Part 1[1]

Assessing proposed Sustainable Developments

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Assessing proposed Sustainable Developments

1. What is a "sustainable" development?

What is a "sustainable development"? It has become a buzz-phrase, something warm and comfortable but often meaning little more than "environmentally desirable"; and it has become a favored way of relabeling a current activity to give it the ring of responsibility. We need to do better than that. Here is a short answer: a sustainable development is one that provides needed products or services in ways that reduce the drain on natural resources, is legal, economically viable, acceptable to all stakeholders and equitable both within and between generations.

In slightly more detail: the word "Sustainability" carries three linked associations:

- Environmental sustainability – the preservation of *natural capital*, meaning clean atmosphere, productive land and water, a vibrant bio-sphere and material and energy resources,
- Economic sustainability – the productive creation of *manufactured capital*, meaning a financial health, a well-balanced built environment and industrial capacity, and
- Social sustainability – the fostering and support of *human and social capital*, meaning education, culture, consideration for the present and future generations, the pursuit of health and happiness.

These three essential "Capitals" underpin society as we know it today (Figure 1). Each capital is like a bank balance on which we draw and into which contributions can be made. They are mutually supportive, each dependent on the health of the others.

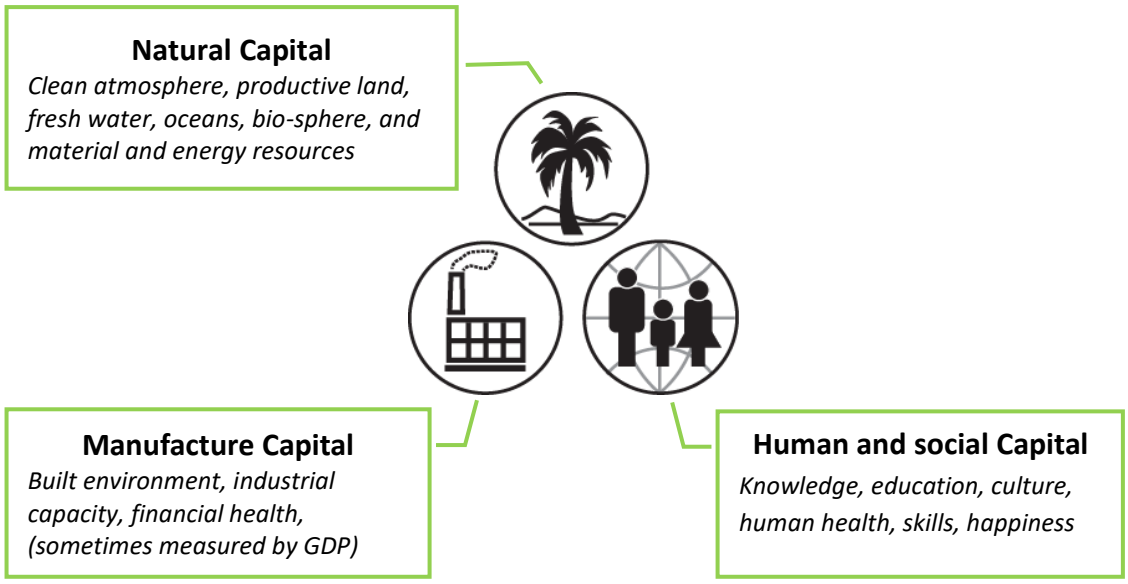


Figure 1. The three capitals

The growth in human population and wealth has increased the demands made on all three. Recognition of the importance of the three capitals has stimulated activities to diminish the undesired impacts of economic growth on them – particularly to diminish resource consumption, emission-release and social and economic inequity. At the same time there are many new proposals for sustainable developments spanning a large spectrum of scientific researches, economic interventions and social engineering projects. Each has a particular motivation. Here are some examples: research on efficient grid-scale energy storage; subsidizing electric cars to reduce the carbon emissions to atmosphere; harvesting electrical energy from waste heat; reclaiming scarce elements from cast-off mobile phones; reducing domestic electricity consumption by phasing out incandescent bulbs. We will refer to them as "proposals" for sustainable development.

