We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

172,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

An Interactive Simulation Game to Enhance Learners' Experience on Ubiquitous Computing Devices

Vincent Tam, Zexian Liao, C.H. Leung, Lawrence Yeung
and Alvin C.M. Kwan*

*Department of Electrical and Electronic Engineering, The University of Hong Kong.
Hong Kong.*

1. Introduction

Advocating the constructive uses of digital games to motivate and/or enhance learners' experience, digital game based learning (DGBL) (Prensky, 2002) has been revolutionizing the latest educational technology or training methodologies in many industrial applications including the training of military officers in tactic planning or resource management in a simulated combat environment. In addition to such specific training, there are numerous successful examples of commercially developed simulation games including the SimCity (SimCity, 2007) or Sims™ 2 Open for Business (SimBusiness, 2007), originally developed for fun and later seriously adopted by the business schools of different universities in North America to motivate or sustain the students' learning interests in specific fields. In many cases, it was shown that the appropriate use of simulation games not only avoids the indispensable costs of human lives or money lost in the hostile combat or investment field, but also effectively motivates and/or raises the learners' interests that may have positive impacts on their actual performance attained in handling the real-world situation, and more importantly reaffirming the important value of simulation in education or training. As clearly described in (Wikipedia, 2007), "Simulation is used in many contexts, including the modeling of natural systems or human systems in order to gain insight into their functioning. Other contexts include simulation of technology for performance optimization, safety engineering, testing, training and education.". In many such applications, simulation can be used to clearly demonstrate the eventual effects of alternative conditions and course of actions.

In general, most educators agree that the use of interactive simulation tools can help students better understand the underlying working principles of many biological or physical systems, and thus at least motivate the learners' interests for further investigation that may lead to improved performance in a specific subject. For example, the use of a computer-aided simulation game named "The Incredible Machine" (Ward, 1998) was found

* Faculty of Education, The University of Hong Kong, Hong Kong.

to enhance the mechanical reasoning capabilities of transition year students, including 17 females and 27 males with their age between 15 and 16 years, to a certain extent in an exploratory study conducted in a vocational school in Ireland. The study strictly followed the pre-test/post-test control group design, with the students' mechanical reasoning skills evaluated by the Differential Aptitude Test for Guidance. There were significant differences in favor of male students in the experimental group with training using "The Incredible Machine" simulation game as shown in the t-test analysis of their pre-test and post-test raw scores. Besides, there are many other successful applications of simulation tools or games in other sectors of education (Kent, 2007; SCS, 2007; SuperKids, 2007).

In Hong Kong, where commercial and financial activities are overwhelmingly active in recent years with a lack of long-term development infrastructure for Engineering related disciplines, many tertiary educators in Engineering are faced with the core problems of motivating the students' learning interests and more importantly helping students realize the real values of the professional training in their own specific field. Therefore, in a Teaching Development Project, we proposed to develop an interesting simulation game inside a virtual university campus containing game rooms with different missions for students to fulfill on wireless mobile devices so as to enhance the learners' experience after classes. All the missions are focused on engaging players to exercise their logical thinking or problem-solving skills relevant to specific Engineering disciplines in a virtual environment without the limitation of many physical factors. For instance, the students can be free from the worries of damaging many digital circuit boards before successfully building a working digital device such as a digital computer or network modem. To promote the spirit of teamwork as in (Ward, 1998), each team of 3 to 4 students will work together to complete all the missions within the virtual campus. The team that obtains the highest score after completing all the missions is the winner. Since our simulation game can be accessed through wireless mobile devices such as pocket PCs, the teams can continue their missions in the game anytime and anywhere. To demonstrate the feasibility of our proposal, we used the Nebula Version 2.0 toolkit to build a prototype of our simulation game containing various game rooms inside a virtual campus that can be accessed through Window-based pocket PCs. When the prototype is completed, a detailed evaluation will be conducted to analyze the effectiveness of our simulation game on motivating and/or enhancing the learners' experience in relevant Engineering disciplines. After all, there are many interesting directions for further investigations. The integration of our simulation game with existing e-learning systems or powerful search engines is worth researching. Besides, any feasible mechanism to increase players' involvement in proposing new missions or acting as mentors to guide other teams after the team has finished its own missions should be thoroughly studied.

