

Advice on exploring the EM archive

Many different characterisations have been given for the products of EM. Sometimes they are referred to as 'models', sometimes as 'artefacts', sometimes as 'construals'. There is a natural tendency amongst computer scientists to interpret them as 'programs'. Contrary to the first impression of every sceptic, the way in which papers on EM elide from one interpretation to another without ever giving a formal characterisation is not a sign of sloppiness. It is - if rather paradoxically - a sign of integrity. In this context, 'model', 'artefact', 'construal' and 'program' are *mere* words that express - in a manner that is exceptionally difficult to make formally precise - particular types of semantic relationship between something generated using a computer and something that can be experienced independent of the computer (some form of *referent*). The interactive experience that an EM product potentially offers to me can indeed be seen as evoking relationships of just such types. It can be a *model* in so far as interactions with it closely correspond to interactions with its referent. It is an *artefact* in so far as it has been constructed by me as a physical entity in such a way as to offer me experiences of a certain kind - visual, auditory, or otherwise engaging the imagination. It can be a *program* in so far as it supports stereotypical interactions that admit standard interpretations and engage with the external world in carefully specified and rehearsed ways. It is a *construal* in so far as it embodies relationships that are being or have been discovered by me in the course of extended exploratory interaction and to which I am still speculatively trying or by now have decided to trust as explanatory of interactions observed in the referent.

Some standard objections

There are standard objections to the perspective on EM offered above. One might be that everything we program on a computer is necessarily programmable on a Turing machine, hence conceptually reducible to an algorithm, *ergo* any pretence that EM has potential as an alternative "science" of computing is pure fantasy. Another might be that if I am not prepared to venture a formal definition for an EM product then we need not waste any more breath on discussing it, since formal definition is the bedrock of theory, and theory is the bedrock of science. Perhaps for many people this is sufficient reason *not* to explore EM practice further, or at any rate to dismiss any expectation that it can offer any more insight into the essence of computing than any other aspect of its ubiquitous practice can afford. Seen in this light, EM is just "modelling with spreadsheets", "programming with dependency", "a restricted variant of equational programming", "an example of a design pattern that is useful in certain contexts" etc.

In putting these objections into perspective, the most important first step is to engage in practical construction using EM principles and tools. This appeal to practical engagement with phenomena in the world imitates the stance from which a physicist such as Feynman counters the idea that physics is more than mathematics. The bedrock of science is not to be sought in words and formal definition, but in interpretation and interaction with the natural world. Of course, as commentators such as Brian Cantwell-Smith have observed, it is hugely problematic to transpose such a vision of science to '*computing* science'. It is also clearly hugely pretentious to suggest that EM has any special claim to significance in this connection. Nonetheless, the endorsement or refutation of this claim is not a matter of abstract argument, but of practical experiment.

EM artefacts are not primarily programs

In interacting with the models from an EM perspective it is vital to appreciate that a model is not to be interpreted merely as a traditional program. This can itself pose a difficulty, since a model may be presented in such a way as to invite interpretation as a program. A helpful analogy may be drawn with the interpretation of a piece of music. A musical score admits a standard interpretation through which it specifies precisely how the performers should act out their roles. In this respect, it resembles a program. But whereas the execution of a program is typically understood with reference to fulfilling some function, the score is intended to offer an aural experience from moment-to-moment. The engagement of the human interpreter with the score can then resemble that of the composer in

relation to an unfinished composition, or instrumentalist in relation to an imperfectly rehearsed performance.

