

IEMC 96 Proceedings

International Conference on Engineering and Technology Management

Managing Virtual Enterprises: A Convergence of Communications, Computing, and Energy Technologies

August 18 to 20, 1996

Vancouver, British Columbia, Canada

**Conference Record IEMC 96
Vancouver, British Columbia, Canada**

IEEE Catalogue Number: 96CH35979
ISBN: 0-7803-3552-X
Softbound Edition
0-7803-3553-8
Casebound Edition
0-7803-3554-6
Microfiche Edition

Library of Congress Number: 96-77286

Copyright and Reprint Permission

Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in this code is paid through:

Copyright Clearance Centre
222 Rosewood Drive
Danvers, MA 01923

For other copying, reprint, or republication permission, write to:

IEEE Copyrights Manager
IEEE Service Center
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331.

All rights reserved.

Copyright © 1996 by the
Institute of Electrical and Electronics Engineers, Inc.

Conference Committee

Conference Co-Chair
William A. Wallace
Rensseler Polytechnic Institute

Conference Co-Chair
Karim R. Lakhani
G.E. Medical Systems

Program Chair
Dundar F. Kocaoglu
Portland State University

Program Coordinator
D. Ann White
Portland State University

Local Arrangements
Bruce Prior
B.C. Hydro

Publications
Tim Wilkes
SaskTel Mobility

Preface

Dundar F. Kocaoglu

Program Chair, IEMC'96

Professor and Director, Engineering Management Program
Portland State University, Portland, Oregon 97207-0751, U.S.A.

Every era in history can be remembered with some significant events that establish the color and characteristics of that time period. Some of these events are inventions such as electricity; some are expeditions such as the discovery of the New World; some are exploratory breakthroughs such as the first Transatlantic flight; some are technological breakthroughs such as the development of the computer; some are destructive events such as a major war; some are constructive events such as the flight to the moon. Twentieth century is full of these significant events. Their numbers are constantly increasing. In fact, when we look at the last decade of this century it is difficult to choose a single event as the one which has left its imprint on that period. Rather than a single event, it is more realistic to identify 1990s with the evolution of a new concept; a new way of doing business. That new concept is the emergence of the virtual enterprise. It is the result of three major technologies: communications, computer and energy technologies; getting together. It is the beginning of obsolescence for many of the traditional approaches to planning, organizing, communicating, directing and control. In short, it is the new approach that is bringing sweeping changes to our life and how we conduct it, as well as to technology and how we manage it.

When IEEE Engineering Management Society was choosing the theme for the 1996 conference to reflect on the characteristics of this era, it became obvious that there was nothing more appropriate than the management of virtual enterprises. The conference attracted worldwide attention. A large number of papers was received. About 180 were accepted. This proceedings contains the ones that were submitted in full length. Several others are also included in the conference as presentations without the full length papers being available for publication.

We believe that this volume contains some of the best papers on management of virtual enterprises. We hope it will make a contribution to research, education and implementation of technology management focused on the virtual enterprise.

Table Of Contents

Intelligent Software Agents As Tools For Managing Ethical Issues In Organisations Caused By The Introduction Of New Information Technology	1
Ali Reza Kian Abolfazl	
Tentative Guidelines For Publications Rights	6
Imad M. Alatiqi	
Suliman Diab	
Said Mansour	
Firas Rasoul	
Hamdi Shalabi	
Management Information And Control System For Research Administration	12
Imad M. Alatiqi	
Ali Mohammad Akbar	
Sudhir Padlakar	
Towards A Better Human Resources Management Within The Virtual Corporation	18
Charles-Henri Amherd	
Zhan Su	
Diane Poulin	
Human Resource Development Challenges In A Virtual Organization	23
W. O. Anderson, Jr.	
Technology Associates Of Colorado: An Experimental Approach To Dealing With The Effects Of Corporate Downsizing	28
Dr. Lawrence K. Anderson	
Mr. Glenn C. Marshall	
Multimedia As Value Enabler For Decision Making In Virtual Enterprises	34
S. Arunkumar	
S. K. Jain	
Content Selection For A Course In Total Quality Management	42
B. Michael Aucoin	
Challenges In Technology Development And Commercialization: A Case Study Of Fallen Power Line Detection	47
B. Michael Aucoin	
B. Don Russell	
Improving Competitive Responsiveness Via The Virtual Environment	52
Ian Barclay	
Jenny Poolton	
Zoe Dann	
Evaluating Quality And Equity Issues In The Management Of Hospital Waiting Lists	63
Judith Barlow	
Rhiannon Tudor Edwards	
Management And Control In The Virtual Supply Chain	69
Lynne F. Baxter	
James M. Ritchie	
H.H. Seeto	

