rebuilding capitals - social, manufactured, natural and financial - so that more and more effective flows of goods and services result. In any long term economy there must be capital if there is to be real wealth. From a systems perspective, the rationale is one of adjusting system conditions rather than directing economic and business activity.

The State of the World

The list of issues is familiar and each of them touches on business: soil degradation; overextraction of water; fisheries exhaustion; the consequences of burning fossil fuels; the availability and/or price of credit. Materials and energy are the most obvious overarching issues. But there is also the growth of population, especially the burgeoning middle classes in Asia, the ratchet effect of jobless growth through business cycles, the increasing cost of welfare and old age provision, the level of youth unemployment and the persistent and growing private and public indebtedness.

A linear, throughput economy based on short term returns appears to be disappointing us after several generations. This prompts the question 'which way out?'



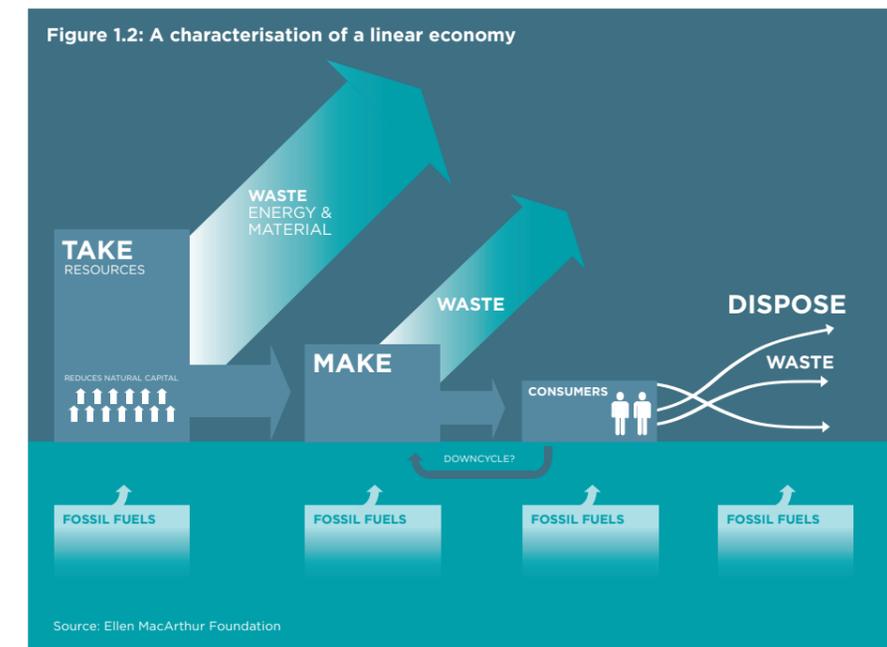
Science and Worldviews

The Enlightenment brought a scientific worldview, one which emphasised rationality. It modelled the world as a mechanism, with the laws of Nature echoed in the economic and social world. It led to the specialisation and reductive approaches which still shape our attitudes and expectations and often keep apart the disciplines. It also reinforces a mechanistic view of the economy driven by the circular flow of income but using a linear approach to resources and waste, and where efficiency (productivity) is the key to wealth. Feedback outside the monetary flow is an externality. More recently, science has moved on and the model of the machine world has been superseded by a worldview in which there is feedback everywhere and relationships are primarily non-linear. The world is much more dynamic and interconnected than we imagined and this more sophisticated systems view demands a different approach to knowledge and to the aims of any intervention: efficiency is traded off for more resilience (less risk) and optimisation is within the system as a whole rather than one component. There are no externalities because it is not possible to answer the question 'external to what?' (all flows matter and are therefore accounted for). A second question follows: 'what are the implications of this new scientific worldview?'

The circular economy

This is one approach to the question: 'which way out is consonant with our evolving scientific understanding or worldview?' A circular economy is an expression of our understanding of dynamic feedback-dominated systems applied to resources, energy and information /money. Rather than modelled on a machine, it takes insights from living systems and is based on regeneration of capital, effective flows and optimising system conditions. It is contrasted with economies modelled on linear resource flows or on localisation and degrowth assumptions.

APPENDIX



To start with let's discuss the basic idea of a linear versus a circular economy.

