An Aggregated Qualitative Accounting Method
for Developing Justified Policies

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"Qualitative accounting" is almost an oxymoron. The word 'accounting' includes the word 'count', and we cannot count qualities.[1] More precisely, we cannot meaningfully add qualities to each other, a quality cannot be measured by a standard unit. Therefore, aggregating qualities for the purposes of accounting might sound like sleight of hand, or deceptive advertising. Fear not. The result will turn out to be quite robust, given a modicum of intelligence and sensitivity. The method is original and useful.

The structure of the paper is given by the following sections: (1) an introduction to the topic, by looking at each word in the title, (2) we look at the UN mandate which will be used as an example to illustrate the method, (3) an explanation of the first part of method: working with the UN mandate, (4) the second part of the method: two orders of sensitivity used for reflection, and why this adds to the robustness of the method (5) broadening the conceptions underlying the method and lastly (6) uses of the method for policy.

Dolsy Smith is developing a software program that does the calculations for you, so that you can experiment with the parameters and indicators. Once developed the site will be made available to the public and is offered as an intellectual service.

1. Introduction: Explanation of the Title

To introduce the topic, I shall work through each word in the title in turn.

Start with 'aggregated'. Readers of Ecological Economics are all familiar with the tension between those of us who recognise the inherent complexity of the problems we

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[1] We can count adjectives, but there will be an infinite number pertaining to any object. This is made most obvious if we consider negative qualities such as 'not being physically connected to the Eiffel tower on Saturday 12th January 2018', or if we consider that we can translate relations into adjectives if we so choose. Also, while there are only a finite number of adjective words, in any natural language, we can make adjective phrases. Each of these will be finite, but there is still a potential infinity of them. The important point about counting qualities is not so much that we cannot count them, but rather, that we cannot measure them, except some in a rather artificial sense.

are dealing with in ecological economics and the policy makers who appreciate what we are doing, but 'still' need to make and defend decisions, where they think of the 'bottom line' in terms of money.

For example, when we[2] are doing multi-indicator analysis, we might 'aggregate', or 'integrate', the results in an input-output table. Or, we might create an 'integrated diagram' or graph of the indicators and their relationships. Examples are in figure 1.
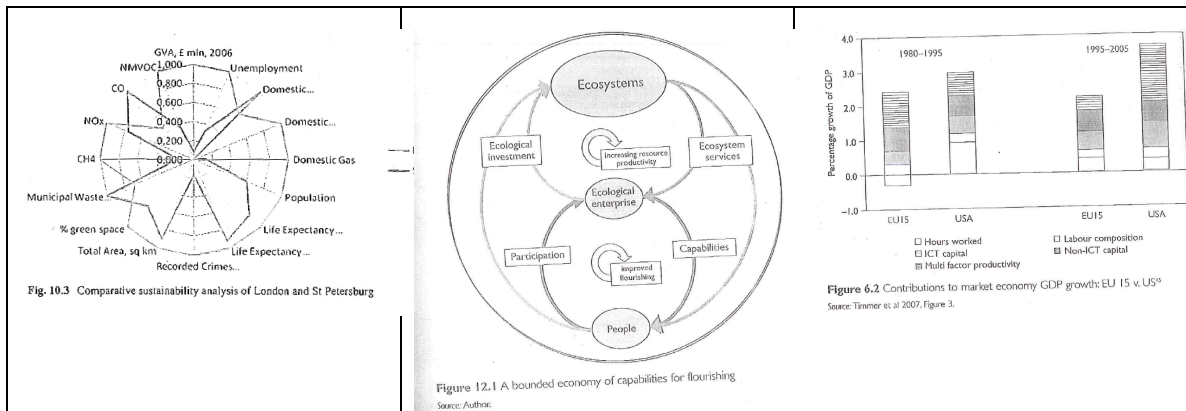

Figure 1.

'Integrated diagram' or 'integrated results' sometimes means little more than 'it all fits in one picture or table, and there are boxes around the words, or colour codes, and arrows linking the boxes'. When 'integrated' means more than this, the words in the boxes are explained, and the colours and arrows are explained, so there are genuine connections, and it is nice to have the material summarised in a table, or a diagram, because this helps us to understand, to 'see' a picture of the complex problem we are dealing with. For an in-depth discussion of such methods see Shemlev (2012).

However, such diagrams and explanations are still too complex for some policy and decision makers! They tell us to "Simplify, simplify, simplify!" Or, "Tell us what the dollar amount is", since the dollar is exactly what they want, an integrator in the brutal sense of ignoring qualitative differences, and producing one number.

We try to accommodate them by putting a price to nature, but we know that this is disingenuous. We are dealing with qualities and complex problems in complex situations. We end our analysis with comparisons, and this means that our 'integrated diagram' still contains a lot of information, in the form of *several* bar graphs, *several* nodes linked by arrows, *several* sectors and measures of performance on those sectors.

