## What constitutes a “good” model?

### A model is a representation of reality

A model can never equate, in scale, detail, or complexity to that which it purports to represent. In the event that such an accomplishment were possible, then there would be no advantage to be gained from studying the model as opposed to the reality itself. Korzybski reminds us that “the map is not the territory” (Korzybski, 1931), distinguishing between the model and reality. A mapping of reality does not become a model, however, until it is externalised and formally stated, thus allowing it to be subject to independent scrutiny (Pidd, 1999).

### A model reflects one of many possible interpretations of a real scenario

Model construction and interpretation are coloured by an individual’s unique set of values, beliefs and biases. Ideally, any prejudices incorporated into the model should be those of the intended users of the model, as Little points out in his description of a model as a “decision calculus” (Little, 2004). It is prudent to talk of a model’s output in terms of expectation, perhaps based on experience and with reference to the model assumptions, but always mindful of the advice of Barabba, in what has been termed Barabba’s Law: “Never say the model says” (Barabba, 1994).

### A model should strive for simplicity as well as simplification

The tendency to complicate models, perhaps arising from fear of omitting some critical component, is well documented, with Salt describing it as “bagatellomania” (Salt, 2008) before suggesting that it is easier to add detail than to remove it. Wahlström (Wahlström, 1994) and Little (Little, 2004) both extol the virtues of including only information that reveals a system’s most salient features, whilst Vaandrager applies the principle of ‘Occam’s razor’ in stating that “among models with roughly equal predictive power, the simplest one is the most desirable” (Vaandrager, 2014). ‘Importance’ may be deduced from the model’s purpose (Pidd, 1999), although one must balance ‘simplicity’ with ‘completeness’, particularly with respect to the more qualitative components of a model (Little, 2004).

### A model should be well framed

“A problem well put is half solved” (Dewey, 1938), although Einstein goes further, having reputedly declared, “If I had an hour to solve a problem, I’d spend 55 minutes thinking about the problem and 5 minutes thinking about solutions”. Appropriate problem structuring is crucial in optimising a model’s level of detail (Pidd, 1999) and also incorporates Williams’ inducement to make use of “formal, theoretically based languages” (Williams, 2008). The expression of a problem in terms of recognised algorithms or previously published work has the potential benefit of permitting a sense of familiarity with the workings of the model, a quality that Morris calls “relatedness” (Morris, 1967).

### A model should have a (specific) purpose

A good model should have a clearly stated object and purpose , although Pidd contends that one does not imply the other (Pidd, 1999) and several purpose-specific models are preferable to a single multi-purpose one (Vaandrager, 2014). Willemain also favours the creation of “a unique model for each problem” (Willemain, 1994). Simplification and specificity are fused in Phillips’ “requisite model”, defined as “a model whose form and content are sufficient to solve a particular problem” (Phillips, 1984). Landry *et al* (Landry, Banville and Oral, 1996) and Wahlström (Wahlström, 1994) note that a model’s purpose incorporates elements of knowledge creation, thought promotion, increased understanding and decision support.

### A model should be useful and usable

Misleading output is undesirable, but so too is that which might be anticipated, since no fresh insight is gained (Wahlström, 1994). The usefulness of a model is tied inexorably to the conditions that led to its creation and so a change of ownership, scenario or environment may prejudice the model’s value (Phillips, 1984). For a model to be ‘usable’ the user interface must be sufficiently intuitive (Little, 2004), although there is a trade-off between usability and adequate intricacy (Landry, Banville and Oral, 1996). Usability may also be affected by less obvious factors, such as financial and resource implications (Gass, 1987).

### A model should be flexible

A model may be considered flexible by virtue of adaptability or extensibility. The division between these two properties is somewhat blurred, but adaptability connotes evolution of capability with retention of original objective, a feature advocated by Little (Little, 2004). Extensability, conversely, implies a branching of purpose either by progressive growth of the original model, or preferably by seeding a generation of related models designed for application to a class of similar (yet unique) problems (Vaandrager, 2014).

### A model should be robust and produce valid results

A robust model is one that is capable of tolerating deviations from the underlying assumptions to some satisfactory degree (Morris, 1967). Little offers a more pragmatic description: “Robust. Here I mean that a user should find it difficult to make the model give bad answers” (Little, 2004). Validation requires that the output of the model is a plausible portrayal of the system of regard (Wahlström, 1994), although the validity is dependent on the subjective appraisal of the model’s output by those who engage with (Landry, Banville and Oral, 1996).

### A model should be transparent

Salt warns against concealing the underlying workings of a model, (“the black box mistake”) (Salt, 2008) because, as Pidd concurs, hidden mechanisms may engender distrust of the model (and/or modeller) (Pidd, 1999), potentially rendering the model useless.

### Putting it all together

In an attempt to rank some of the qualities above, Willemain asked “twelve selected expert modelers” to list the “qualities of an effective model” in order of importance (Willemain, 1994). The summary of responses was as follows: “1) validity, 2) usability, 3) value to the client, 4) feasibility, and 5) aptness for client’s problem”.

Finally, in contemplating the desirable features of a model, Vaandrager (Vaandrager, 2014) offers the following thoughts:

“Often, the criteria are hard to meet and typically several of them are conflicting. In practice, a good model is often one which constitutes the best possible compromise, given the current state-of-the-art of tools for modelling and analysis. But a truly beautiful model meets all the criteria!”