Virtual Enterprises And The Growth Of The Information Sector In Canada.....	74
Hadj Benyahia	
Profile Of The Virtual Employee And Their Office.....	79
Dana Mary Bracco	
Requirements For Virtual Enterprise Management In Developing Countries	84
Carlos Frederico Bremer	
Walter Eversheim	
Jörg Kampmeyer	
Research On The "Agglomeration Economies" Model* —Analysis Of The Development Of High Technology Zone	89
Li Cai	
Changbo Qui	
Technological Learning, Architectural Innovations, And The Virtual Utility Concept.....	94
Elias G. Carayannis	
Alistair Preston	
Shimon Awerbuch	
Technological Life Cycles Causes And Effects	106
Mario W. Cardullo	
World Class Manufacturing Techniques For Implementation For Small & Medium Sized Enterprises.....	112
Hassan Farsijani	
Andrew Carruthers	
The Virtual Enterprise Framework And Toolbox	117
John W. Center	
Joyce A. Thompson	
Control Of Electronic Business Transactions (Ebt) In The Banking Industry.....	124
H. Michael Chung	
Kristen Russell	
Design Of An Information System For A Networked Industry	128
Sophie D'amours	
Pierre Lefrançois	
Benoit Montreuil	
Review Of Organization Structures Of Concurrent Teams Responsible For Product Development In The Electronics Industry.....	134
Tugrul Daim	
Designing The Virtual Enterprise	139
Richard C. Dorf	
A Virtual Framework For Technology Acquisition.....	142
Cj Broadfoot	
Jc Greenwood	
S Forbes	
Ts Durrani	

An Appraisal Of R&D Management Research Literature As The Output Of A Virtual Organisation.....	148
Leslie T Falkingham Richard Reeves	
Investment In Facility Flexibility Under Uncertain Competitor Market Entry	153
Richard M. Franza Cheryl Gaimon	
Facility Flexibility A Manufacturing And Marketing Interface	158
Cheryl Gaimon Alysse Rosewater	
Outsourcing Focusing On Core Competencies By Leveraging Resources.....	163
James C. Gordon Aidan C. Gordon	
Improving The National Science And Technology Policy Development Process	168
James Gover, Fellow Elias G. Carayannis Mark Peterson	
Engaging Engineers In Science And Technology Policy Development.....	175
James Gover, Fellow Mark Peterson	
Social Networks And The Development Of Two Oil Technologies In Norway.....	180
Arent Greve Julia Harkola	
Virtual Teams - Constrained By Technology Or Culture?	185
Francis Hartman Connie Guss	
Quality Management In Software Development Process An Empirical Model.....	191
József Györkös Ivan Rozman Romana Vajde Horvat Marjan Hericko	
Identifying Critical Factors Impacting Virtual Work Group Performance.....	196
M.E. Hacker B.M. Kleiner	
Virtual Organizations - An Opportunity For Learning.....	201
Francis Hartman Rafi Ashrafi	
Paradoxes In Corporate Theories Of Technological Innovation	206
Claus Holm John Parm Ulhøi	
New Trends In Space Program Management	212
Edward G. Howard Steve Kirkner	
A Conceptual Framework For Quality Information Systems.....	217
Syohei Ishizu	