Figure 1.2 is meant to convey, in the simplest of ways, the character of the existing 'linear' materials economy. It is a throughput economy - a take, make and dispose economy powered by the use of fossil fuels. The term *throughput* is important as this type of economy is built on a model of extraction and harvesting of resources, materials and energy, single-life products, mass consumption and disposal back into the environment.

The term *throughput* can also be thought of as a flow of resources, materials and energy. It works best when there is plenty to take and plenty of room to dispose. The linear economy, or at least the industrial linear economy, has been hugely successful for many decades creating prolonged periods of economic growth, as measured by per capita income and GDP, for many people. In other parts of the world subsistence, rural or pre-industrial economies dominate, often with low per capita incomes, low levels of economic growth and widespread poverty. This short course and the concept of the circular economy is predicated on the perspective that, while the linear economy has been hugely successful, there is growing evidence to indicate that the conditions underpinning these successes may be changing and perhaps drawing to an end. This will be covered in week 2 of the course.

In contrast a circular economy operates on the basis of rethinking the throughput model and asking whether there is a better or more effective way to use the abundance of materials, resources and energy that we appear to be squandering. A very important building block to address this was the *Cradle to Cradle* perspective developed by Michael Braungart and William McDonough (2002). A key component of the *Cradle to Cradle* perspective was the idea of two distinct materials pathways: one for non-toxic biological materials and the other for high-quality technical materials (see Figure 1.3). Braungart and McDonough (2002) also argue that over time more of the economy needs to be powered by renewables. In week 5 of this course we will have a webinar by Katja Hansen, a senior researcher on Cradle to Cradle at Rotterdam School of Management, and one of the foremost experts in the field.