This chapter is organized as follows. Section 2 reviews some previous works relevant to our proposal including the use of computer simulation games in education and training, and the Nebula toolkit. Section 3 details the system architecture design of our interactive simulation game to enhance learners' experience on mobile devices. We give an empirical evaluation of our proposed system on various criteria in Section 4. Lastly, we summarize our work and shed lights on future directions in Section 5.

2. Related Works

In this section, we will consider some related works including the use of interactive computer simulation games for learning, and also the Nebula toolkit that we used to develop an interactive simulation game for our Teaching Development Project.

2.1 Interactive Simulation Games for Learning

Among the theories of learning, constructivism (Moll 1990, Piaget 1963, adsworth 1979) proposed that learners need to construct their own understanding of new ideas likely developed in the course of "active involvement with the environment", by individuals who must assimilate and accommodate experiences into existing schemata. Piaget (Piaget 1963, Wadsworth 1979) accorded a special role to cognitive conflict in which when an individual is confronted with different points of view, he/she must reflect on his/her own sets of beliefs, compare his/her idea with those of others. As a consequence, the individual restructures and refines his/her own schemata. Vygotsky (Moll 1990, Vygotsky 1978) proposed that cognitive change involves internalisation and transformation of what was created. Essentially, Vygotsky focused on what an individual could achieve with help, through interaction with others. While working within this zone of proximal development, the learner can actively construct knowledge based on his/her personal experiences. After all, both theories highlighted the importance of "interaction" with the environment or other people, flexibly provided in many computer simulation games nowadays, for learners to assimilate experiences into existing schemata in order to construct new knowledge.

As defined in (Wikipedia, 2007), a simulation game, also known as the sim game, a game of status or mixed game, is a game that contains a mixture of skill, chance, and strategy to simulate an aspect of reality, such as a stock exchange. In the industry of computer games, simulation games simply represent a wide super-genre covering many successful titles including the MS Flight Simulator (FSim, 2007), SimCity (SimCity, 2007), Civilization, and the Sims (Sims, 2007). Among these computer simulation games, there were many like the Sims or Sims™ 2 Open for Business (SimBusiness, 2007) that were originally developed for fun and later seriously adopted by different business schools or academic institutes for training their students in specific fields. In many cases, it was shown that the appropriate use of simulation games not only avoids the indispensable costs of human lives or money lost in the real-world combat or investment field, but also effectively motivates and promotes the learners' interests, thus likely producing positive impacts on the actual performance attained when handling the real-world situation. Besides, there have been various institutions that tried to develop their own computer simulation games for training or research. For instance, an exploratory investigation (Wade, 1998) about the effectiveness of a computer simulation game named "The Incredible Machine" for the mechanical reasoning skills was conducted in a vocational school in Ireland. In a control experiment with groups of 3 or 4 students working in a collaborative environment, it was revealed that no significant improvement was found between the experimental group and control group based on an analysis of pre-test and post-test results. However, interesting gender differences were found. Significant differences biasing towards male participants were discovered in the t-test analysis of pre-test and post-test raw scores, demonstrating the effectiveness of such computer simulation game on the mechanical reasoning ability of the male participants. Furthermore, the students' feedbacks collected in this study also

suggested different patterns of mouse usage, reactions to the game, interaction styles, and strategies used by the groups.

2.2 The Nebula Toolkit

Being motivated by relevant investigations as described in Section 2.1, we started a Teaching Development Project aiming to develop an interactive simulation game mainly to motivate and sustain students' learning interests in the use of Information Technology in Engineering related disciplines. After spending a few months in literature reviews and information search, we decided to adopt the Nebula toolkit to develop our interactive simulation game. Basically, the Nebula Device 2, namely the Nebula2, toolkit (Nebula2, 2007) is one of the leading open source 3D game and visualization engines used in many commercial games and professional visualization applications. It offers a complete abstraction layer from the underlying host system for the needs of real-time 3D games, thus providing a more realistic environment for most computer simulation games. One can think of Nebula2 as an operating system for games with the following features:

- an object model which integrates scripting, persistency, and safe referencing through smart pointers;
- wrapper classes for file-system access;
- wrapper classes for multithreading;
- wrapper classes for networking and inter-process communication across machines;
- an accurate time source (milliseconds or better);
- a collection of mathematical classes (vector, matrix, line, bounding box, etc.);
- a flexible scripting subsystem with support for several scripting languages (currently Tcl, Lua and Python);
- a 3D graphics subsystem with support for the D3D9 HLSL shaders;
- a 3D audio subsystem on top of DirectSound with support for static and streamed sound
- an input subsystem on top of DirectInput;
- a graphical user interface (GUI) subsystem for creating 2D user interfaces;
- a complete resource (including textures, meshes, shaders, fonts, animation data, etc.) management subsystem, with support for loading resources in a background thread;
- virtual file-systems (file archives) for faster loading;
- a flexible scene graph subsystem;
- a statically linked, stripped down Tcl version (called MicroTcl), featuring 36 core Tcl commands which does not require any additional runtime files.

3. The System Architecture of Our Interactive Simulation Game

Based on the Nebula2 engine and libraries for their supported features as mentioned previously, we carefully designed the system architecture of our interaction simulation game to enhance the learners' experience on mobile devices. The system architecture is depicted in Figure 1 below.

Essentially, the whole software system of our interactive simulation game is composed of two major parts: the game engine which deals with high-level game logic, and the Nebula2 kernel which handles low-level functions such as graphics, keyboard/mouse inputs, etc.

The game engine has three components: game entity, scenario loader and message pump. Each game entity represents an object in the game. By attaching different properties to a game entity, the game entity can behave differently. For example, with a physics property, the game entity can collide with other entities whereas without it, the game entity could simply go through. When events arrive, a message dispatcher of game entity is responsible for passing them to an appropriate property handler. Game entities in a particular scenario are managed by an entity manager created by the scenario loader. When switching the scenario, all the entities in this scenario will be read from the SQLite database by the scenario loader, created by the entity manager, and ultimately stored back to the SQLite database by the entity manager for the future retrievals. The game engine is event driven. Events can come from the nebula2 kernel, such as keyboard/mouse input, or from the network, such as actions of other players. The message pump dispatches all these messages to the appropriate entity handlers in order to keep the game running. In addition to such high-level game logic as handled by the game engine, all the low-level input functions are implemented by the Nebula kernel. For specific details about the Nebula2 kernel, refer to (Nebula, 2007).

Basically, our interactive simulation game consists of several game rooms that try to emphasize relevant subjects in Information and Communication Technology (ICT) that should be of interests to Engineering students in general. The relevant subjects in ICT we chose for the game rooms include Computer Architecture, Database Management and User Interface Design. Clearly, given the flexibility of our system architecture, other relevant subjects can easily be integrated into our simulation game. Inside the simulation game, each group of 4 students will enter into a different game room, one after another, to perform some designated tasks and then earn a score after accomplishing the tasks. For example, in the game room for Computer Architecture, students will be asked to pick up the correct components out of a diverse range of computer devices lying on the floor, and then configure such components to build a working desktop computer. During the game, the chosen leader of each team will act as a coordinator as well as the ultimate decision-maker to perform the actual actions such as the steps to compose a desktop computer in the simulation game room for Computer Architecture. Each member of the team, possibly located in different corners of the campus and being connected by the WiFi networks, can discuss what to perform next via the online chat-room facility provided on the mobile devices. After all, the scores obtained by going through various game rooms will be accumulated for each team, and can be checked via the web interface. And the team with the highest score will be selected as the winner of the simulation game.

Fig. 1. The system architecture of our interactive simulation game

4. Prototype Implementation and Evaluation

We used the Nebula2 toolkit (Nebula, 2007) and its supporting technologies such as the SQLite, MicroTcl scripts, and several C++ programs to build a prototype of our interactive game containing several mini-game rooms inside a virtual campus that can be accessed through Windows-based desktop or pocket PCs. The use of mini-games like robot-shooting or duct/path connection are aimed to introduce some fun and also the flexibility in the design of each game room that can be an individual game component by itself, or combining with other mini-game rooms in an adventure to focus on some specific subject/topic. In our prototype implementation, we built an adventure of 3 mini-game

rooms inside the virtual campus, that try to emphasize relevant subjects in Information and Communication Technology (ICT) for Engineering students in general. The relevant subjects in ICT we chose for the mini-game rooms include Basic Organization of Computers, the (more advanced) Structure of Microcomputers and lastly Application Programming on Computers. Clearly, given the flexibility of our system architecture, relevant subjects in ICT such as Database Management and User Interface Design, or other different topics can easily be integrated into the virtual campus of our simulation game.