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[2] I do not want to set up a dichotomy of 'us' and 'them', this is merely a rhetorical device. Many policy makers are alive to the complexities of the decisions they have to make. But they feel in a trap. They have to justify their policies, and the language that is best understood for doing this is that of money. It is 'best understood' because we are familiar with it, and because it seems to be quite objective, because of the mathematics that accompanies the calculations.

Now think of 'qualities'. Money does not measure quality of life. At best, it is a very indirect measure. For example, Jackson (2009) shows us that with disposable incomes of less than 10,000 – 15,000 dollars per capita per year, income per capita of a country is quite a good statistical indicator of wellbeing. But above that amount we need to pay heed to more direct indices of wellbeing. See figure 2 as an example of one well-being indicator no longer tacking GDP per capita after the 10,000 – 15, 000 dollars point on the graph. Most ecological economists are well aware of this, but meet resistance with policy makers. If they happen to be aware of the need to look to alternative indicators of wellbeing, then they have to make choices, and it is not clear how to do this. The dollar amount was the perfect integrating mechanism, it is easier to stay with this, especially since we think it is well understood.

What makes the conflict worse, is that ecological economists are well aware of the importance of environmental indicators as revealing the conditions under which a
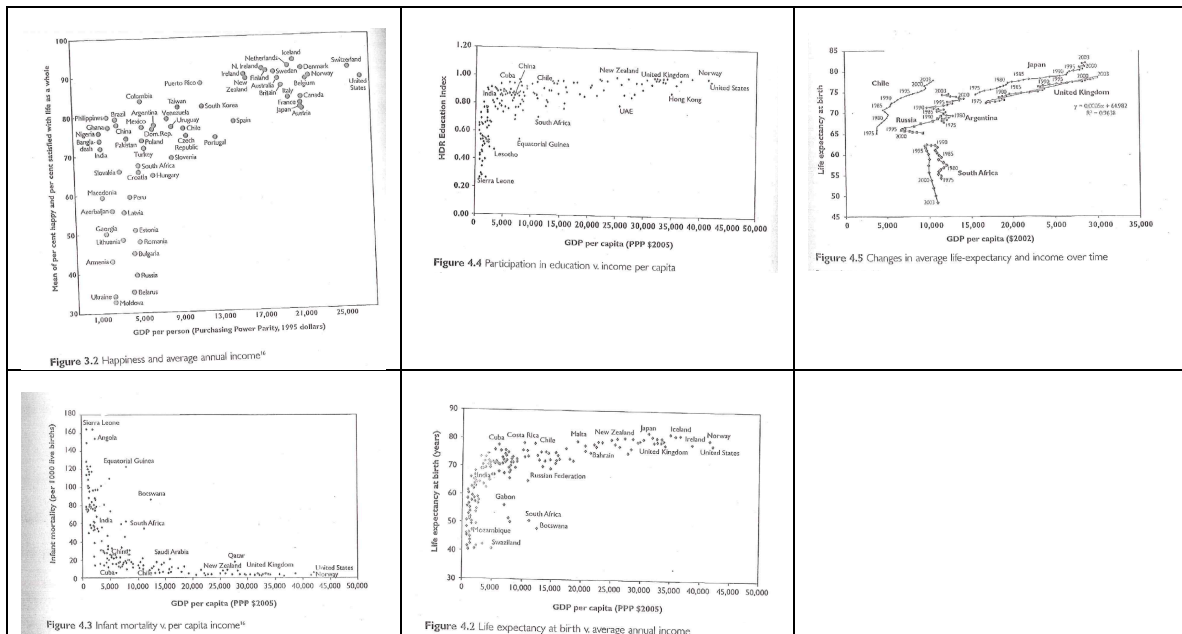

Figure 2.

society has a chance to flourish, and that environmental indicators are not well tracked by GDP pre capita!

It is for reasons such as these that we are interested in aggregating measures of the qualities of human life and environmental indicators directly, and not use GDP per capita. Examples of social indicators are health indices such as longevity, education indices, general well-being indicators such as the happiness index and so on. Examples of environmental indicators are rates of deforestation, pollution of fresh water, changes in temperature and so on. As we all know, when we ignore such indices, and settle for the

measure of income, or GDP per capita, coupled with a zealous belief in economic growth,[3] this leads to disastrous consequences for society and the environment.

However, we should not be too hasty. The policy maker is not wholly wrong, since by using the monetary indicators to guide policy, he, or she, is exempt from immediate blame. This is because he, or she, can point to the economic/ monetary/ fiscal 'reality', and this is a 'hard' number. It therefore, looks objective to us. Moreover, in many societies, we are conditioned to accept this as the 'bottom line'. So much should be familiar.

The problem of tension between the two perspectives is twofold. One has to do with 'simplicity of analysis'. The other has to do with the cultural conditioning that encourages us to accept the monetary story as a justification. If we can solve the first problem, we can go some way to solving the second.