APPENDIX

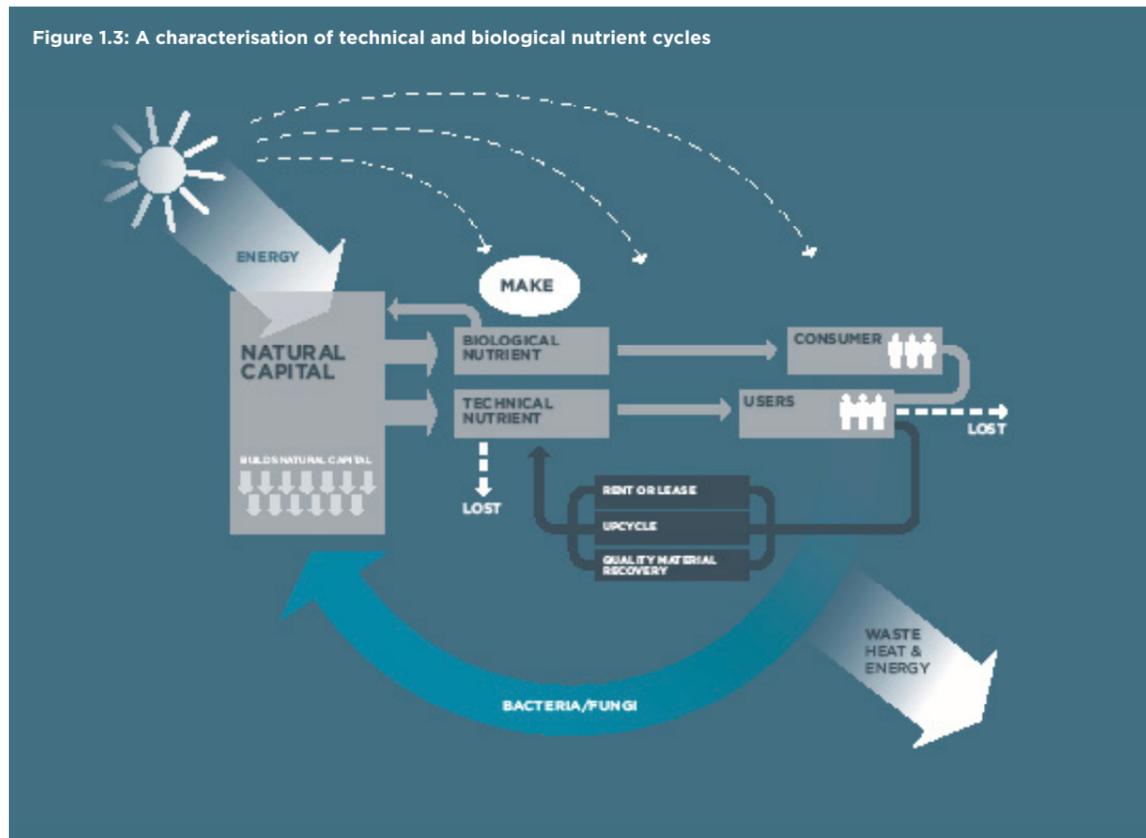


Figure 1.3: A characterisation of technical and biological nutrient cycles

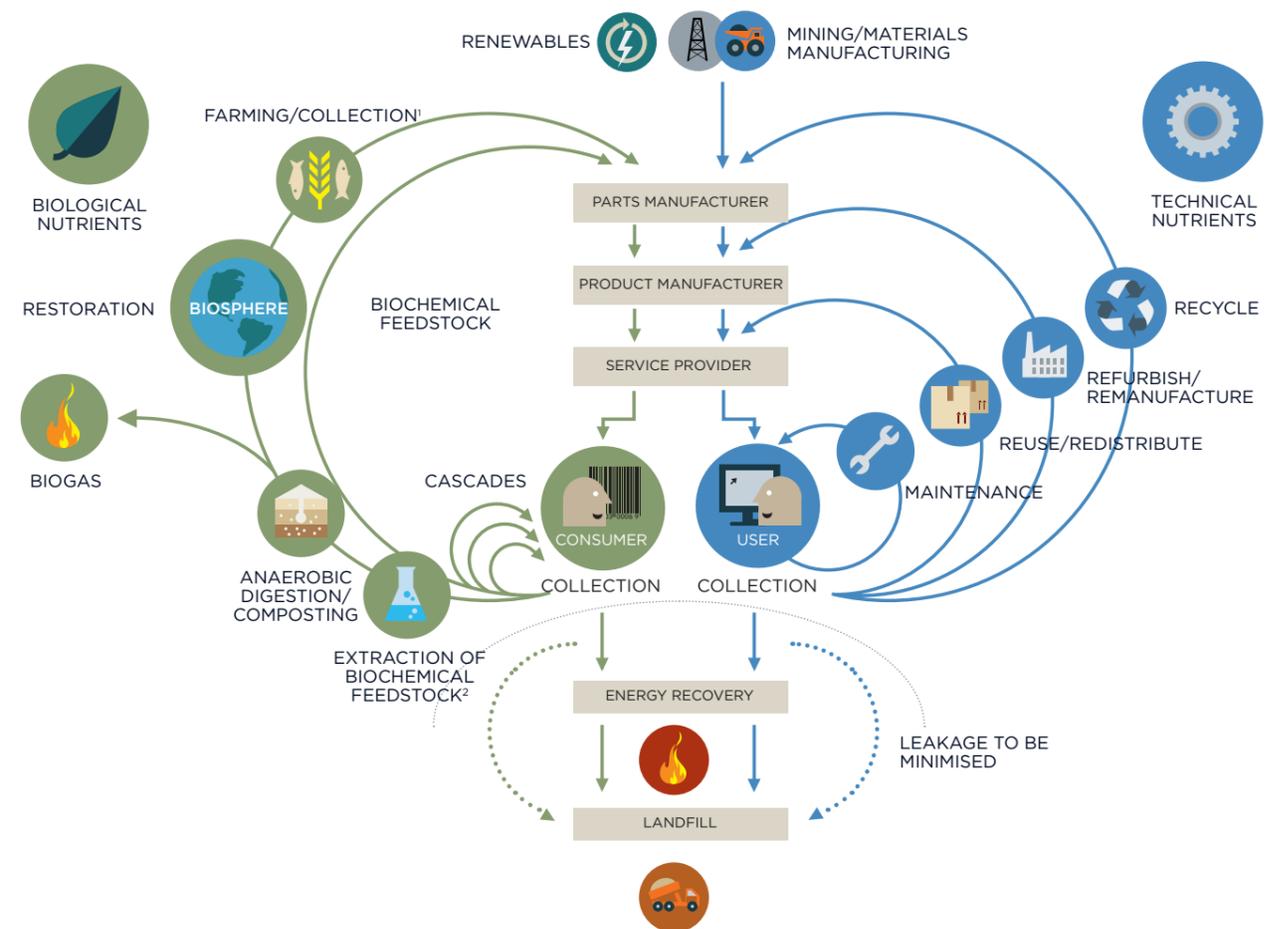
The image and diagram we will use extensively in this course (Figure 1.4) is a more sophisticated version of Figure 1.2. Developed over a period of time by the Ellen MacArthur Foundation, it first saw light in the report *Towards the Circular Economy Volume 1* (EMF 2012), which forms part of your core reading for this course.