To play the simulation game, each team of 2 to 3 students should “individually” log in the game server via a networked PC and then select to enter into a game room of a virtual campus to perform some designated task. Among the team members, the players should nominate one student as the team leader to submit the final decision to each question/task. The team members are allowed to use the text-based voting mechanism or voice using the peer-to-peer Session Initiation Protocol (SIP) to communicate with each other before making any decision so as to encourage teamwork. After completing a set of questions/tasks, each team will be given a score, based on their time and accuracy, which will be added to their overall score. The team with the highest overall score is the winner. Figure 2 shows the user interface of the “virtual campus” for players to navigate among the game rooms available in our simulation game.

Fig. 2. The user interface of the virtual campus displayed in our simulation game

As shown in the diagram, the overall scores of all the participating teams can be checked by clicking on the “Marks” button inside the virtual campus from time to time to encourage constructive competition among the teams. For example, in the mini-game room for Basic

Organization of Computers as shown in Figure 3, each team of students will be asked to select the right components out of a wide range of computer devices including the processor, memory or network card, and also put such components into the correct slots to build a working computer. Each team leader will act as a coordinator to collect opinions from other team members via voice communication over the SIP server, and then make the necessary decisions to obtain a computer configuration for online submission. Our Nebula2 game engine will proceed to check if it contains all the essential components such as the processor and RAM for a working computer. Accordingly, it will send a message to congratulate the team for their good work. Otherwise, an error message will be displayed to allow the whole team to revise their configuration for later submissions.

Fig. 3. The user interface of the mini-game on the basic organization of computers displayed in our simulation game

Besides, to promote our TDG game through “trials” to be played on mobile devices anytime and anywhere, we ported our TDG game using embedded Visual Basic to run on (standalone) pocket PCs. This will allow us to study the performance attained by different teams with and without the “trial practice” of our TDG game, and more importantly the possible impact(s) of revisions on mobile devices over the retention period of the knowledge/skills covered in our TDG game. Figure 3 shows the similar interface of our TDG game ported onto the Dell™ Axim X41v pocket PC installed with an Intel(R) processor of 624 Mhz, and the Windows Mobile 5.0 operating system.

Fig. 4. The user interface of the pocket PC version of our simulation game

After the above prototypes was completed with extensive testing, a thorough evaluation was conducted to analyze the effectiveness of our simulation game on motivating and/or enhancing the learners' experience in relevant Engineering disciplines. In particular, we have carefully prepared a set of questionnaires and invited individual students from different classes/programmes in the Department of Electrical and Electronic Engineering (EEE) to try out our pocket PC version, that is mobile and can be tested anywhere, and then complete the questionnaire for our detailed analysis.

Essentially, after the (standalone) pocket PC version of our simulation game was built in early January 2007, it was distributed to various (around 8) EEE students, randomly selected from different classes/programmes, to try out the game with their feedbacks collected through the above-mentioned questionnaire to evaluate the potential benefits of employing simulation game to stimulate and also engage the students' learning interests in different EEE or possibly other courses. It should be noted that due to the "limited number of mobile devices" (only 1 pocket PC) available for this teaching development project, it was impossible to perform the system evaluation on a class scale. Therefore, we had to randomly select students to try out our game and then conduct survey on an individual basis. Table 1 summarizes the evaluation results obtained from our survey with the average score displayed out of a scale of 1 (lowest) ~ 5 (highest), the higher the score, the better the impression/impact of our simulation game, for each question.