This article describes a 5-step method for analyzing a proposed sustainable development. The method are described in Section 3 and illustrated by a running case study (blue boxes) that shows how the steps work but should not otherwise be taken seriously (serious case studies are available separately).

Any such proposal impinges in one way or another on the three capitals. The capitals are introduced at the very start because they provide the set of values against which we will judge the merits or failings of a proposed development. Sustainable developments are not simple – there are environmental aspects, there are aspects relating to material and energy resources, and there are legal, economic and social dimensions – and they are often presented in ways that favor the case made by the proposer or are biased towards the views of the opponents; in short, they are multi-dimensional, complex and, often, poorly defined. So we start with a brief description of a strategy for dealing with complex systems.

2. Dealing with complex systems.

It is natural to feel uncomfortable when confronted with problems that are multi-dimensional, interactive and poorly defined. The answer is to have a framework for critical thinking that recognizes the complexity and the interdependence and allows you to work with them.

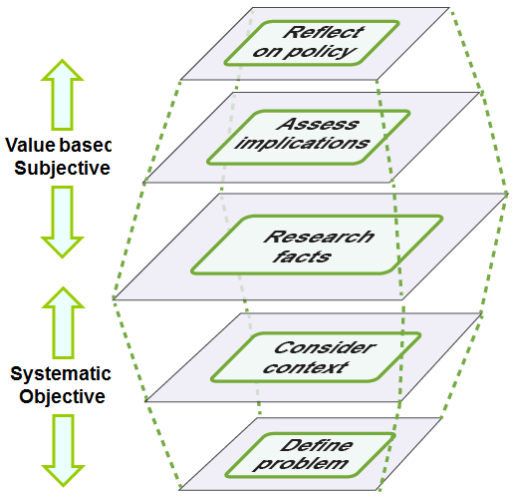


Figure 2. Layering as a way of thinking about complex problems

One approach is to split the problem into layers (Figure 2). The bottom layer, the starting point, is a statement of the problem. Problems have a context: the circumstances that surround them. Why and how has the problem arisen? Who is involved? What outcomes would be desirable? What consequences might they have? These form the second layer. Given the answers to these questions, factual information about the problem and its context can be researched in a systematic, value-independent way. Technical, economic and legal aspects, for instance, lend themselves to objective research. No implications are sought here; the facts are simply assembled while suspending all judgment. The facts are stored on the third layer.

Complex problems would not be complex if systematic research alone could solve them. The complexity arises when trying to compare things that are measured in different units or are not "measured" at all: personal judgments, culture or belief-dependent values. To move from the third layer to the fourth, that of value-based assessment, may require recognition of diverse views, only resolvable by discussion, debate and compromise to reach a mutually acceptable position.

The final step is one of reflection. What conclusions for strategy or action can be drawn from the debate? It is possible that any solution to the problem will leave some of the parties involved dissatisfied. Are there ways to involve them in ways that reduce the dissatisfaction?

This layer-based approach clearly separates the objective, fact-based aspects of the problem from the more difficult value-based aspects. It allows thinking about interaction *within* each layer, followed by interaction *between* layers. Broadly speaking the lower layers inform the ones above, so that the approach has a sequence and a direction (from bottom to top). That is not to say that it is linear – thinking about any one layer may require further clarification of the layers below. But it does give a framework.

Let's now see how it might play out in analyzing a proposal of sustainable development.

3. Assessing proposals of sustainable development: the method

Here (Figure 3) is a five-step strategy for assessing a design or project (an proposal) that claims to contribute to sustainable development. Each step is a layer. Handouts with check-lists and templates guide the implementation. The strategy is illustrated with a running example that shows how the steps work but is not otherwise to be taken seriously.