Electronic Messaging - The Lifeline Of The Global Enterprise	221
Kai Jakobs	
Rob Procter	
Robin Williams	
Fuzzy Multiobjective Linear-Programming-Based Justification Of Advanced Manufacturing Systems.....	226
Cengiz Kahraman	
Ziya Ulukan	
Ethem Tolga	
The Effect Of OO Life Cycle On Software Project Management	233
Emdad H. Khan	
Moheb R. Girgis	
The Future Of Information Systems - Using Social Systems To Create Protocols For The Virtual Environment.....	241
Chris Kimble	
Tina Conkar	
Processes And Tools To Support Knowledge Management In A Virtual Organization.....	247
Timothy G. Kotnour	
Michael Proctor,	
Management Of Software Development Processes.....	253
Marjan Krasna	
Ivan Rozman	
Managing Emerging Technology Development Through The Network Organization.....	258
Arun Kumaraswamy	
Raghu Garud	
Ajit Prabhu	
Integration With Human Resources Management Key To Sustained Quality Improvement.....	264
Li Chung Shih	
Movement Toward A Virtual Engineering Management Program.....	268
E. Ray Ladd	
First, Fast, And On-Time. The Path To Success. Or Is It?.....	275
Denis Lambert	
Stan Slater	
Information Management For Knowledge Amplification In Virtual Enterprise.....	281
Jun Numata	
Bangyu Lei	
Yukinori Iwashita	
A Corporate Business Excellence Process.....	286
Richard J. Leo	
Is Design Quality A Function Of Time?	296
Alan Leong	
Robert P. Smith	
Systems Engineering The Application Of Processes And Tool In The Development Of Complex Information Technology Solutions.....	301
Regina S. Lightfoot	

Information Technology Support Of Strategic Management Activities.....	308
Richard G. Donnelly, Regina S. Lightfoot	
The Impact Of Information And Communciation Technologies On The Strategic Decision Making Process	316
Richard G. Donnelly Regina S. Lightfoot	
Scorecarding A Case Study In Effective Management Of Virtual Enterprises.....	323
Bob Littlewood	
Structuring A Virtual Team Working Coordination System (Vtwcs) In The Management Of Projects.....	328
Xin Liu	
Decision Support Re Product Development.....	334
Lisbeth Crabo Ljungman	
Managing A Virtual Hospital	341
Hannu Jaakkola Pekka Loula	
Intelligent Reference Models For Designing Virtual Factories.....	346
Julio Macedo	
Using Information Technology To Leverage Research Productivity	351
Larry A. Mallak	
Information System Support For House Of Quality	357
Heloisa Martins Shih Li Chung Shih Stanley S. L. Kwok	
Economic Decision-Making In The Virtual Firm	362
Thomas W. Mason	
Creating A Virtual Enterprise In Manufacturing To Manage The Risk In Discontinuous Innovation.....	366
Christopher Mcdermott	
Does The Parallel Approach Make Sense In The Development Of Discontinuous Innovations?	
Christopher Mcdermott Robert Handfield	
Reengineering Team Processes In Quality-Focused Software Development Environments....	375
Eugene G. Mcguire Anita J. La Salle	
Tools For Engineering The Agile Enterprise.....	381
Laura Meade Adrien Presley K.J. (Jaime) Rogers	
A Mathematical Understanding Of The Success Of Multidisciplinary Development Teams.....	386
Bart R. Meijer	