This diagram has been highly significant in presenting the overall idea of a circular economy in a visual form. The central spine of the diagram is the linear, throughput, take-make-dispose characterisation from Figure 1.2. On either side of the central spine are the biological and technical cycles from Figure 1.3.

The feedback loops lie at the heart of the circular economy. These are the processes, interventions, business models or actions to either **cycle** the technical nutrients or **cascade** the biological nutrients to achieve greater productive value and potential cash flow from multiple stages of nutrient use. On both the technical and biological sides, materials tend towards disorder over time.

Business models such as *extended product life or design for disassembly* and other techniques secure added value from the resources. In very simple terms waste is designed out in favour of 'food' for additional cycles. Some materials can even be upcycled or improved in quality over time by judicious processing. The potential value of these additional uses of the same resource forms a key part of the business interest in the circular economy. Figure 1.4 also shows the economy being run on renewable energy and ultimately biological nutrients being returned to the biosphere to restore stocks of natural capital.

Figure 1.4: A characterisation of material, energy and resources flows in a circular economy



To accompany this diagram EMF also produced this [short animation](#) which is intended to help explain the circular economy to a new audience.

In week 1 and during the rest of the course we make reference to a number of terms that we need to spend some more time on if we want to really develop an understanding of the deeper origins of the circular economy framework. In week 1 we highlight the importance of language and terminology.

The term 'circularity' is often found as part of the language of feedback-rich systems. Other terms drawing on metaphors from living system perspectives appear in the work of a number of schools of complementary thought:

APPENDIX

Michael Braungart and William McDonough (*cradle to cradle*) talk of 'nutrients' and 'food' and diversity <http://www.c2ccertified.org>

Walter Stahel (*performance economy*) talks of stocks and flows, contrasting 'river' (throughput) and 'lake' (stock-based) economies <http://product-life.org/en/node>

Gunter Pauli (*blue economy*) speaks of 'metabolism' <http://theblueeconomy.org/blue/Home.html>

Janine Benyus (*biomimicry*) talks of the importance of what we learn from nature rather than what we take from it. <http://biomimicry.org/janine-benyus/>

Why do we need to draw attention to these ideas and the language used? In its crudest terms as soon as you connect up the ends of a linear economy to make it circular, you are required to speak in different ways. This is because in making the connection you have created a feedback-rich dynamic system (Figure 1.4), a system which behaves very differently to a linear system. This takes us into the world of complex adaptive systems. We will not go any deeper into this topic but for those who might be interested we direct you to a very concise but still detailed article on complexity by Thomas Homer Dixon (2011).

So here is an important point to grasp in this opening week:

A circular economy is analogous (but not identical) to a living system and as such there are benefits to knowing how living systems work. Such systems have rules, as well as unpredictability, which can be exploited by innovator and entrepreneur alike. EMF Reports 1, 2 and 3 (2012, 2013, 2014) provide ample evidence of where such opportunities may lie and be developed. The emergence of the circular economy and the opportunities it presents have captured the interest of business leaders motivated by profit and business resilience, closely followed by policy makers, academics and educational leaders. The circular economy appears to offer a positive systemic model or framework for addressing many of the serious global and local economic and wider societal challenges confronting us in the 21st century – in ways that make sense.

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EXAMPLE 2: FROM THE ONLINE HE RESOURCES AREA EXTRACT FROM CHAPTER 2 OF A NEW DYNAMIC VOLUME 1

SUMMARY

There follows in Table 1 an attempt to contrast linear and circular modes for the general elucidation of the idea that systems entrain and the consequences are just that - consequences - and much less a matter of choice at an individual level than might be supposed. It surely beholds us, if extending and exploiting circularity in business is the aim, to know what we are involved in and how a subtle change of the rules of the game (whether brought by changing technologies and other dynamics) might have far-reaching consequences over time.