In this paper, I offer an alternative to the monetary justification. 'Aggregated' will mean *one arrow*, not a comparative graph. The arrow will represent the aggregation of the sorts of diagram we see in Figure 1. For purposes of comparing countries, for example, instead of using GDP per capita, we can use the aggregated arrow of each country. Each arrow has a length and a direction on a circle with a radius. See figure 3. Both components: length and direction on the circle bear information. They can be used to make an ordinal comparison of institutions and policies: over time or across other institutions, countries or what have you. The measure of the arrow: length and direction will be robust, i.e., stable and relatively accurate.

So, we shall be aggregating a number of qualities into one arrow. Let us return, then, to the notion of 'qualities', and say a little about the 'method'. In the method, qualities are ranked at two levels, one general, one specific. We start with three very general qualities.[4] They are inspired by[5] the three *gunas* of ancient Hindu literature. The *gunas* are: *sattva*, *raja* and *tamas*. They have been translated as: "The Pure, The

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[3] What I mean by 'zealous belief' is an uncritical belief that necessarily, or *a priori*, if the economy of a society grows that society is better off, well-being has been increased.

[4] We might think of these are meta-qualities.

[5] The use of the *guna* terms is only meant as a conceptual inspiration. It is not meant as a spiritual exercise in Hindu philosophy. The choice of the concepts of the three *gunas* will be discussed in the conclusion.
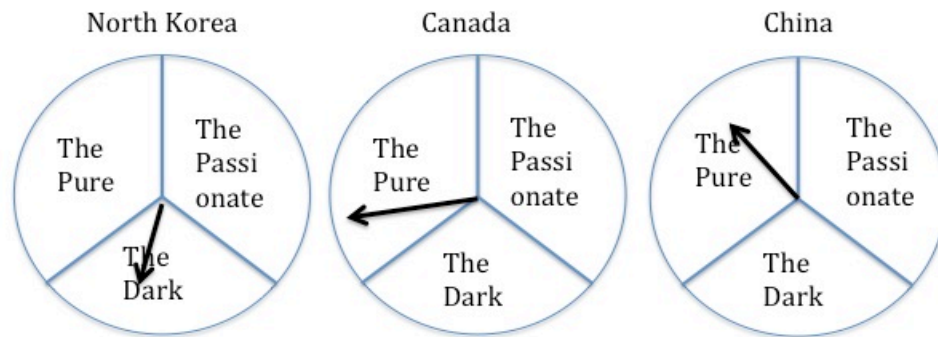
Figure 3.[6]

Passionate and The Dark", respectively. (Johnson, 1994 p. 71), quoted in (Pani, 2009, p.217). Since the three *gunas* are meant only as inspiration for the ideas that follow, we shall use the English translation henceforth.[7] In the method, we divide a circle into three with three radii, and label each third with one of the general qualities. Our arrow will be a 'compass arrow' on a circle divided into thirds.[8] See figure 4.

Each of these general qualities, has sub-qualities. Examples of sub-qualities of The Pure are: pure, good, constructive, respectful, harmonious, pleasant, soft, easy, light, natural, seamless. Examples of sub-qualities of The Passionate are: passionate, active, plush, confused, regal, exciting, sensational, perfumed, exotic, brassy, colourful, showy. Examples of sub-qualities of The Dark are: darkness, destructive, harmful, painful, chaotic, abrasive, constricting, despotic, putrid, diseased, supressing, morbid, violent, invasive.

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[6] I should like to thank Professor Andrea Pedeferri for making the diagrams of the compass.

[7] We use the English translation in order not to offend against religious or academic sensitivities. In their ancient Hindu context, the three *gunas* are meant to be used as spiritual guides to: behaviour, choices and the intentions behind those choices. Here, they are simply taken as very general qualities. The reason they are inspiring is that with a little familiarity and work with the concepts and their sub-qualities, we can quickly and easily identify one of the three *gunas* as predominating in any decision, policy, institution, object or event. They are that general. Almost any quality bearing item (decision, policy, institution, object or event) has one dominating and only one dominating. There can be borderline cases. However, to determine the dominating quality, sometimes, it will be important to qualify the *way in which* we are thinking or seeing the item. We shall return to this.

[8] Lest there be some confusion, let us be clear. The compass does not have North, South, East and West. Instead, it has three thirds. The general qualities give us a general orientation of our arrow.
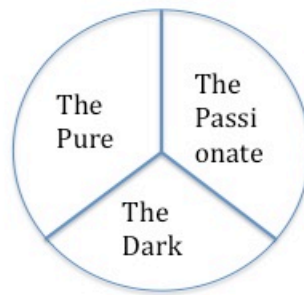
Figure 4.

The importance of the three general qualities is that every object, event, institution or society will have one that predominates. The importance of the sub-qualities is that they will help us choose indicators of the general qualities, so that we can measure the degree to which an object, event, institution or society has the predominant general quality.

