Educating ICT Leaders Through ICT – An Innovative Approach
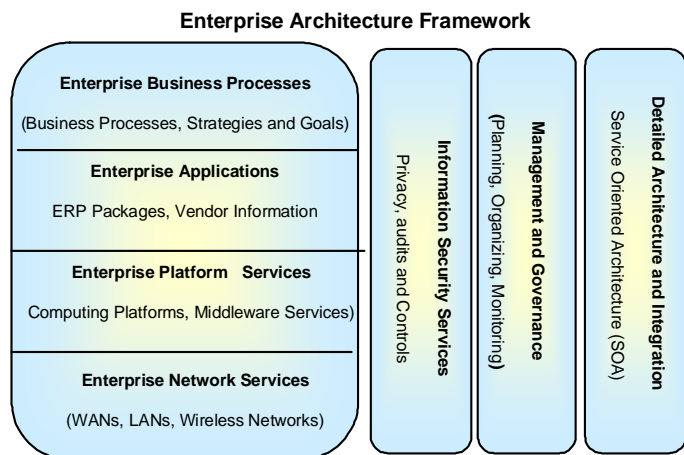## Amjad Umar, Ph.D.

Executive Summary

Educating ICT (Information and Communication Technologies) leaders is a challenging task, especially in developing countries. A research project focusing on computer aided consulting has produced innovative services that can be used to educate ICT leaders in complex real life situations. This paper describes the main results so far: a strategic IT planning, integration, security & administration environment and a knowledge portal for entrepreneurship – both integrated around a comprehensive patterns repository for several industry segments. Results have shown that these computer aided consulting services greatly help in teaching difficult to explain concepts in difficult to teach ICT courses. Short course descriptions, sample projects and services used in university and industrial courses are briefly discussed. Sources of additional information are provided for access to complete course information, text materials, and hands-on tools.

The Challenges

Developing countries need ICT (Information and Communication Technology) leaders who can manage and lead entrepreneurships and small to medium businesses (SMBs). However, educating these leaders is difficult in developing countries due to the lack of local expertise and resources. A unique challenge in educating ICT leaders is that they need to develop problem solving skills for complex real life situations and manage the intricate business and technology interdependencies in these situations. The well known enterprise architecture framework [Lindstrom 2006, Buchanan 2002], shown below, attempts to capture the key challenges by showing the business and technology aspects of modern enterprises (i.e., enterprise business processes, enterprise applications, platform services and network services) as different horizontal layers. These horizontal layers represent highly interdependent building blocks that must be properly secured, integrated, and managed/governed (represented as vertical bars that cut across different horizontal layers of the framework). For example, the ICT leaders should be able to handle the following typical real life situations:

- What business processes (BPs) should be automated and re-engineered to compete and succeed
- What type of IT infrastructure (application packages, computing platforms, and network services) are needed to support the BPs
- How to integrate new applications with the existing, including legacy, systems by using SOA [Carter 2007]
- How to secure the company assets to minimize risks and how to develop security audits and controls
- How to develop project plans for implementation and how to establish the most suitable IT governance policies, procedures and controls based on frameworks such as COBIT (www.isaca.org)

Enterprise Architecture Framework

Enterprise Business Processes
(Business Processes, Strategies and Goals)

Enterprise Applications
ERP Packages, Vendor Information

Enterprise Platform Services
Computing Platforms, Middleware Services)

Enterprise Network Services
(WANs, LANs, Wireless Networks)

Information Security Services
Privacy, audits and Controls

Management and Governance
(Planning, Organizing, Monitoring)

Detailed Architecture and Integration
Service Oriented Architecture (SOA)

Educating ICT leaders to deal with these situations, especially in developing countries, is a difficult task. Without proper education and training, the industries in developing countries lack in-house expertise to deal with important ICT issues and have to rely on external consulting services. Unfortunately, good quality consulting services at affordable rates are also not readily available in developing countries. This creates yet another gap between the developed and developing countries.