Impact Of Owner Involvement On Innovation Lessons from Power Plant Projects.....	391
Roger Miller	
Strategic Enterprise Realization And Transformation Processes	402
Benoit Montreuil	
Johann Vallerand	
Diane Poulin	
Instrumenting Product Development Activities In The Virtual Enterprise	409
Jeffrey A. Morrow	
Managing It Implementation In Virtual Enterprises.....	413
Bjørn Erik Munkvold	
It-Enabled Affiliations As Organizational Forms.....	419
Barrie R. Nault	
Albert S. Dexter	
Providing Competence Resources For New Product Development	423
Jan Österlund	
Organisational Networks In R&D.....	428
Bernice Pacitti	
Alan Pearson	
Earned Quality Improving Project Control	434
J.P. Paquin	
J. Couillard	
R. Paquin	
D. Godcharles	
Virtual Corporation Tradeoffs.....	443
Robert J. Parden	
Selection Of A Manufacturing Process With Multiple Benefit Attributes	447
Celik Parkan	
Minglu Wu	
An Exploration Of Technology Intensity Measures.....	453
C. Carl Pegels	
Maps Of Virtual Structures In R&D.....	459
Karol I. Pelc	
Reengineering Businesses Into 'Virtual Enterprises'	464
Clive Pereira	
The Virtual Enterprise And The Sources Of Technology In.....	470
Lois S. Peters	
Process Modeling To Support Integration Of Business Practices And Processes In Virtual Enterprises	475
Adrien Presley	
K. Jamie Rogers	
Best Manufacturing Practices... A Uniquely Successful Approach To Teaming And Partnering	480
Richard L. Purcell	

Virtual Organizations And Management Control	486
Lyn Purdy	
Frank Safayeni	
Unni Astad	
Project Management And The World Wide Web.....	491
Joseph G. Questore	
Product Design Using Virtual Environments--A Conceptual Evolutionary Approach	494
James. M. Ragusa	
Grace Bochenek	
The Importance Of Electronics In Modern Cars.....	500
Raimo Ranta	
Hannu Jaakkola	
Collaboration In Meta-Organizations Research Issues And Challenges.....	505
Bharat P. Rao	
The Effect Of Organization Architecture On New Product Development.....	510
Tomlinson G. Rauscher	
Factors For Success In Acquiring Information Technology.....	517
Ali Q. Jawad	
Richard Reeves	
An Integrated Management Model For Virtual Enterprises	
Vision, Strategy And Structure	522
R. Leigh Reid	
James B. Tapp	
Donald H. Liles	
K. J. Rogers	
Mary E. Johnson	
Virtuality And Uncertainty In The Domain Of Discontinuous Innovation	528
Mark P. Rice	
Process Improvements In Distributed Computing Support In A	
Large Corporate Environment	533
Michael E. Richerson	
Support Of Networked Workstations In A Large Enterprise	535
Michael E. Richerson	
Managing Contracted Services In A Large Corporate Environment.....	538
Michael E. Richerson	
Quality And Productivity Improvements In Support Of Computer Workstations In A Large	
Corporate Environment.....	542
Michael E. Richerson	
Laptop Computers & The Ultimate Virtual Enterprise - Education	550
A.T. Roper	
If Technology Is Such An Important Strategic Issue, Why Do The	
Top Executives Play A Minor Role In Its Decision Process?	555
Gerald H. Rosenfelder	
Guy H. Gessner	

Real-Time Resource Tracking System For Semiconductor Industry	559
Saengpongpaew, Pichit	
Sirinaovakul, Boonmark	
The Iterative Component Of Design	564
Michael J. Safoutin	
Robert P. Smith	
Organizational Visions Of Virtual Manufacturing Sociotechnical Aspects Of Adopting Technology Computer-Aided Design Based Manufacturing Process.....	570
Samar K. Saha	
Economic Benefits In Using Electronic Data Processing In The Administration And Services In The Finnish Cities	576
Jarmo Salmi	
User Participation In Standardization	583
Liora Salter	
Video-Conferencing In A Classroom	591
Chetan Sankar	
Public-Sector Vs. Private-Sector R&D In India A Comparative Analysis Of Two R&D Teams	596
Jayaram K. Sankaran	
V. Suchitra Mouly	
Infrastructure Requirements For Selected Management Practices	600
Ahmet Satir	
Impact Of Client/Server Computing On The Telecommunications Industry.....	605
Salvatore P. Savino	
Steven M. Queroli	
The Learning Laboratory Supporting Learning Organizations With Agent Systems	611
Detlef Schoder	
Ralf E. Strauss	
Tom Hummel	
Comparison Of Cooperative R&D Arrangements Among Competitive Firms.....	616
Jaeyong Sim	
Moonsik Bae	
Orchestrating Multiple Changes A Framework For Managing Concurrent Changes Of Varied Type And Scope.....	627
Albert W. Small	
Elizabeth A. Downey	
A Framework For Optimizing A Virtual Learning System For Minorities And Industry In The Field Of Engineering.....	635
Paige E. Smith	
Brian M. Kleiner	
Information Security Issues Facing Virtual Enterprises	641
Gerhard Steinke	
Ronald Leamon	

