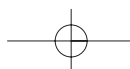
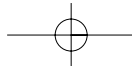


**TWO-HANDED INTERACTION IN COMPUTER  
SUPPORTED 3D CONCEPTUAL MODELING**





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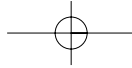
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# TWO-HANDED INTERACTION IN COMPUTER SUPPORTED 3D CONCEPTUAL MODELING

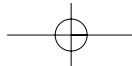
## Proefschrift

Ter verkrijging van de graad van doctor  
aan de Technische Universiteit Delft,  
op gezag van de Rector Magnificus prof. ir. K. F. Wakker,  
in het openbaar te verdedigen ten overstaan van een commissie,  
door het College voor Promoties aangewezen,

Op maandag 4 oktober 1999 te 13.30 uur

door **Maarten Wim GRIBNAU**

elektrotechnisch ingenieur  
geboren te Den Helder



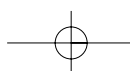
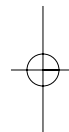
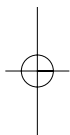
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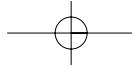
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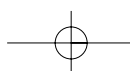
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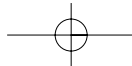




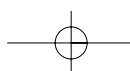
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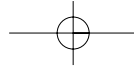
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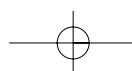


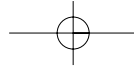


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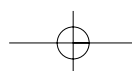
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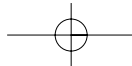
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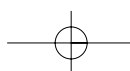
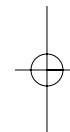
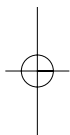


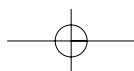
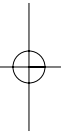
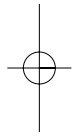
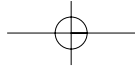
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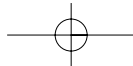




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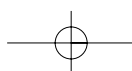


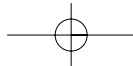
## ACKNOWLEDGEMENTS

The book lying in front of you is the result of a lot of work by the author but it could not have been realized without the help of a lot of people. I would like to thank a few of them explicitly, realizing that I take a risk disappointing people that I do not name here. They should know that I am grateful for their contribution.

I would like to start with the people that were most closely involved with the project. First, I would like to thank my promotor Jim Hennessey. He saw the possibility to convert an electrical engineer with an interest in computer graphics into an interaction design researcher with affinity for the field of Industrial Design. He was a source of inspiration and support throughout the project while keeping me focussed on our target audience: the designers. Jim; thanks for the freedom to explore new territories and for the guidance that surpassed a usual working relationship. Early in the project, we invited Erik Jansen and Joris Vergeest to the project. Together with Jim, the group was a source of fruitful ideas and they helped to formulate plans, to reflect upon the findings and to identify the most significant results. Later, Pieter Jan Stappers joined so that he too could experience how meetings always tended to overrun the time scheduled for them but always for a good reason. Pieter Jan joined at the time that most of the research described in this book had already been carried out. However, his help in the interpretation of data of the experiments was inspiring and his help in the later phases was invaluable. I hope that we can continue our collaboration in future projects.

The research described in this work was part of the IDEATE research projects. The group reflects the strong point of the faculty of Industrial Design Engineering. It hosts a diverse group of researchers that stimulate each other to look further than their own territories. A former group member, Ilse Verstijnen, introduced me to the world of statistics and experimental designs. Her help in the preparation of the first experiments and the interpretation of the results was much appreciated. Gert Pasman was a sparring partner in many ways. His comments and advice were important and if all



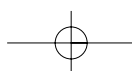


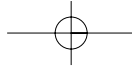
else failed, we could go to our squash club and forget about work. Corrie van der Lelie has helped during the last phase of the project by taking care of the graphical design of the thesis. Over the years, there was the opportunity to be involved in a number of student projects, some of which were directly related to the project described in this work. The work of Gianni Orsini in the beginning of this project helped to identify innovative tools designers might need for conceptualizing. In addition, the work of Maarten de Fockert and Sierd Westerfield should be mentioned. They helped to design and build Turntables version two and three respectively.

Support came from outside IDEATE also. The lab of the section Form Theory has become familiar terrain over the years. Together with Tom Djajadiningrat, software was developed that was useful in both of our projects. Luckily, our projects ended before Apple's QuickDraw 3D library was "Steved". I also want to mention Cees Overbeeke who convinced management that I could really finish the project in time (although the deadline came very close). As for Rob Luxen and Lars Leenheer, they did a nice job in building the ultimate serial interface for the Mac and they never complained when I came into their office wondering if they could fix something yesterday.

In developing the hardware and software, I found that a number of companies were very cooperative, some of which I would like to mention. The former Apple QuickDraw 3D team was responsive and helpful when I reported bugs in the dusty corners of QuickDraw 3D. Ron Serber of Pegasus helped with the development of driver software for the FreeD on the Mac. The Wacom people have helped by providing the details of their tablet driver. The people at Ascension were supportive when a Mac driver for the Flock of Birds needed to be developed. Cooperation with Robin Landsbert of Microspot was much appreciated. If we had started cooperating earlier, 3D World would have been the ideal platform for prototyping and development.

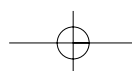
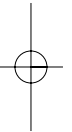
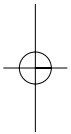
Ralph Stuyver represents a bridge between the University and the home front. As a former IDEATE member, he has been involved with my research. On the other hand, we have done some projects outside the University in my sparse spare time. Although the development of games for the Internet was not directly related to

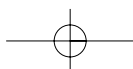
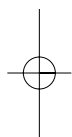
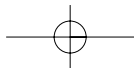


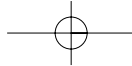


the research, many lessons were learned. In addition, it was refreshing to finish projects in a relatively short time for real customers, giving me a taste of how things are like "outside". The projects with Ralph, his companion Rik Wagter and the BumbleBees were time consuming but rewarding in many aspects.

Every Ph.D. student will probably agree that an understanding home front is indispensable. I was so lucky to find this true for me too. My wife Margo (this is still new for me) supported me in every way and understood my periods of absent-mindedness. I sincerely hope that the joy of delivering this thesis will soon be overshadowed by the birth of the two healthy children we expect. If all is well, my family will have the rare experience of attending a Ph.D. defense twice in a row since my brother Joost recently obtained his Ph.D.. I would like to thank them and my friends for the support they gave me and for their sincere interest in my work.





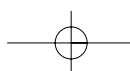


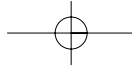
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