Questions	Avg. Score
A. Do you think the simulation mini-game on pocket PC is easy-to-play ? 1. Strongly disagree 2. Disagree 3. Neural 4. Agree 5. Strongly agree	3.9

<p>B. Do you think the use of simulation game in our EEE or other courses can help to initiate the students’ interest in learning?</p> <ol style="list-style-type: none">1. Strongly disagree2. Disagree3. Neural4. Agree5. Strongly agree	<p>3.5</p>
<p>C. As compared to the conventional revision exercise, can the use of simulation game in our EEE or other courses simulate and also engage more students’ interest in learning?</p> <ol style="list-style-type: none">1. Strongly disagree2. Disagree3. Neural4. Agree5. Strongly agree	<p>3.4</p>
<p>D. Do you consider the use of simulation game in our EEE or other courses can provide a more funny and relaxing way to learn basic concepts in specific areas?</p> <ol style="list-style-type: none">1. Strongly disagree2. Disagree3. Neural4. Agree5. Strongly agree	<p>4.0</p>
<p>E. Do you consider the use of simulation game in our EEE or other courses can increase the effectiveness of learning from student’s perspective ?</p> <ol style="list-style-type: none">1. Strongly disagree2. Disagree3. Neural4. Agree5. Strongly agree	<p>3.4</p>
<p>F. Do you consider the use of simulation game in our EEE or other courses can provide a more relaxing way to revise about basic concepts after classes?</p> <ol style="list-style-type: none">1. Strongly disagree2. Disagree3. Neural4. Agree5. Strongly agree	<p>3.8</p>
<p>G. If such a simulation game is available freely in our EEE or other course website, how likely will you use/play such a game for learning/revision ?</p> <ol style="list-style-type: none">1. Definitely will not use2. Will not use3. Difficult to decide4. Will use	<p>2.9</p>

5. Definitely use	
H. If such a simulation game is available freely in our EEE or other course website, how often will you use/play such a game for revision/learning? 1. Difficult to decide 2. 0 3. once a week 4. twice a week 5. 3 times or more a week	2.0

Table 1. The evaluation results of our survey about the effectiveness of our simulation game to motivate and/or enhance the learners' interests in specific Engineering discipline

Basically, the feedbacks from these students are fairly positive, with the average score as 3.5 out of a scale of 1 ~ 5 supporting that simulation games can help to initiate students' learning interest. Over 87% of the students consider the use of simulation game as providing a more funny and relaxing way to learn about concepts in specific areas, and around 50% of the students plan to play the simulation game once or twice each week when such a game is available from our EEE or other course websites. Besides the formal survey, our team also communicated informally with other EEE students after classes to collect their views and feedbacks on the possible use of simulation games in promoting their learning interests. Most students expressed interests in using our simulation game for learning/revision in the future.

5. Concluding Remarks

Undoubtedly, interactive simulation games, with many successful examples to come, will form an important part of the digital game-based learning that aims to enhance or reshape the learners' experiences. In a Teaching Development project, we proposed to develop an interactive simulation game inside a virtual university campus containing game rooms with different missions for students to fulfill on wireless mobile devices so as to enhance the learners' experience after classes. All the missions are focused on engaging players to exercise their logical thinking or problem-solving skills relevant to specific engineering disciplines. Through wireless mobile devices such as pocket PCs, the teams can continue their missions in the game anytime and anywhere. To demonstrate the feasibility of our proposal, we used the Nebula Version 2.0 toolkit to build prototypes of our simulation game containing various game rooms inside a virtual campus that can be accessed through both Window-based desktop and pocket PCs. When the prototypes were completed, a detailed evaluation was conducted through a carefully designed survey to analyze the effectiveness of our simulation game on motivating and/or enhancing the learners' experience in relevant engineering disciplines. From the survey results, some initial and encouraging feedbacks are collected. There are several interesting directions for future investigation. First, the integration of our simulation game with existing e-learning systems or powerful search engines is worth researching. Besides, any feasible mechanism to increase the players' involvement in proposing new missions or acting as mentors to guide other teams after the team has finished its own missions should be thoroughly studied.

6. Acknowledgements

The authors wish to thank Professor Diane Salter and Professor Daniel Churchill for their fruitful discussions. In addition, the authors are grateful to the generous supports to our teaching development project entitled "Student-Centered Learning Facilitated by Cooperative Simulation Games on Wireless Mobile Devices" by the Faculty of Engineering and also the Department of Electrical and Electronic Engineering, the University of Hong Kong.