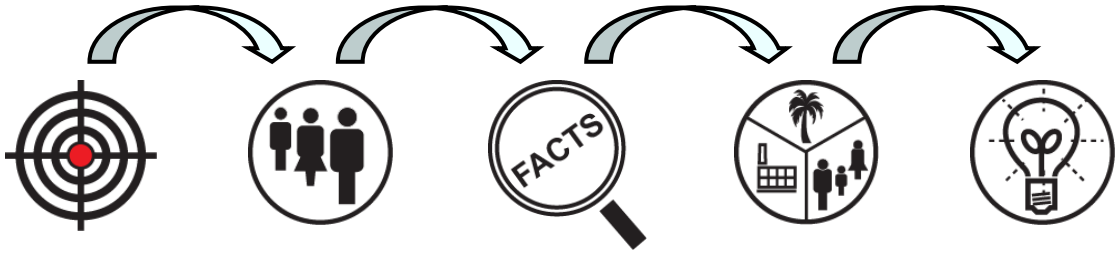


Figure 3. The five-step method

Step 1: Problem definition – unpacking the proposal. Any proposal of sustainability has an underlying motive that we will call its *Objective.* If the proposal is going to make a difference it must act on a scale that is significant in comparison with that of the problem itself. Thus, legislation requiring supermarkets to provide only bio-degradable plastic bags (with the aim of reducing "plastic pollution) will make a difference only if plastic bags from supermarkets constitute a significant fraction of *all* plastic bags. Similarly, a proposal has a time scale. Insisting on bio-degradable bags within 12 months presupposes that the supply chain for the bio-degradable film used to make them can cope with the resulting demand within that time. It is not possible to judge the viability of the proposal without knowing how large it will be and how soon it should happen; and if comparison is to be made with alternatives we need to identify a functional unit (Table 1). We identify step 1 with the target-icon.

Table 1. Unpacking the proposal

Questions	Facts that are sought
Objective?	What's the motive? What should the project achieve?
Size scale?	What's the scope? How many? How much? How extensive?
Time scale?	At what future date should the objective be achieved?
Functional unit?	What is the unit on which the assessment will be based?

Running example: The proposal. The Beneficial Brewing Corporation markets beer in 16 ounce (473 ml) aluminum cans. Their sales average 500 million cans per year, roughly 1% of the US beer market. At the Annual General Meeting (AGM) a group of eco-minded shareholders propose that the company should use steel cans instead of aluminum cans because steel has a lower embodied energy and carbon footprint than aluminum. The CEO of Beneficial Brewing is thereby presented with a proposal for a sustainable development. Here it is:

- *Objective:* reduce energy demand and carbon emission by replacing aluminum by steel cans.
- *Size scale:* 500 million cans per year
- *Time scale:* less clear, but the shareholders will expect some sort of response by the time of the next AGM in one year's time.
- *Functional unit:* here, the same as the size scale: 500 million cans per year.

Figure 4. An aluminum beer can

We need a size scale and timing for this and any such analysis. As in this example, the original statement of a proposal is often vague about these, yet they are always there. If they are not explicit, we will infer sensible default values from the context.

The first step, then, is *to clarify the Objective and its size scale and timing.*

Step 2: Identify stakeholders and their concerns. Stakeholders are individuals, groups or organizations that are in any way affected by the proposal. Some, like the originators of the proposal in question, wish to see it succeed. Others may have reservations or voice outright opposition. It is important to identify the stakeholders and their concerns, identified by the stakeholder-icon. If the concerns are not addressed the proposal will face obstacles and may fail to gain acceptance. If this happens the proposal is not sustainable.

How are stakeholders identified? A simple check-list, like that in Table 2 acts as a prompt. The National Press can provide background: controversial proposals (building land-based wind farms, for instance, or fracking for shale gas) cause stakeholders to express their concerns through Editorials, News and Business reports, Letters to the Editor, Commentaries in the Press, on radio and television, blogs, Facebook and Twitter. Ultimately, however, stakeholder concerns are best identified by face-to-face meetings, phone interviews or questionnaires.

