Preface

Realistic and immersive simulations of land, sea, and sky are requisite to the military use of visual simulation for mission planning. Until recently, the simulation of natural environments has been limited first of all by the pixel resolution of visual displays. Visual simulation of those natural environments has also been limited by the scarcity of detailed and accurate physical descriptions of them. Our aim has been to change all that. To this end, many of us have labored in adjacent fields of psychology, engineering, human factors, and computer science. Our efforts in these areas were occasioned by a single question: how distantly can fast-jet pilots discern the aspect angle of an opposing aircraft, in visual simulation? This question needs some elaboration: it concerns fast jets, because those simulations involve the representation of high speeds over wide swaths of landscape. It concerns pilots, since they begin their careers with above-average acuity of vision, as a population. And it concerns aspect angle, which is as much as to say that the three-dimensional orientation of an opposing aircraft relative to one's own, as revealed by motion and solid form.

The single question is by no means simple. It demands a criterion for eye-limiting resolution in simulation. That notion is a central one to our study, though much abused in general discussion. The question at hand, as it was posed in the 1990s, has been accompanied by others. Questions of the visibility of vehicles and features of the landscape (air-to-ground issues) have taken precedence over questions of the speed and direction of other aircraft (air-to-air issues). Other questions have arisen about the visibility and comprehensibility of landscapes seen by new spectra (issues of night vision and infrared imagery) as well as questions of the geographic fidelity of simulation in synoptic view (issues of photogrammetry and mapping). All this will enable us to see better in simulation. (The answer to the original question, by the way, is more than a couple of nautical miles, but the answer will be elaborated elsewhere. Cf. the chapters by Covas et al., and Gaska et al., on this theme.)

The present volume began as the proceedings of a two-day symposium hosted by Defence Research & Development Canada (the Advanced Deployable Day/Night Symposium, November 13th and 14th, 2007, in Toronto). The background for the work lies in a long-standing collaboration between Defence Research & Development Canada in Toronto, and the Arizona facility of the US Air Force Research Laboratory. We document a number of new technologies, and also methods for their evaluation. One may ask the benefit of developing advanced technologies, when often governments can procure simulation and display technologies "off the shelf". We have gathered many interested parties from industry and academe, as can be told from the many affiliations of the authors in this volume. Through our efforts, we trust that we have succeeded in nudging North American industry in a new direction. Several of our concerns – high-resolution projection and night-vision simulation serve as examples – were once considered "niche markets". That phrase was meant shorthand for technologies as yet unprofitable for exploitation. It's not a phrase that would aptly be applied to these areas any longer. We did predict that the course of industrial development would fill some gaps in technology, and generally we have been rewarded, with progress in distributed computing for simulation, and with the development of small and reliable solid state lasers for light sources. This volume is a condensed compilation of our own efforts, and their unified representation. Alternate technologies do exist in healthy competition with these, of course, and we remain more attentive than dogmatic about such new possibilities.

Prototype production is unlike engineering design is unlike experimental psychology. What an art it is, then, to balance these things. It would be an exaggeration – it could be called a pragmatic exaggeration – to claim they can be complementary in the business of simulation. Balancing them has been one of the pleasures of this enterprise, which does not end with the present volume. Instead there are many directions open for the future. Here are some favorites: the development of a four-colour projection system, the experimental evaluation of sensory substitution for image fusion, and the development of full atmospherics for night vision simulation. The first idea is to extend traditional projector systems, which depend on three lights such as red, green, and blue to develop a full gamut of display colours in simulation. The addition of a fourth channel in the near-infrared would enable the use of night vision devices in a simulator – given careful attention to the simulation of environmental reflectance in the near infrared. Currently there are several display systems that are being developed along these lines. The second idea is to use sensory channels to carry new scenes of the same multiplicity or complexity, where a display is meant to represent the appearance of non-visible parts of the spectrum, as well as the visible scene. The use of haptic devices, and the fused representation of scenes in the true thermal range, are examples that have been put forward, and which could well be elaborated in future. The third idea is that variations in appearance due to clouds and moisture are even more important to night vision and infrared sensing than such variations are within the ordinarily visible range. The development of full models of these variations, based on physical principles, is then proportionally important to the realism of night vision simulation. Such an effort may sound fairly abstract, until you want to find your way about when the weather has turned. The latter theme is developed in chapters by Clark et al. and by Zhu, Church and Labrie in this volume. As a philosopher once prefaced his book: may others come along and improve on this.

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