7. References

- Kent NGfL. (2007). Simulations – Google Search Kent NGfL website. Retrieved: June 15, 2007, from <http://www.kented.org.uk/ngfl/software/simulations/index.htm>.
- Moll, Luis C. (1990). *Vygotsky and Education – Instructional Implications and Applications of Sociohistorical Psychology*. Cambridge: Cambridge University Press.
- Piaget, J. (1963). *The Psychology of Intelligence*. Paterson, N.J.: Littlefield, Adams.
- Prensky, M. (2002). *Digital Game Based Learning*. New York: The twitchspeed.com. Retrieved: June 13, 2007, from <http://www.twitchspeed.com/site/news.html>.
- SCS Publication team. (2007). *Simulation: Transactions of the Society for Modeling and Simulation International website*. Retrieved: June 3, 2007, from <http://www.scs.org/pubs/simulation/simulation.html>.
- SuperKids Software development team. (2007). *SuperKids Software Review of RockSim – Model Rocket Design and Simulation Software*. Retrieved: June 5, 2007, from <http://www.superkids.com/aweb/pages/reviews/science/06/rocksim/merge.shtml>
- The FSim development team. (2007). *The MS Flight Simulator website*. Retrieved: June 5, 2007, from <http://www.fsinsider.com/Pages/default.aspx>.
- The Nebula development team. (2007). *The Nebula Device website*. Retrieved: June 13, 2007, from <http://nebuladevice.cubik.org/>.
- The SimBusiness development team. (2007). *Aspyr - The Sims™ 2 Open for Business website*. Retrieved: June 15, 2007, from <http://www.aspyr.com/product/info/3>.
- The SimCity development team. (2007). *The SimCity Societies*. Retrieved: June 15, 2007, from <http://simcity.ea.com/>.
- The Sims development team. (2007). *The Sims Official Site*. Retrieved: June 15, 2007, from <http://thesims.ea.com/>.
- Vygotsky, L. S., (1978). *Mind in society*. Cambridge; MA: Harvard University Press.
- Wadsworth, Barry J. (1979). *Piaget's – Theory of cognitive development*. New York: Longman Inc.
- Ward, J., Carroll, P. (1998). *Can the Use of a Computer Simulation Game Enhance Mechanical Reasoning Ability: an exploratory study*. Working Paper Series MCE-0998, 1-20. Retrieved: June 10, 2007 from <http://citeseer.ist.psu.edu/431172.html>.
- The Wikipedia development team. (2007). *Simulation – Wikipedia, the free encyclopedia*. Retrieved: June 1, 2007, from <http://en.wikipedia.org/wiki/Simulation>

Advanced Learning

Edited by Raquel Hijn-Neira

ISBN 978-953-307-010-0

Hard cover, 444 pages

Publisher InTech

Published online 01, October, 2009

Published in print edition October, 2009

The education industry has obviously been influenced by the Internet revolution. Teaching and learning methods have changed significantly since the coming of the Web and it is very likely they will keep evolving many years to come thanks to it. A good example of this changing reality is the spectacular development of e-Learning. In a more particular way, the Web 2.0 has offered to the teaching industry a set of tools and practices that are modifying the learning systems and knowledge transmission methods. Teachers and students can use these tools in a variety of ways aimed to the general purpose of promoting collaborative work. The editor would like to thank the authors, who have committed so much effort to the publication of this work. She is sure that this volume will certainly be of great help for students, teachers and researchers. This was, at least, the main aim of the authors.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Vincent Tam, Zexian Liao, C.H. Leung, Lawrence Yeung and Alvin C.M. Kwan (2009). An Interactive Simulation Game to Enhance Learners' Experience on Ubiquitous Computing Devices, *Advanced Learning*, Raquel Hijn-Neira (Ed.), ISBN: 978-953-307-010-0, InTech, Available from:
<http://www.intechopen.com/books/advanced-learning/an-interactive-simulation-game-to-enhance-learners-experience-on-ubiquitous-computing-devices>

INTECH
open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2009 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike-3.0 License](https://creativecommons.org/licenses/by-nc-sa/3.0/), which permits use, distribution and reproduction for non-commercial purposes, provided the original is properly cited and derivative works building on this content are distributed under the same license.

IntechOpen

IntechOpen