Table 2. Possible stakeholders

Local or national Government	Suppliers	Customers, existing and potential
Owners	The public or local community	Lobbyists and interest-groups
Employees	Trade Unions	Investors, shareholders
Health and planning authorities	The Press, radio and television	Managers, colleagues or team
Alliance partners	Business partners	The scientific community

Stakeholders differ in their level of interest and the influence or power that they can exert. Figure 5 is a diagram with Stakeholder Interest and Influence as axes. The likely behavior of a particular stakeholder depends, to some extent, on the position they occupy on this diagram. Once positioned, it is possible to reflect on the mutual influence or dependence of the stakeholders, shown here by arrows.

Example (continued): Stakeholders. The CEO of Beneficial Brewing asks: who is interested or affected if we change from aluminum to steel cans? The shareholders have urged the change and are in a position to exert pressure on the company to adopt it: they are stakeholders with both interest and influence. The makers of aluminum cans may not wish to lose trade, but the makers of steel cans may be happy to get it – both are interested parties. Surveys suggest that most beer drinkers do not know or care what the cans are made from – they are stakeholders with little interest or influence so long as they get their beer. Law makers could, if so motivated, pass legislation mandating the use of steel cans but there is little reason to think that they would; they have influence but no interest. The important stakeholders are those above the diagonal (dotted) line. This is useful information, focusing the attention of the CEO on the key players and their concerns. Their views must be recognized in seeking the best path forward.

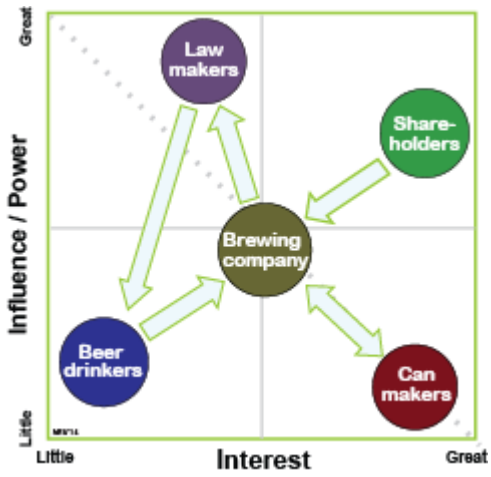
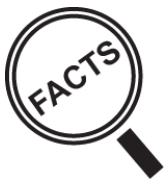


Figure 5. The stakeholder diagram for the CEO of the Beneficial Brewer, with paths of influence.

The second step, then, is to *identify the stakeholders and their concerns* – they set the context in which the assessment is carried out.

Step 3: Fact finding. To get further we need facts and facts need research. What sort of facts?



- Facts about the proposal and the resources needed to make it happen. What environmental impact will it have? Are there regulations with which is must comply? Is it fair and equitable? What will it cost?
- Facts that relate to the stakeholder's concerns. Are the concerns justified? What information is needed to confirm or refute them?
- Facts relating to essential infrastructure. What products or services will have to be in place to support the proposal if it goes ahead?

Each of these questions can be researched in an objective way using generally-available sources: books, databases, interviews and the Internet, guided by check-lists. The step is identified by the Sherlock Holmes icon.

What facts would be helpful to the CEO of Beneficial Brewing? They are best listed under six headings shown in the six segments of Figure 6.

- ***Materials.*** Is the supply-chain secure? Is a supplier of steel cans available? Have they the spare capacity to provide 500 million cans per year?
- ***Energy.*** The shareholders believe that steel cans require less energy than aluminum cans. Is this true? What are the values? If the change was made, how much energy would the company save in a year? What is this as a fraction of the total energy used by the company? Is it significant?
- ***Environment.*** What are the relative environmental impacts of the two sorts of can? Does one have a lower carbon footprint than the other? Is one recycled more effectively than the other?
- ***Regulation.*** What regulations bear on the use and recycling of cans? Is it the same for steel and aluminum? Are there any other legal or regulatory constraints?
- ***Society.*** Are steel cans acceptable to drinkers of Beneficial Beer? Would the lower embodied energy of the cans be seen as a demonstration of environmental responsibility?
- ***Economics.*** Do steel cans cost less than aluminum cans? What is the cost of re-equipping to cope with the change from steel and of aluminum? What are the benefits? Do they justify the cost?