Choosing indicators to measure the qualities is sensitive and sophisticated work, and is familiar to anyone working with multi-criteria analysis. But once we have done the work, the justifications for the policies can be as detailed and sophisticated as the choice of these indicators. The method here is Bayesian,[9] and this will bring a certain stability and robustness to the final arrow.

The execution of the method happens 'behind the scene'. But it will be recovered when we use the method to 'justify the policy'. The policy maker can be shown the simple resulting arrow as in Figure 3, to show him that his country is qualitatively worse or better off than other countries. The arrow on the circle is not much more difficult to read than a chart comparing GDP per capita of different countries, and if we want to use the arrow to *develop new policies*, then we can be guided quite specifically in this by looking behind the scene.

We missed 'accounting'. The indicators are statistics. They are just signs that the quality is present. An example of a statistic that indicates The Pure for the world as a whole might be: land-surface of natural environment undisturbed by man. An example of a statistic that indicates The Passionate for the world might be: number of international sports events. An example of a statistic that indicates The Dark for the world might be: number of war conflicts between countries. In the method, we would collect many indicators of sub-qualities, and use a little mathematics to aggregate them into one arrow. But note: we use the arrow, and the sub-quality indicators to *account* for our policy. The accounting method becomes interesting when we use it to watch the arrow change length

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9 Sometimes the word 'evolving' is used since it is a more popular and common word. The idea is that we can up-date the statistic at any time. We shall do this at two levels, and this will require some sophistication of thought.

or direction over time, or when we use it to compare regions, or countries, or institutions to each other. For example, see figure 3 again.

As the arrows change over time, we can track the success of policy decisions, *accounting* for degree of success along two measures: length and direction. It is in this sense that we shall be developing an *accounting* method.[10] We use the length and direction of the several 'aggregated arrows' for *accounting for* and *justifying* our policies. The accounting and justifying can be traced back to the indicators that influence the length and direction of the aggregated arrows. For this reason we have transparency in our accounting. The work behind the scene can always be revealed. We also have a guide as to what to change in order to later influence the direction and length of the aggregated arrow in future policy decisions. The latter will be the underlying causes of the indicators that exert the most influence on the length and direction of the arrow. By addressing the underlying causes we develop new policies that can be tested by comparing direction and length of arrow over time.

2. The UN mandate Used as an Example

In our case, for the sake of illustrating the method, we shall be putting ourselves in the place of policy decision makers in the U.N. We shall be concerned with international relations. However, as ecological economists we are aware of the preconditions for international relations: the earth as a finite physical and biological entity supporting human society.

We shall hold ourselves responsible to the mandate of the UN. That mandate, *in abstracta* will be sufficient for us to develop a first 'prescriptive arrow'. This is the direction in which the UN policies are *supposed* to take us in order to fulfil the mandate.

We then develop our aggregated arrow based on statistics and compare it to the prescriptive arrow. We shall then use the comparison of the two arrows to guide changes in policy and to justify those changes.

To develop our aggregated arrow, we shall choose indicators of international relations and indicators of the state of the environment. For example, international relations indicators of The Pure might be number of trade agreements across pairs of countries. An international relations indicator of The Passionate might be international sports competitions: their quantity, prominence and quality. An international relations indicator of The Dark might be numbers of pairs of countries at war. These are indicators of the state of international relations. But since we are interested in the preconditions for international relations, *viz.* the earth as a whole, we shall also be interested in

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[10] Accounting usually concerns money. We have accounting books and there is a balance sheet. The bottom line tells us if we are in debt or in credit. We shall not end up with this. Instead, the method integrates the many statistical indicators into one 'integrated arrow'. We then develop several arrows over time or institutions for the sake of comparison.

environmental indicators such as: energy, material throughput and waste indicators; biodiversity indicators, such as species extinction or ecosystem health indicators. So, these are the qualities that we shall aggregate to guide future policies with respect to the mandate.

Article 1 of the UN mandate is:

 "The Purposes of the United Nations are:

1. To maintain international peace and security, and to that end: to take effective collective measures for the prevention and removal of threats to the peace, and for the suppression of acts of aggression or other breaches of the peace, and to bring about by peaceful means, and in conformity with the principles of justice and international law, adjustment or settlement of international disputes or situations which might lead to a breach of the peace;

2. To develop friendly relations among nations based on respect for the principle of equal rights and self-determination of peoples, and to take other appropriate measures to strengthen universal peace;

3. To achieve international co-operation in solving international problems of an economic, social, cultural, or humanitarian character, and in promoting and encouraging respect for human rights and for fundamental freedoms for all without distinction as to race, sex, language, or religion; and to be a centre for harmonizing the actions of nations in the attainment of these common ends." [http://www.un.org/en/sections/un-charter/chapter-i/index.html]

As ecological economists, we recognise the preconditions for international relations, and so we add a fourth item:

4.   include: pollution, loss of habitat, human use or destruction of natural resources.