Table 1 is a characterisation of different systems and their consequences. There is nothing here about explicit social policy or political systems. Business always expects to work under whatever political layering is applied in a country. A circular economy can work under a whole range of arrangements. However, one assumes that there is reason to suggest that it would be encouraging of and work more readily where individual aspirations for democracy, free association, prosperity and independent living in functioning and diverse communities are valued. In character, a circular economy is evidently more likely to point to a variety of scales, be more connected, participatory and likely to balance competition and cooperation, if only because resource and energy constraints push it that way and, curiously, because of how our brains work.

A whole systems aesthetic is likely to exercise the empathetic neural pathways. These pathways are key learning pathways which relate to how others experience situations, but like all neural pathways they need exercise – use – to be effective contributors. These pathways are exercised more often in a circular economy context because understanding and working with suppliers and customers in ways which are aimed at increasing effective flows requires taking on others' points of view: common standards, cooperation, co-working and more 'open source' approaches. A sensitivity to the bigger picture, including the interdependence exhibited in systems approaches is obvious. Cognitive scientists, such as George Lakoff and others, point to the empathetic neural pathways as operating as a counterpoint to the more 'selfish' and materialistic or focussed pathways more commonly applied – or simply more appropriate for success in a linear economy. After all, a different mode of thinking or a mindset is just that – different – and the character and place of business in relation to society is likely to be different too, simply by entrainment generated by the system.

APPENDIX

Table 1 Characterisation of linear and circular economies and their consequences

Linear	Circular	Notes
Externalises costs in search of production cost reduction	Internalises costs in search for quality service/performance and low risk	Refers to manufactures like white goods of medium complexity, especially those with reasonable use periods
POS = point of sale and ends most responsibility	Usually rent/lease/recovery but business extends responsibility. POS = point of service	If biological pathway assumes non-toxic "waste = food" consumption via appropriate cascading
Creates waste streams for municipalities and individuals to deal with	Reduces waste streams and provides value streams instead	Might reduce GDP as this does not distinguish between 'goods' and 'bads' in its calculation
Promotes global scale in production to secure low costs and market position	Regional and local scales feasible as value is more in the service provided than the selling of product	Note changing approaches to manufactures - e.g. devolved digital manufacturing
Encourages standardisation to add to efficiency/ease of consumption	Encourages standardisation of components and protocols to encourage repair, recovery and reuse	Open source - download designs not ship products
Consumption turnover encouraged - planned obsolescence etc. Possession trumps access	User mentality, trouble free service or performance sought (reliability). Less turnover. Access trumps possession	Huge opportunity for marketeers to profit from this
Economic growth driven by compound interest and money as debt	Investing in restorative long-term schemes driven by complementary currencies, negative interest, money issued debt free	Reverses the effect of net present value calculations
Prices reflect only the private costs of production distribution, sale etc.	Prices reflect the full costs aided by reduction of externalised costs	

Table ©Ellen MacArthur Foundation/Ken Webster 2013

Linear	Circular	Notes
Tax on labour encourages labour productivity (substitute capital or energy). Reduces employment if growth not strong	Taxes off income and other renewables and on waste, non-renewables, unearned income. Increases employment generally	
Recycling represents another raw material flow and ignores lost embodied energy and quality	Recycling represents a low grade option - an outer loop. Sometimes necessary	Recycling legitimises a linear economy by promising what it cannot possibly achieve - a closed loop on short-cycle, low-value materials
Transforms natural and social capital into financial capital via a short-term preference - rapid, large flows	(Re)builds capital (stocks) from which to derive more and better flows over the longer term	Assumes in circular economy that natural and social capital are degraded at starting point
As the throughput model externalises costs there is a truncated materials flow to concern the product designers	As the product and service are wholly dependent on a functioning materials flow which is 'closed loop' the 'fit' is imperative. Whole systems design indicated	
Economic growth evolves to become a need to offset labour productivity and to meet interest payments	Economic growth replaced by more sophisticated measure: assumes increasing prosperity and well being as part of a restorative cycle	A long standing discussion
Production > sale in a linear system can be very competitive for product sales and market share in the context of need for low costs and thus economies of scale, often global [supply push for branded products]	Whole systems design is inherently more 'we' than 'me' orientated. Cooperation will be required as well as competition. Markets, regional or local, perhaps more differentiated [demand pull for generic products]	
Basic metaphor is 'world as machine and parts'. Humans can understand predict and control. Individual is centre of the world and can work instrumentally to achieve ever greater results	Basic metaphor is of living systems - 'metabolisms' - where we have complex relationships in which we are participants, have influence and limited opportunity to understand (we need to review frequently)	The general case is one where the system is non-linear, the special or less common case is the linear

EXAMPLE 3 FROM THE ONLINE HE RESOURCES AREA
 An extract from our professional development workshop resources collection

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ACTIVITY 02

MATERIALS FLOWS, THE BIG PICTURE

COULD ALUMINIUM USE BE 'CLOSED-LOOP'?