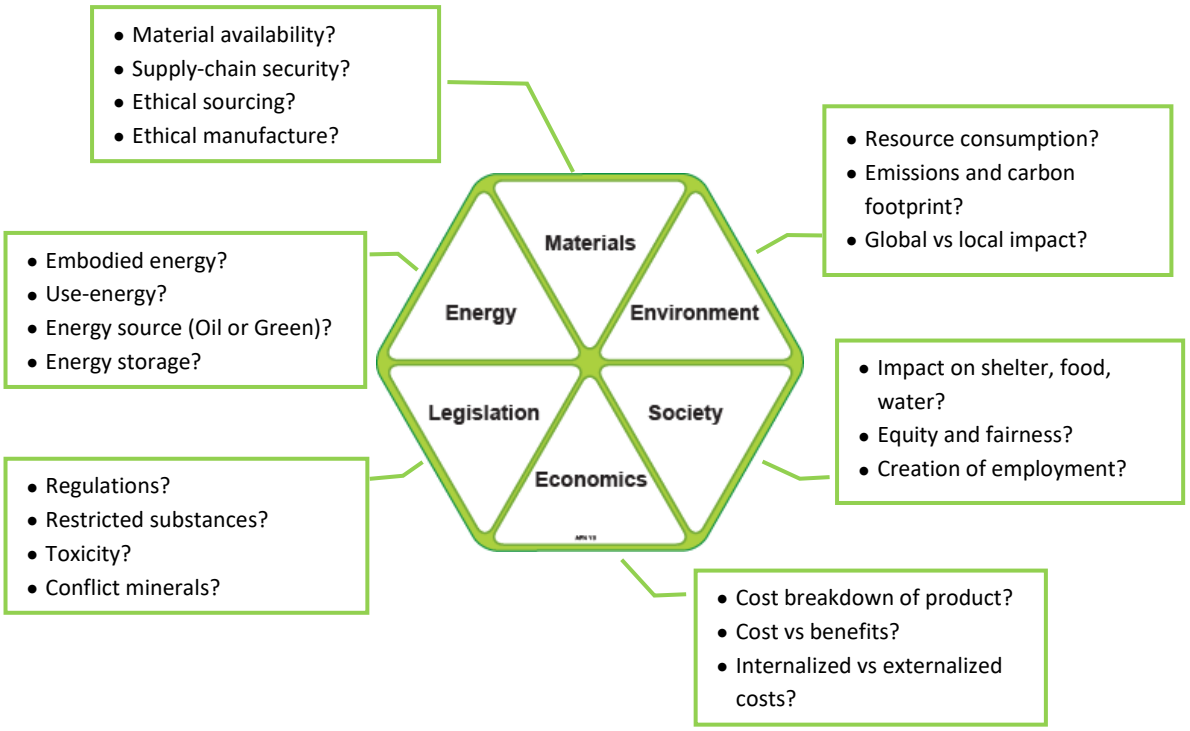


Figure 6. The six major sectors that are involved in most articulations of sustainable development.

Example (continued): Fact-finding.

Material, Environment and Energy. It is true, as the shareholders of the Benevolent Brewing Co claim, that steel has a much lower embodied energy than aluminum for virgin material – it is about 25 MJ/kg for steel; that for aluminum is 200 MJ/kg, a factor of 8 larger. Cans are not made from virgin stock but from stock with a considerable recycle content. The embodied energy of typical grades of can-stock are about 18 MJ/kg for steel and 110 MJ/kg for aluminum, a factor of 6 this time. Does this mean that the embodied energy of the two sorts of can differ by the same factor? The answer is no – a 5000-series aluminum 440 ml can weighs 13 grams; the equivalent steel can weighs 44 grams (Figure 6), so the embodied energies per can differ by much less – that of the aluminum can is just 1.7 times more than the steel one.