3. The Method, Part 1

(i)   Draw a circle to represent the general quality of the state of the world. We are choosing the jurisdiction of the UN, with our augmented version which includes the environment. Divide the circle into thirds by drawing three radii as in Figure 6

(ii)   Label the thirds: The Pure, The Passionate and The Dark, respectively. See figure 7.

Figure 6

Figure 7

The Pure

The Passionate

The Dark
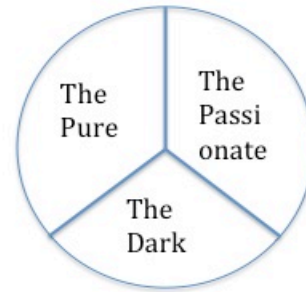
Figures 6 and 7.

(iii)   Think about the mission of the UN. Is the mandate to make the world Pure, Passionate or Dark? If we look at the qualities in the mandate: peace and security, the principles of justice and international law, friendly relations among nations, respect for the principle of equal rights and self-determination of people and lastly, our own addition: the integrity of the non-human biosphere; if we look at these, then the arrow is strongly in The Pure, and since there is discussion of enforcement and law, this moves towards The Dark, since The Dark is controlling. Of course we do not want The UN to become oppressive, and have the arrow move into the third labelled The Dark. But also we recognise that the mandate is not about The Passionate. So we draw an arrow that is quite long, in The Pure third of the circle and with a direction towards The Dark. See figure 8. This is our *prescriptive* arrow, so anything that the UN can do to bring the world in alignment with this arrow is considered to be good policy.
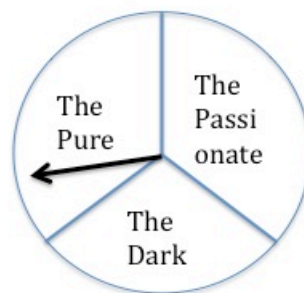
Figure 8

The Pure

The Passionate

The Dark

Figure 8.

(iv)   We now want to make an aggregated arrow for purposes of comparison between what we would like to be the case (the prescriptive arrow) and what is the case, the aggregated arrow. For this we shall need some statistics and indicators about the qualitative state of the world.

(v)   We now choose indicators of each of the general qualities. Start by work within one of the thirds, say, The Dark since this is the easiest. Choose, say, two, international relations indicators and two environmental indicators: pairs of countries at war, number of countries that have the death penalty (since this violates human rights), number of bird, reptile, fish or mammal species made extinct in a year, amount of deforestation.

(vi)   For each indicator, we should decide on a minimum and maximum. The percentage within that minimum and maximum will determine the length of the arrow. A minimum for warring nations is 0. A maximum is probably less than the total number of pairs of countries in the world. So, say, the maximum number should be somewhere around the maximum we have ever had at one time. Pairwise, this might be 30. How many pairs of countries are at war presently? 10. So the arrow will have a length of 1/3 of the radius of the circle. Using these numbers we fill in a box that represents the length of the arrow relative to the length of the radius of the circle, as in figure 9.[11]

General Quality	Indicator	Minimum	Max	Actual
The Dark	Warring nations	0	30	10
The Dark	Countries with death penalty	0	30	32
The Dark	Species extinction	3	100	100
The Dark	Deforestation (acres)	8,000	2,000,000	100,000

Figure 9.

(vii)   We now want to think of the direction of the arrow. Are the wars for reasons that would move it towards The Passionate, that is, based on ideological differences, or over power and imperialism, or are they trying to ensure basic livelihood, access to resources, rights. In the former case, the arrow will move

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[11] This might look a little alarming, since arbitrary and subjective. There are two points to note on this. First, we do this all the time. We choose a statistic *because* we think it is significant. It shows us something qualitative. Second, the maximum and minimum is determined, as with all representations of statistics on a nice table or on a graph, by what will fit nicely on the page, or in the box. Statistics are used for comparative purposes. We want to *show*, or clearly *represent* the differences. To do this, we very naturally decide on a scale of maximum and minimum. See figure 1!

towards The Passionate, in the latter case, the arrow will move towards The Pure. We shall return to the obvious subjectivity involved in making such judgement and representing it using a direction of the arrow. Regardless, this will give us direction, represented as degree around the circle. This is the last box for the indicator in figure 9.

Do the same for the other indicators. Represent each indicator with an arrow that is in a particular third, and within that third, has a length and direction. See figure 10. Note that there are 4 arrows in each general quality, each representing a different indicator.
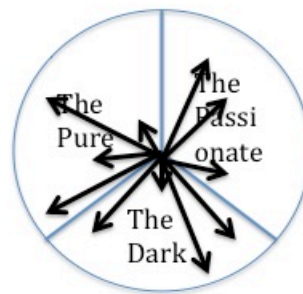

Figure 10.