Partnership Management Within The Virtual Enterprise In A Network.....	645
Zhan Su	
Diane Poulin	
The Design Of An Integrated Circuit Using A Virtual Enterprise	651
Sherif Sweha	
A Quantitative Framework For Designing Efficient Business Process Alliances	656
Srinivas Talluri	
R.C. Baker	
Uncovering Key Variables In Organisational Knowledge Management Using Intensive Research Methods	662
W A Taylor	
Managing With Technology A Predictive Information System For Remote Supplier Development.....	667
W A Taylor	
W Doherty	
Managing Technology Transfer For Value Creation And Competitive Advantage Toward A Contingency-Based, Information Processing Model.....	672
Russell W. Teasley	
James G. Almeida	
Richard B. Robinson	
The Landscape Of Innovation And Supply A Graphical Model For Visualising The Interrelationship Between The Innovation Functions And The Supply Chain.....	678
L. Thurlings	
Qfd Application To A Software-Intensive System Development Project.....	683
Tuyet-Lan Tran	
Management Of Information Technology Using Analytic Hierarchy Process	690
Godwin J. Udo	
Real-World Challenges Using The Virtual Enterprise For Successful Product Development Projects.....	698
Cinda Voegtli	
Teaching Multimedia For Management Through Distance Learning.....	705
Laurie B. Waisel	
William A. Wallace	
Linking Manufacturing Acquisition Strategies With Firm Success Evidence From The Semiconductor Silicon Industry.....	710
Steven T. Walsh	
Christopher McDermott	
Robert Boylan	
Ensuring Competitive Product Design With Teamworking Coordination	715
X B. Wang	
P D F. Kilduff	
Extension Of "Small-E" Ethics In Engineering Comparison Of Students In Two Countries.....	721
R. B. Ward	

Regarding Virtual Growth.....	725
David J. Wells	
Scott R. Willett	
Telecommuting And Consulting Engineering.....	735
John Whittaker	
Tim Cartmell	
System Design For An Integrated Document System And Its Impact On Standards Development Efficiency.....	741
Swantje Willms	
Emile Morse	
Michael Spring	
Engineering Research Center A New Virtual Innovation Organization In China.....	747
Qingrui Xu	
Jin Chen	
Bin Guo	
Managing Innovation Portfolio Experiences And Lessons In China	753
Qingrui Xu	
Bin Guo	
Jin Chen	
New Wave Of Managing Innovation.....	761
Hiroyuki Yamasaki	
Jun'ichi Baba	
The Virtual Enterprises In Japan.....	766
Kazuo Yanagishita	
The Application Of The Principal Component Method In Business Cycle Analysis And Prediction	770
Tan Yuming	
Yan Jianmei	
A Model For Analysis Dynamic Characteristics Of Strategic Alliance	776
Sida Zhou	
Minimum Distance Method (Mdm) For Group Judgment Aggregations.....	781
Sida Zhou	
Dundar F. Kocaoglu	
Product Development Strategy For Small And Mid-Sized Air-Conditioning Enterprises In China.....	787
Xiuwen Zhu	
John Whittaker	

Intelligent Software Agents as Tools for Managing Ethical Issues in Organisations Caused by the Introduction of New Information Technology