Figure 7. 440 ml aluminum (left) and steel (right) cans

The forming energies to make the cans also differ. To make a valid comparison the CEO of Beneficial Brewing needs a Life Cycle Assessment (LCA) for the production of each type of can. A detailed LCA from 2002[2] reaches the conclusion that the differences both in energy and in carbon emissions for the two types of can are so small that, given the inherent uncertainty in all embodied energy data, the energies and carbon emissions of the two are not significantly different.

Legislation and Regulation. Much regulation, easily found via a web-search, now applies to packaging such as cans. The UK Packaging (Essential Requirements) Regulations of 2003 is typical. It applies to any company that makes, fills, sells or handles packaging. It aims to minimise waste and ensure that packaging can be reused, recovered or recycled. To comply, a producer must join a registered compliance scheme. The legislation applies equally to aluminium and steel cans.

Economics. Can-grade steel costs about $0.4/kg; so the material cost for 500 million steel cans is about $8.8 million. Can-grade aluminum costs about $1.7/kg, making the material cost for 500 million cans $11.0 million. There could, therefore, be a possible saving of $2.2 million in changing to steel.

Society. Are steel cans as acceptable to the beer drinking public as aluminum cans? Surveys suggest that most don't care, and the fact that the two competing brands pictured in Figure 7 use different can materials reinforces this perception.

Step 4: Forming a judgement. The fourth step is one of drawing together the facts from Step 3 to form a balanced judgment. To do this we need value-criteria by which the impact of the facts can be assessed. The value criteria are provided by the three Capitals (Figure 7) identified by the icon shown here.