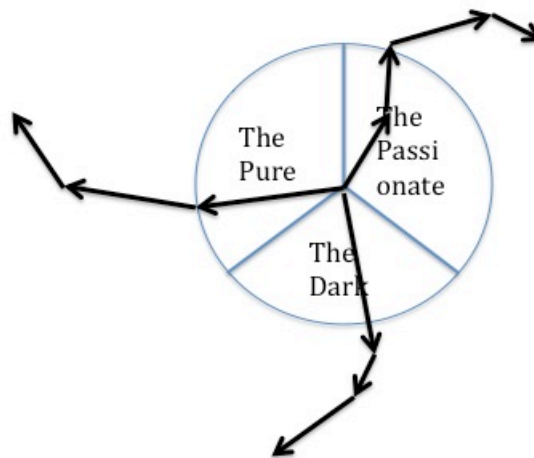(viii)   Within each third, add the vectors. See figure 11.

Figure 11.

(ix)   We now have a jointed arrow in each third. Draw a triangle linking the three end points of the arrows as in figure 12.[12]
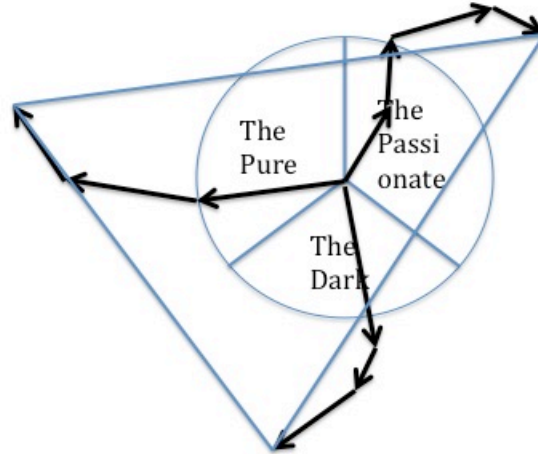

Figure 12.

(x)   Erase the vectors. See figure 13.

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[12] The following is a very nice question: why draw a triangle, rather than just adding all the vectors together? There are three reasons. One is that there is a connection between the three general qualities. One slides into the other. If we are too occupied with The Passionate, then we are in danger of slipping into The Dark. We might do this to recover lost passion, to control the situation. If we are less interested in The Passionate, we normally slide towards The Pure. There is a connection between The Pure and The Dark as well. The pure can become boring, or even restrictive and oppressing, for example, if we have to be vegetarian, grow our own food, make our own clothing, we might find this arduous and unpleasant. The movement also does not go only towards The Dark. A period of life in The Dark, can lead to wonderful creativity, to The Passionate. It can also lead to The pure, since we realize how lucky we are if we escape. The second reason is more technical. It is that arrows that are diametrically opposite will cancel each other out under vector addition. If we are looking at qualities this will not make much sense. For example, if we were to discover that the number of suicides was off-set by the number of people taking showy athletic classes, this would not make much sense. It would be worse if together cancelling arrows are of very different types, one is a social indicator and one is an environmental indicator. Nevertheless, we want to aggregate all of these to give one arrow. The last reason is that to justify, judge or test policy it is better to keep the thirds conceptually separate. If the arrow is too much towards The Dark, then we want to find out not only how to lessen the aggregative influence of the arrows in The Dark, but also increase the arrows that pull away from it most.
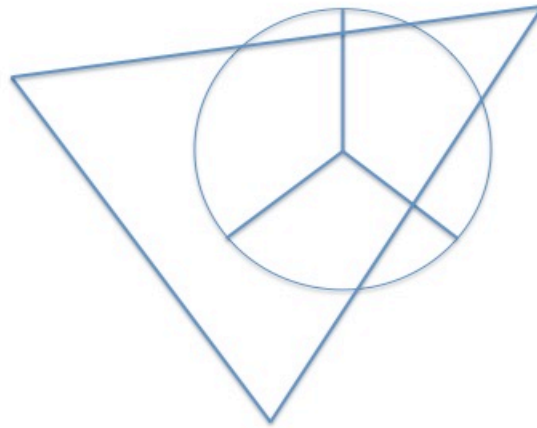
Figure 13.

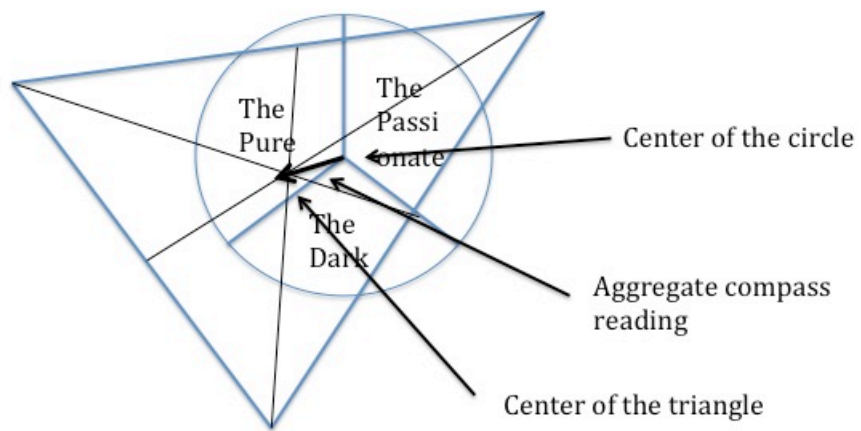(xi)   Find the centre of the triangle. See figure 14.