OUTLINE

The theme of this activity is 'big picture' flows and the consequences of feedback in different contexts. Can aluminium use be 'closed-loop'? When, if at all? How? Does it matter? The main stimulus for this activity is a Sankey diagram that visualises the stocks and flows of aluminium internationally. Aluminium is a very significant metal in the global economy and in the discussion, participants are encouraged to reflect on ways to improve the prospects for aluminium in relation to creating more 'circularity'.

RESOURCES AVAILABLE

- 2:R1a Intro PPT slide
- 2:R1 Photo of an aluminium smelter
- 2:R2 A Sankey diagram of aluminium flows
- 2:R3 A graphic to illustrate what happens to resources used in an aluminium can over several cycles
- 2:R4 Aluminium prices
- 2:R5 Aluminium flows - cars

ORGANISATION

- Small group (2-3) discussion around aluminium datasets
- Larger group (4-6) discussion on aluminium and 'circularity'

TASK(S) AND RUNNING ORDER

- 1) In small groups develop dialogue around the aluminium smelter photograph and Sankey diagram
- 2) Consider in groups the graph about recycling and aluminium cans
- 3) Reflection: where would your emphasis go in improving the prospects for aluminium in relation to creating more 'circularity'?

TIMINGS

Overall approximately 60 minutes.
 Task 1 / 2: 40 mins. Task 3: 20 mins.

THUMBNAIL RESOURCES

DOWNLOAD HIGH RESOLUTION VERSIONS FROM WEBSITE

2:R1a INTRO PPT SLIDE

KEY ENQUIRY
 Could aluminium use be 'closed loop'? (Time)

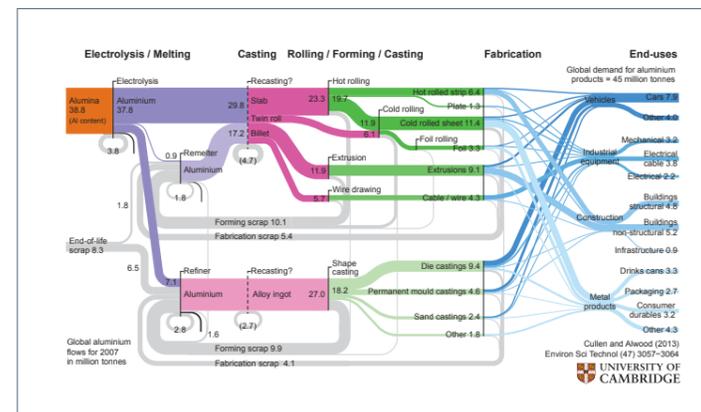
TASK(S)

- 1) In small groups develop dialogue around the aluminium smelter photograph and Sankey diagram (Time)
- 2) Consider in groups the graph about recycling and aluminium cans (Time)
- 3) Reflection: where would your emphasis go in improving the prospects for aluminium in relation to creating more 'circularity'? (Time)

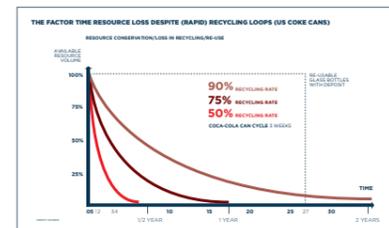
2:R1



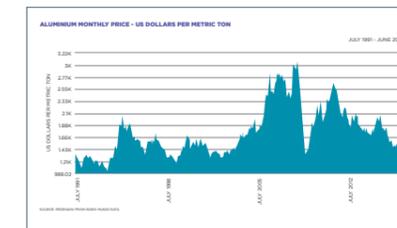
2: R2



2:R3



2: R4



2: R5

