

# The economy is not a toaster

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**Abstract.** Every engineering discipline, including system engineering, is based on a number of assumptions. These assumptions are often unstated, usually taken for granted and seldom scrutinized for their validity. These assumptions also predetermine the range of applicability of that engineering discipline. This paper clearly identifies the taken-for-granted assumptions of system engineering, and tests their validity against a range of typical application areas. This investigation will clearly delineate the applicability area of system engineering.

## The economy is not a toaster

model      a simplified physical or mathematical representation of reality, as used in science or in economics

Webster's Unabridged Dictionary, 1999

The principle of a hierarchy states that all systems exist in a multi-layer hierarchy, and that the principles valid at one layer are equally valid at all other layers. Nevertheless, extreme care is needed in applying this principle since it contains a hidden danger.

A toaster may properly be viewed as a system, although a very simple one. The economy of a country may also be viewed as a system, although a much more complex one. Hence, by the principle of a hierarchy, if Vusi is an expert at repairing toasters, he will also be able to fine tune the country's economy. In other words, system engineers can handle any system, simple or complex.

It is perfectly true that the economy may be viewed as a system, and that the economy can at least partially be modeled as a system. But does that mean that the economy actually is a system? And since a toaster can also be viewed and modeled as a system, does that mean that a toaster also is a system, and that the economy is thus similar to a toaster?

There are fundamental differences between a toaster and the economy. For instance, the toaster's user has a simple objective: Rapidly and safely toast bread to a selected brownness level. But what is the objective of an economy? To grow the gross domestic product? Or to grow the gross domestic product without degrading the environment? Or to grow the gross domestic product per capita? Or to eliminate poverty? Or to reduce unemployment? Or to improve the quality of life for the citizens? These are all worthwhile objectives. An economy has a large number of diverse stakeholders each having completely different objectives. Most of the issues surrounding economics arise because of disagreements about objectives. These disagreements usually cannot be resolved, but through political bargaining a temporary compromise can hopefully be achieved.

At higher levels in a hierarchy, for instance an economy, there are many more stakeholders with many more diverse and inherently-conflicting values than at lower levels, for instance a toaster. As one moves up the hierarchy, the toaster's technical problem is transformed into the economy's socio-political problem. Mastery of toasters is self-evidently a poor preparation for negotiating next year's objectives for an economy.

## **Solving unstructured problems**

In the case of a toaster, *what* is required is easy to define, the question is *how* best to achieve it. It is a well-structured problem, since the objective-defining part of the problem is trivial. On the other hand, for an economy there is no agreement on objectives and on measures of performance, making it an ill-structured problem. This lack of agreement is not simply due to poor understanding or an information scarcity, but is fundamental. It may be due to incompatible ways of viewing the objectives, as outlined above. It may also be caused by the taken-for-granted mental model of the economy as an objective-satisfying system. That may itself be false, since we have seen that an economy's objective is merely to maintain a dynamic balance between a set of incompatible objectives. It is a messy and ill-structured problem.

## **Soft system methodology**

Over a thirty years period Peter Checkland of Lancaster University has developed the so-called soft system methodology to solve ill-structured problems. Hard system thinking, such as traditional system engineering, tackles well-defined problems, for instance optimizing the output of a chemical plant. Soft system thinking is more suitable for poorly-defined problems, for instance determining a health care policy in a resource-constrained situation.

This difference between hard and soft system thinking is not untrue, but it fails to make a clear intellectual distinction between them. Hard system thinking assumes that the world is a set of systems and that these can be systematically engineered to achieve objectives. In contrast, soft system thinking assumes that the process of inquiry into problematic situations can be organized as a system.

In other words, the assumed systemicity is shifted from taking the world to be systemic to taking the process of inquiry to be systemic. That is a fundamental shift (Checkland, 2005).

## **This is not a pipe**

To confuse a mental framework, for instance a system, with the reality it attempts to imitate, for instance an economy, is inexcusable. As a sociologist once wrote "... there is a depressing tendency for social theorists to discuss the nature of social theory rather than the nature of social reality."