[2] http://www.apeal.org/uploads/Library/LCA%20study.pdf

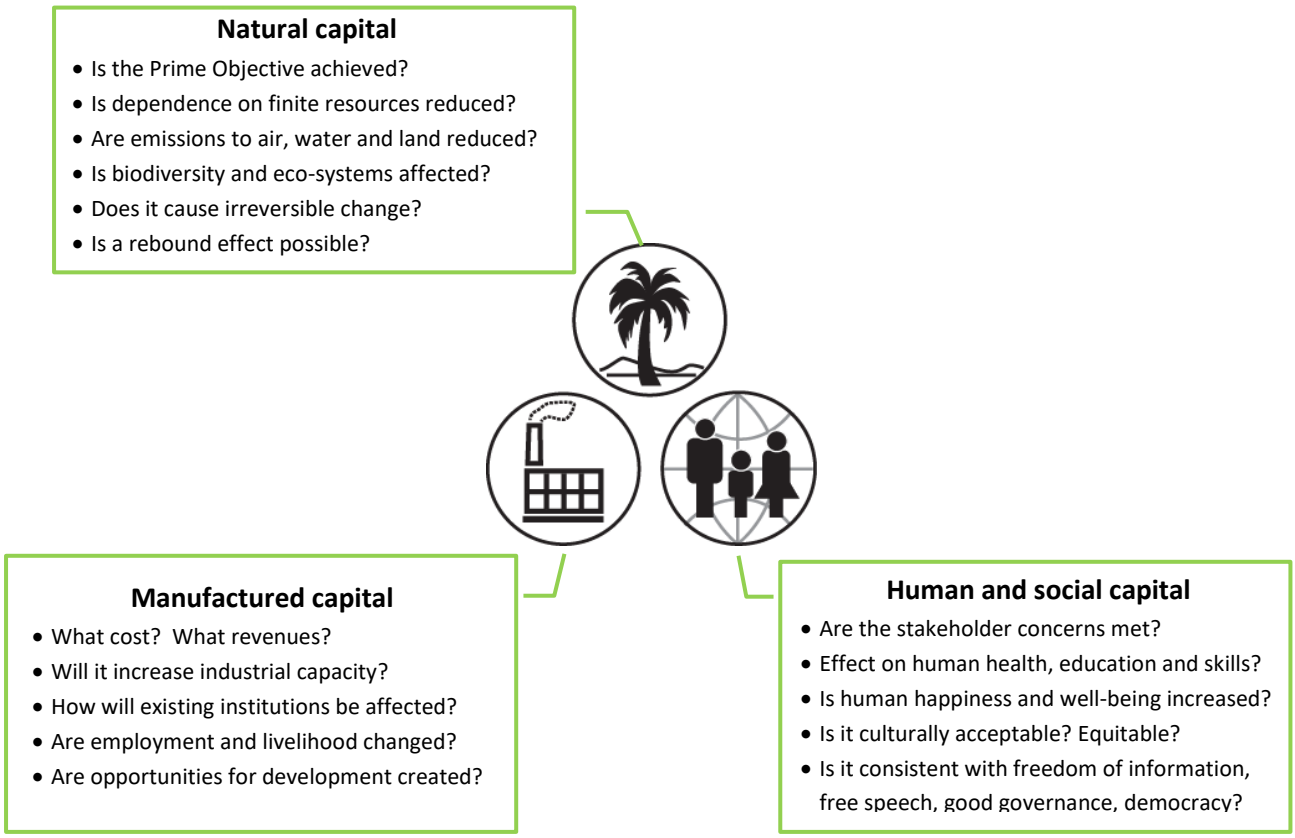


Figure 8. Synthesis – debating the impact of the facts on the three capitals. Check-lists help with this and the other steps.

It is here that values, culture, beliefs and ethics enter more strongly. Think of each Capital as representing the world-view associated with a particular set of values. An environmentalist might argue that the impact on natural capital ranked most highly: after all, the natural environment is the support system of all life. Humanists might see the sharing of knowledge, understanding, reason, humanity and happiness as the central pillars of a civilized society and feel that any impact on human capital was unacceptable. To an economist, economic stability and growth of manufactured capital could seem to be the first priority, arguing that these provide the resources needed to protect the environment, enable innovation and support a vibrant society. Each of these groups recognizes the cases made by the others; indeed they have many concerns in common. But their final judgment will be influenced by their underlying beliefs and values, cultural, religious and political. It is no surprise that one set of facts can be interpreted in more than one way. A balanced view is best formed by debating the facts from the perspective of each of each of these value-sets in turn, seeking to identify what is of value and what is unacceptable to each.

All this must be accepted. The important things to retain

- Respect for the facts
- Respect for alternative interpretations of the facts
- Respect for the value of compromise reached by reasoned debate.

Example (continued): Synthesis.

The CEO can now present the facts to the Brewery Board and initiate a discussion of their impact on the three capitals.

Natural capital. Contrary to the intuition of the shareholders, the facts suggest that the differences in embodied energy and carbon footprint of steel and aluminum cans are too small to be significant. This is because of the high recycle content of can-stock, because aluminum cans are much lighter than those made of steel and because (according to the LCA) the deep-drawing of aluminum to make cans is less energy intensive than the equivalent process for steel. The supply chains for both metals are robust with no global or national shortages (indeed at the time of writing there is over-capacity). Beneficial Brewing requires only 1% of the can market and cans account for about 10% of the global aluminum consumption so the impact of material choice by Beneficial is very small.

Human capital. A can is ….well….just a can. The material of which it is made carries no emotional, cultural or (since it is decorated) intrinsic aesthetic baggage that needs unpacking. No significant impact here.