Figure 14.

(xii)   Draw an arrow from the centre of the circle to the centre of the triangle. See figure 15.
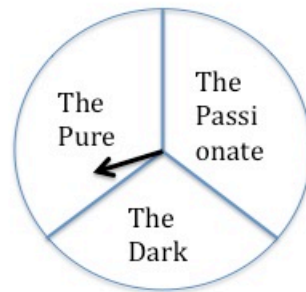
Figure 15.

(xii) This is the aggregated qualitative compass reading according to the mandate of the UN, and *given* the particular indicators we chose, together with the weighting and direction we thought represented that indicator. We now have to do some more sensitive and philosophical work, since we were working with a first approximation, and choosing indicators quite randomly. So the arrow has to be tested for robustness and stability. The robustness is necessary for the policies to stand up under scrutiny and for them to be effective over time.

4. Two Orders of Sensitivity Concerning the Method: Adding Robustness

The first order of sensitivity concerns general issues with statistics. For example, we want to up-date the information in close to real time. So we update the number in the box after the minimum and maximum. There is no reason to do this for all of the indicators at the same time. After all, some of the statistics are quite time-sensitive, and fluctuate quickly. Others are more stable. We might then even look at time-lapses between development of policies and changes in the statistic. Some problems are urgent and can be addressed swiftly, such as a food shortage. Others take much longer, such as controlling an epidemic. Others take still longer such as restoring ecological systems. Up-dating the information is important for robustness of the indicator. It is common to the Bayesian approach to statistics. This will be important for the robustness of the compass reading, since the updating will overcome our initial guesses about the minimum, the maximum, and the further quality of degree on the circle. But there is other philosophical work to be done.

We return to the initial development of the arrow. We are interested in getting an accurate aggregated arrow. Another general issue at this first order of analysis is that chose two indicators for each third of the circle. Those indicators might not be representative of the success or failure of the UN in achieving its mandate with respect to the general quality, or of the state of the world with respect to the general quality. Ideally, we would then add more indicators. We fill out more boxes and have more arrows representing the numbers in the boxes.

A third general issue is that the quality of the data might not be very good. Sometimes it is quite difficult to get reliable information. We know how to get better information in theory, but it is not always feasible to do so. If the quality is suspect, then the indicator should probably be omitted. But, at this stage, we want to include the same number of indicators in each third of the circle. So, if we take one indicator away from a third, then we should take one away from the other thirds as well. Otherwise we shall have a deceptive distortion in the final arrow.

The second order of sensitivity belongs to what is referred to as 'second order science', 'meta-science' or 'cybernetics'. We might call the following 'second-order Bayesian' analysis. The second-order problem is that we might want to revisit our statistics themselves, not add or subtract some, but change them a little. For example, we might discover that the wording of the statistic is not refined enough. We might want to separate the cases of wars between those strictly between two countries and wars with alliances between several countries. Maybe this is because one is more 'important' than the other with respect to the UN mandate. This re-visiting of the choice of statistics and refinement of the choice is a second-order of sensitivity. Initially, this takes practice and feel, but as we develop our skills in choosing indicators, and as the statistics we choose are more reliable, the arrows representing their aggregation will also become more robust, that is, less inclined to swing or change direction, with additions or subtractions of information. After our second-order analysis, at some point, adding more indicators should no longer make much difference to the length or direction of the aggregated arrow. This also constitutes robustness of the method. So, if the arrow is still changing, then there is more work to do, and the work might have to be done at one or both levels of analysis. There is another aspect to this second-order of analysis.

Once we have a robust aggregated arrow, the interesting and revealing work begins. We use the arrow for two related reasons. We use it for comparative purposes. If we represent the UN, and are using the arrow, we might be interested in our success as an institution over time. So we would compare arrows in different years, or better over different decades. We can make retrospective arrows too, provided we have the statistics. We might also compare world regions or countries in order to give priority to policies that address those areas. More important, we might use the arrow to account for our policies and determine whether or not they were successful. Before we discuss this in more detail in the final section, we can do a little more philosophical work on the method. It can be generalised in several ways.