Ali Reza Kian Abolfazi
Fax: (+45) 8615 5032

Department of Organisation and Management
The Aarhus School of Business
Haslegaardsvej 10
DK-8210 Aarhus V
Denmark
Email: Kia@hdc.hha.dk

In this paper we reconsider the notion of value in the context of Information Technology (IT), and show how the introduction of new IT can change values in organisations. Subsequently we introduce the notion of Intelligent Software Agents (ISAs) as autonomous, social, reactive, proactive and subservient software computer systems. We further look at how the introduction of ISAs to knowledge-intensive industries can help human agents in their understanding of the development of new values while the new IT is taking place in their workplaces, and how the already existing values in the organisation can be dealt with at the same time.

Introduction

The introduction of new IT, as any other kind of new technology, in organisations usually changes or even destroys many of the values attached to the work done by the employees in the organisations. By values we simply mean the way in which the organisation is defined through the employee and by his/her performed work. In another word, the value here is the way the employee him/herself feels that he/she contributes to the existence of the organisation and consequently defines him/herself. Thus, the introduction of new technology in organisations not only changes the organisations themselves but also the way employees identify themselves with the organisations. Therefore, managers when working on the introduction of any kind of new technology, are confronted with ethical issues. Should they abandon the introduction of IT in order to prevent dissatisfaction of employees, or should they simply ignore the workers' problems and replace those who cannot keep up with the rapid changes of the nature of IT? In the following we shall see how these managers can be helped.

Values

Human beings "are socially constructed. What we mean, how we see the world, our values and valuables are all produced, learnt or acquired by and through interacting with others. Our means of communication such as natural languages cannot be learnt without this kind of interaction. Social norms defining the acceptable or appropriate ways to behave and opinions to hold make the boundaries within which we acquire and develop our behaviour and behavioural patterns. Without these norms, we simply cannot maintain our ways of communication, which are in the core of our existence as species" (Abolfazlian, 1996a). But on the other hand we are the true makers of the same History, culture and society that are supposed to produce us:

A process going on between man and nature, a process in which man, through his own activity, initiates, regulates, and controls the material reactions between himself and nature. He confronts nature as one of her own forces, setting in motion arms and legs, head and hands, the natural forces of his own body, in

0-7803-3552-X/96/\$5.00 © 1996 IEEE

order to appropriate nature's productions in form adapted to his own wants. By thus acting on the same time changes his own nature. He develops the powers that slumber within him and subjects them to his own control (Marx1, 1906 - 1909, p. 197).

All human concepts such as values, knowledge etc. are made as a result of interaction with nature and through her own forces. Thus human activity² is what makes the very same society and its societal rules that consequently draw the boundaries in which human beings will find themselves defined. But these activities are mediated through tools, specially sign systems³. Human beings use a variety of different tools and gadgets to master their mental processes. We call them *psychological tools* or *instruments*:

Psychological tools are artificial formations. By their nature they are social, not organic or individual. They are directed toward the mastery or control of behavioural processes.....just as technical means are directed toward the control of processes of nature (Vygotsky, 1979).

Natural languages, algebraic symbol systems, schemes, diagrams, mechanical drawings and different aspects of IT are some examples of psychological instruments. By using these instruments and making them part of our behavioural processes, they alter the entire flow and structure of mental functions. They do this by forcing us to re-structure our mental functions and activities in accordance with their structure just as for instance using technical tools determine the form of labour operation and thus alter the process of a natural adaptation. Thus these psychological tools are a defining part of all human concepts, especially values. As mentioned before, human activity is mediated, especially through psychological tools. A human worker's values in and toward an organisation are not only realized and mediated through his/her technical/psychological tools but are also defined by the very same tools. Any change of the mentioned tools, e.g. a secretary's desktop publishing system or a knowledge worker's interface to for instance IT, will change or even destroy the values connected to the work done by the employee. Organisations are introduced to new technology, especially new IT, as a natural consequence of the ever continuous stream of new tasks within the boundaries of organisations. Factors such as *Information anxiety*, i.e. a human agent's negative emotional response to the increasing volume and diversity of available information in our modern Knowledge Societies and organisations are some of the factors that rapidly influence the way we work and our values in the organisations. As a consequence, we need to take these factors into consideration while managing the ethical issues that arise in the organisations because the introduction of new IT changes the aforementioned values. We propose a new kind of specially designed psychological tools, namely Intelligent Software Agents as a useful support system in these managerial situations.