In 1928 the Belgian surrealist painter René Magritte painted a pipe with as title *This is not a pipe*. He explained this apparent paradox as follows:

"The famous pipe. How people reproached me for it! And yet, could you stuff that pipe? No of course not, it's only a representation of a pipe. So if I had titled my painting 'This is a pipe', I would have been lying."

The key point is that the painting is not a pipe, but rather an *image* of a pipe.

Many system engineers have never learnt that fundamental lesson: A model is not reality, but only a representation of reality. Most system engineers' wives don't look like Naomi Campbell or Penelope Cruz, and neither do they expect them to. But for some reason most confuse a model of reality with reality.

Pygmalion, the king of Cyprus, sculpted an ivory statue representing his ideal of womanhood, and promptly fell in love with her. In answer to his prayer, the goddess Aphrodite brought the statue to life, and named her Galatea.

Ovidius, *Metamorphoses*, AD 8

## The moon-ghetto metaphor

System engineering has had phenomenal success whenever applied, for instance Project Apollo in the 1960s put a man on the moon and brought him safely back. So successful was system engineering that a simple question soon arose: "If we can put a man on the moon, why can't we solve the social problems of city slums?" The system engineering approach would be the solution to social problems such as endemic poverty, dysfunctional health delivery systems, intractable traffic congestion and decrepit public housing. The transplant of tools from technical to social matters was seen as merely the latest example of the inexorable progress of scientific management. *Here* was a large pool of system engineering skills and *there* was a mess of problematic social systems. All that was missing was the will and the way of matching them.

In 1965 US President Johnson launched his plan to achieve a Great Society by enacting a torrent of liberal social legislation covering civil rights, education, housing, social security, medical care, conservation and urban development. James Webb, the NASA administrator, developed a concept called Space Age America where science and technology were to be harnessed for peaceful purposes, and for solving social and environmental problems.

In retrospect this approach became known as the so-called moon-ghetto metaphor: "If we can put a man on the moon, why can't we ...?" A ghetto of course is a densely-populated slum. Why don't we substitute technocratic expertise for irrational and biased political decision making processes? The allure of the moon-ghetto metaphor was so seductive that it was soon used. Experience soon proved that the methods that had worked so well on hard engineering problems fell apart when given a chance to show their worth on social problems. The assumption that methods capable of getting a person to the moon could with advantage be used on such lesser matters as solving the problems of inner city ghettos, turned out to be a delusion.

The temptation of the moon-ghetto metaphor has not died. As recently as November 2007, Fred Thompson, a US Republican presidential hopeful, stated: "How long has it been since we put a man on the moon? Yet we cannot secure our own border against illegal immigrants."

## Hard system approach versus soft system approach

The differences between the hard system approach and the soft system approach are summarized in Table 1 (Rosenhead 2001). The soft system approach tackles what are sometimes known as "wicked problems". The most demanding issue is to determine what the problem is. Different stakeholders have different priorities. Such issues are not resolved by a single decision-maker, but by group decision-making. In contrast, the hard system approach has been characterized as "mathematically sophisticated but contextually naïve" (Open Systems Group 1981).

Table 1: Differences between hard and soft system approaches

<i>Hard system approach</i>	<i>Soft system approach</i>
A single decision-maker exists	Many stakeholders exist, but no single decision-maker
Stakeholders are passive participants having complete consensus	Stakeholders are active participants with consensus achieved through an extended bargaining process
Problem statement is independent of stakeholder views and beliefs	Problem identification and objective definition depends entirely on stakeholder perceptions
Optimize a single objective. Multiple objectives can be traded off on a common scale	Stakeholder objectives are conflicting and incommensurate. No optimum exists. Seek a solution that more or less satisfies most stakeholders

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## Biography

Ad Sparrius has been awarded four degrees -B Sc, B Eng, MSEE, and MBL, and is professor extraordinarius at UNISA's Graduate School for Business Leadership. Ad got involved in system engineering during the late 1970s, and has been passionate about that discipline ever since. Most of South Africa's system engineers had their initial system engineering and project management training with Ad Sparrius.