5. Broadening the Conceptions

Having honed our skills, we might want to revisit the larger picture of the circle itself. We do not have to use the three general qualities. The point is to aggregate indicators of general qualities that we are concerned about. We could have others. For example, we could have The Environment, Society and Economy. Or, Intrinsic Value, Use Value and Exchange Value. Making up three general qualities is deep philosophical work, but not

impossible. Moreover, we do not have to be wedded to the number three, for the number of general qualities. However, if we divide the circle into four, this will give the wrong sort of results since we would draw a square, not a triangle, and the geometry will suggest that there are clear *opposite* indicators that will cancel each other out. This might be the intention, but if we do not have this idea of strictly pairwise-opposing qualities,[13] then we would have to move to more dimensions. That is, if we have four general qualities, we would work on a 3-dimentional sphere, if we had five qualities, we would need four dimensions. The mathematics is there to accommodate the aggregation, but the pictorial representation of three or more dimensions is more difficult to understand, so it becomes less useful for policy makers. In other words, the number and particular general qualities is conceptually independent of the general mathematics used for the aggregation, but three is easy to represent.

Another consideration about the circle is that we might not divide the space between the three qualities evenly. Equivalently, we might have more indicators in one third than in the others. This would reflect our greater concern with one general quality over the others. Similarly, in our example, we chose the circle to represent the UN mandate, and we chose an equal number of environmental and social indicators. We can change that too. If we think that the environmental point is a *sine qua non* for the social indicators, then we might want to emphasise it over the other points. How can we do this? One way is to choose more environmental indicators than social indicators in each third. Equivalently, we could increase the length of the arrows representing environmental indicators, by playing with the minimum and maximum numbers in the boxes. Equivalently, we could make that segment of the circle smaller than the other two segments. These methods are equivalent to each other and should be chosen according to what is more intuitive in the final representation. But we should be careful about these new adjustments to the circle, since they will make justification and policy guidance more refined, sensitive and nuanced, so harder to explain, more complicated to justify, and more difficult to use as an accounting tool. Nevertheless, such discussions are scientifically and philosophically useful, and should be had, in order to add depth to the justification for the resulting policy, or critique of a policy. The method is *meant to* draw out such discussions.

6. Uses of the Aggregated Arrows, Policy Change and Policy Justification: Qualitative Accounting

How do we use the method and the arrow to justify, judge and modify policy? Remember that we set up an initial arrow that was the prescriptive arrow, indicating where we think the UN mandate indicates as a good direction for the world. We then compare this to the aggregated arrow. If we are unsatisfied by the direction and length of the arrow, we should change our policies. We do this by looking back at the specific indicators. Which ones were influencing the aggregated arrow most? Which ones were pulling it away most

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[13] For some uses of the compass it might be a good idea to have strictly opposing general qualities, but this is what we tend to do already, and it is not refined enough for some applications.

effectively from our goal? We can then address the statistic straight on, or we can look to the underlying causes. If we think that the integrity of the biosphere is a precondition for the other points in the mandate, then we might look to see if there are environmental causes: conflicts over scarce natural resources, for example. We then justify policy change by referring exactly to the statistic and its underlying causes. This is true qualitative accounting. We account for our actions and decisions, by reference not only to particular piecemeal considerations, but by referring to a wider picture, an integrated analysis.

Similarly, if someone wants to *challenge* our policy decision, or *judge* a policy, he, or she, can be quite specific in his, or her, criticism along the lines of the first and second orders of analysis outlined above. For example, he, or she, might challenge a particular statistic as representative of, say, an indicator The Dark. Each step in the method is a justification, and is vulnerable to criticism. But it is under this very focused criticism that we gain in understanding and robustness of our decisions. The second-order science approach is reflexive. It is the interaction between the hard facts – the statistics, and the increased understanding of what the statistics indicate qualitatively and what they contribute to the whole picture that is important. The method helps us to *develop* this reflexive refinement in our analysis.[14] The parts of the method that add robustness should not be overlooked. They are what help to shore up the qualitative aspect.

'Developing justified policies' is where, once we have robustness, we monitor changes over time or across comparison groups, with the implementation and enforcement of policies. New policies should be designed to change length or direction of the descriptive arrow. If they fail to do this, then we revisit the policy with reference directly to the indicators, again at the first and second levels of analysis. This is not much more complicated than comparing GDP per capita, and it is a much more sophisticated, scientific and accurate way of developing and justifying policy decisions.

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[14] The other aspect of second-order science that is important is the inclusion of the observer, or scientist. The person or committee who is making the aggregated arrow has biases and preconceptions. They are culturally embedded. One of the redeeming features of the method is that it draws this out. We often suppress or overlook this information when we engage in analysis of this sort. But it is wholly important. Who we are, and how we see a statistic, what sort of quality it suggests, whether we are alarmed or indifferent, depends on our personality, our culture and our selves. Self-awareness is therefore also very important. However, we find it alarming to think about because we want to consider ourselves to be 'scientists', and we are taught that 'scientists' are detached observers. This is a myth. It is true only in some very rare cases of science. (References?) It is better to admit this up-front and face it.

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