Conclusion

This treatise has collated practical evidence to support the controversial proposal that (within the broader framework of the Empirical Modelling (EM) framework) MWDS can play a central role in a radical shift in perspective on computer use. Much of the evidence has been drawn from the work of project students and research students who are primarily interested in model building for its own sake, rather than in deep issues about empirical access to knowledge and meaning. Whatever the philosophical stance of these students where computation is concerned, the products of their model building and the nature of the model building activity reflect the characteristic features of MWDS as identified in this treatise. These include:

- the primitive state-based perspective within which dependencies amongst observables are recorded (cf. Section 1.6);
- the absence of boundaries to models and the discretionary nature of the constraints on model behaviour (cf. Chapters 3 and 5);
- the conceptual continuity in change that accompanies the evolution of a model (cf. Sections 3.1 and 5.2).

As Chapter 3 has illustrated, their models feature exceptionally rich definitive models of state, reflect a wide range of agent perspectives and applications, and raise several novel issues where development, organisation, management and use are concerned. The choice of models also indicates a common perception that MWDS has unrealised potential for more accessible use, subject to improvement in the supporting tools. In so far as this treatise documents this previous model-building activity, it brings together a body of uncontroversial ideas about MWDS that has been the primary source for project work in the EM tradition over the last fifteen years. In the process, it helps to enrich our understanding of the observation-dependency-agency framework, to clarify the model-building principles, and to document some of the problematic issues for the tools.

Prior to this treatise, much research in EM has been devoted to how the virtues of MWDS can be practically exploited in practical applications. Key topics include: concurrent systems modelling [BNS88, BNOS90, BACY94], computer-assisted collaborative working in engineering design [BACY94a, FB01], computer-based system development [BC92, BACY94b, BS98, BCRS99], and computer support for education and business [Bey97, BRR00, CRB00]. Although this research has not focused on the underlying principles behind the use of MWDS, it has arguably generated much circumstantial evidence for a fundamental distinction between MWDS and traditional conceptions of programming. Relevant topics that have been discussed at length in previous publications include: the 'necessarily' informal nature of an LSD account [Bey87, BN87, BN88, BNOS90], the scope for using MWDS to support modelling activity that has a subjective quality characteristic of the creative arts [Bey01], and the 'essential' conflict between theoretical and practical perspectives in several areas of computer science, such as AI, databases and programming [Bey92, Bey93, BCY94, Bey99]. These related researches, which develop the application of MWDS beyond the scope of this foundational treatise, supply significant additional context for the discussion throughout (and especially for Chapters 5 and 6). An important contribution of this treatise is that it, in turn, consolidates on the background ideas and resources on which much previous research has drawn.

An evident weakness in our work on MWDS to date is the general lack of empirical evidence – and in particular the absence of independent evidence from external groups of modellers and users – to support our account of its key characteristics. The 'real' applications of MWDS have so far been limited to Cartwright's proposed deployment of the JaM2 API [Car98] in broadcasting applications at the BBC, and the use of the Temposcope discussed in Chapter 4. Such exercises in comparative software development as we have conducted [Sun99, Chen02] tend to confirm the difficulty of relating MWDS to alternative approaches (such as object-oriented development). This serves only to distance our work from existing practice, and potentially represents a serious obstacle to wider dissemination and adoption. This problem may be partially addressed by the development of open source versions of our tools and a web repository for models.

As a computer-based model-building approach, MWDS may have particular relevance in the future where Gooding's agenda of understanding empirical access to knowledge, meaning and reference is concerned. One of the motivations for Gooding's concern about received philosophies of science is the significant use that physicists make of computer simulations in experiments, and of the distinction between observational data and the data in their computational models. In Gooding's view:

> "The failure of computational approaches to deliver real discovery programs – to make discoveries with data that is as 'raw' as the stuff scientists work on – is largely due to the fact that most work with the impoverished notion of discovery still favoured by analytical philosophy." [Good90, p. 5]

The concern highlighted in this treatise is whether the traditional computational foundational framework supports the philosophical and practical stance that Gooding advocates. The further investigation of this controversial issue has an important bearing on the potential future applications for the computer as a medium for simulation and communication.