Intelligent Software Agents

Intelligent Software Agents (ISAs) are essentially computer systems whose constituent parts have a special relation to one another and to the environment in which they are realized. What makes the above mentioned relationship special is some especially developed features that these software systems have to possess in order to be identified as ISAs. Although different research groups have different ideas of what exactly these features are and how they should be developed in the agents, there seems to be an

¹ In general, I do not agree with Marx's ideas with regard to Economics, and I do not see myself as and am not a proponent of Marxism.

² Activity is the nonadditive molar unit of life for the material corporeal subject ... a system with its own structure, its own internal transformations, and its own development.

³ The interested reader will find a more detailed description of the nature of human activity and its role in human conceptualization in (Abolfazlian, 1996b; Wertsch, 1979).

agreement among almost all of these groups on which features agents, at least, must have. As we have seen in (Abolfazlian, 1996a), they have to be:

- *Autonomous*
- *Social*
- *Reactive*
- *Proactive*
- *Subservient*

An ISA is *autonomous* if it can operate without neither direct human interference nor any interference from other agents working in the same environment. It should also have control over its own actions, plans and internal states. The ISA should be *social* in that it has to be aware of its surroundings. It also has to be able to interact autonomously with other agents, human or non-human, using an interaction tool or gadget. Even though verbal languages are mostly used as tools of interaction by these type of agents, any sign system will suffice for our purpose here. We shall look at some of these systems further on. It is worth emphasizing again that the aforementioned interaction has to be made autonomously by the agent itself otherwise we cannot talk about social interaction with regard to these type of agents.

ISAs should be *reactive*. By reactivity here we simply mean that the agent has to be able to detect changes in its environment and autonomously respond (react) to these changes in the most appropriate way. What appropriate means here is again highly dependent on the surroundings of the agent and specially the other agents in and the societal rules of the society in which the particular agent operates. We should again notice that the respond of the agent should be made autonomously.

ISAs are not just supposed to be reactive as defined above which implies that they have to wait for changes in their environment in order to first detect them and then to react to them autonomously. They must also be capable of taking initiatives and set up sets of actions that will satisfy their goals. In other words, they have to be *proactive*.

ISAs should be *subservient* in that they have to work on behalf of other agents, human or non-human. By defining subservient in this manner we take a position which is very close to the one taken by the Economics when talking about Theory of Agency. Although this feature is not one of the more standard ones we shall see how this will fit within our framework in a very natural way.

Let us now briefly look at an example of these Intelligent Software Agents⁴.

Softbots

The Softbot (Software Robot) is an ISA running on the internet (Etzioni et.al, 1994). It is a fully implemented Artificial Intelligence (AI) device running on UNIX operating system. "The softbot interacts with its environment, specially different internet resources, through a UNIX shell and the World Wide Web (WWW). As effectors, softbot uses a wide range of file manipulation commands such as 'ftp', 'telnet' and 'mail'. As sensors it uses 'archie', 'gopher', 'netfind' and several other internet facilities. It has a very expressive interface that gives its interaction with the users (human agents) a much more social character. On the other hand it is able to dynamically choose the internet facility to be used in a certain situation. It also is able to autonomously choose the order in which different internet facilities should be used. For instance if it wants to find Ms. Beverly Williams' email address it may choose the 'netfind' facility to start with. But it knows that in order to use the netfind it has to feed it by an institution name or address. Thus it starts by looking in the bibliographic databases that it has access to in order to find an article or technical

⁴ For more examples, look at (Abolfazlian, 1996a).