Manufactured and financial capital. If the prices of steel and aluminum are directly reflected in can prices, a switch to steel could provide an annual saving of about $2 million. At a (guessed) shipping price of 50¢ per filled can, Beneficial's revenue stream from beer is of order $250 million, so this saving is about 0.8% of turnover. But against this must be set the cost of re-equipping the brewery's production line to deal with steel cans and the possible disruption of production while this happens. The CEO and the Board take the view that the risks exceed the benefits.

Step four, the Synthesis step, is the most difficult one. Check-lists, provided separately, help with it.

Step 5: Reflection. The fifth and last step is that of *reflection on alternatives*. Is the Objective achievable? Is its influence on a scale that makes a significant difference? Do the benefits to the three capitals outweigh the negative impacts? Can the analysis suggest a new, more productive, way of achieving the initial Objective? This final step is identified by the illumination icon.

Example (continued): Reflection. Is the shareholders' "proposal" – the change of material for the cans – a sustainable development or not? Taken together, the impacts on the three capitals suggest that it is not. But the shareholders are stakeholders with both interest and influence. Their views must be respected.

This is the moment to return to the Beneficial Brewery, pour a glass of beer, and ponder on alternatives – preferably those that do not require re-equipping the production line. The Objective was to reduce depletion of natural capital associated with beer cans. Could aluminum cans be made thinner and thus less energy intensive? Aluminum can makers have already thought of that. Increase the recovery of aluminum cans for recycling by charging a deposit? That will work only if it is mandated nation- or state-wide, something the brewery cannot do by itself. But the brewery could lobby for such legislation, thereby demonstrating to shareholders its commitment to the environment without the disruption of a change of material.

4. Assembling the layers

The layers are stacked in Figure 9 in the ascending sequence:

- Proposal statement
- Stakeholder and their concerns
- Fact-finding
- Synthesis: interpretation of the facts
- Reflection.

The lower layers inform the ones above. As explained earlier, the layer-based approach clearly separates the objective, fact-based aspects of the problem that can be explored in a systematic, scientific way from the more difficult value-based aspects. It encourages thinking about interaction within each layer, and gives a logical path to explore the interaction between layers.

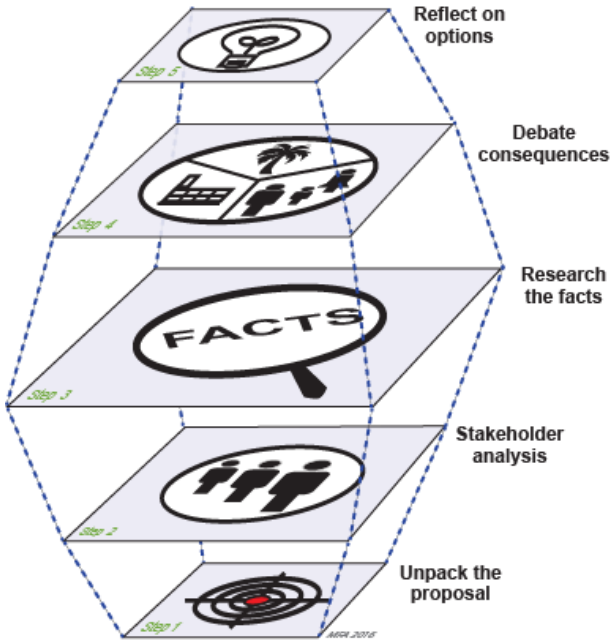


Figure 9. The layered approach to analyzing an articulation of sustainable development.

5 Summary and Conclusions

There is no completely "right" answer to questions of sustainability development; instead there is a thoughtful, well-researched response that recognizes the many conflicting facets and seeks the most productive compromise. The layer-based approach described here provides a framework for doing this. The method is designed to help teachers introduce students to sustainability analysis in a simple, progressive way.

6 Further Reading relating to the method

Ashby M.F., Ferrer-Balas, D. and Segalas Coral, J. (2015) "Materials and Sustainable Development" Butterworth-Heinemann Ltd , Oxford. ISBN-10: 0081001762 ISBN-13: 978-0081001769