Research Approach

To address the aforementioned challenges, a unique educational approach is needed that plays the *dual* role of a) solving real life problems of the type indicated above for real life industry segments, and b) educating the students on the complex issues of IT planning, integration, security and administration. Research and analysis of educational as well as professional practice tools revealed no clear winners. Most educational tools are too simplistic and do not capture real life situations while most professional practice tools solve real life problems but are not designed for learning. This finding, and additional research, led us to investigate consulting practices because good consultants play dual roles of problem solvers as well as educators.

The main output of this research is an innovative *Computer Aided Consulting for IT (CACIT) toolset* that has been developed by analyzing consulting practices (including our own) and utilizing the latest thinking in patterns [Adams 2001, Alexander 1979, Gamma 1994], enterprise ontologies [Fox 1997], knowledge services [Mentza 2007], service innovation [Chesbrough 2006], systems building [Boehm 1999, Cooper 1999], and behavioral research in accuracy versus effort of IT [Burton 1993, Todd 1992]. Results of our research have been published extensively [18, 19, 20, 21, 22, 23, 24]. CACIT (pronounced as *kassit*), displayed in the following figure, currently consists of:

Computer Aided Consulting for IT (CACIT)

- An integrated intelligent system [Zha 2006], called PISA, that can be used to quickly build real life business scenarios and then guides the user through IT planning, integration, security and administration tasks.
- A knowledge portal for entrepreneurship, called GEZA, that provides a set of knowledge services [Mentza 2007] ranging from starting a business to international partnership and outsourcing opportunities.
- An industry pattern repository called PARIS that houses business patterns [Adams 2001] for more than 20 industry segments including healthcare, transportation, telecom, and manufacturing.
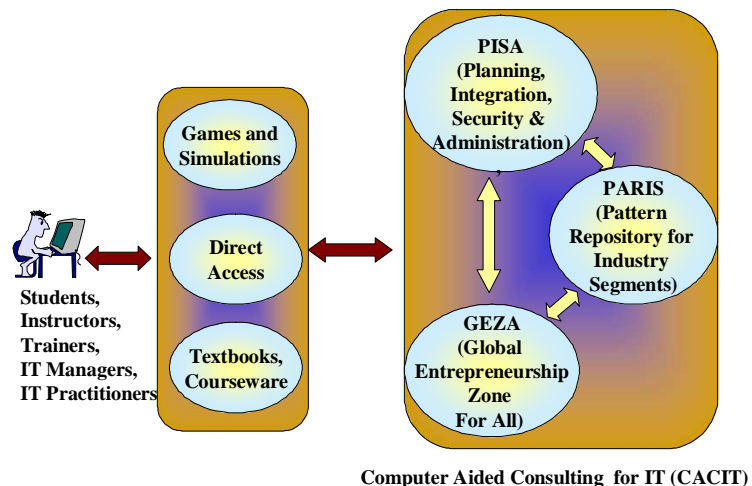
PISA, GEZA and PARIS collectively can be and have been used for educational as well as consulting services. Instead of several disconnected tools that address parts of the enterprise architecture framework, CACIT captures the complex interrelationships and interdependencies between the horizontal layers and the vertical bars of the framework for real life situations. The users can directly invoke the needed CACIT services or access them through business games and simulations supported by textbooks and course materials. The following sections briefly describe these services and show how they can be used to support university and corporate training courses in strategic IT planning, enterprise architectures and integration, SOA, business modeling, and entrepreneurship.

PISA (Planning, Integration, Security & Administration)

What is PISA: A family of intelligent consultants ("Advisors") that collaborate with each other through a knowledgebase to help in planning, integration, security & administration of IT services. Different PISA Advisors cover different aspects of the IT framework shown earlier.

Main Features of PISA (see the following figure):
- Enterprise modeling (business strategies)
- Enterprise application planning
- Computing platform planning

- Network planning (wired/wireless)
- Security planning (risks, audits)
- SOA planning (business case for SOA)
- SOA solutions for internal & B2B apps
- Evaluation of SOA solutions based on cost, security, and performance
- Project planning (WBS, Gantt charts)
- Completely documented IT plans
- Advanced modeling capabilities that allow the users to plug in a wide variety of existing tools (e.g., simulation models and spreadsheets)
- Ability to build composite organizations (e.g., large corporations, mergers and acquisitions, supply chain networks, B2B marketplaces and business networks) from a set of organization units.
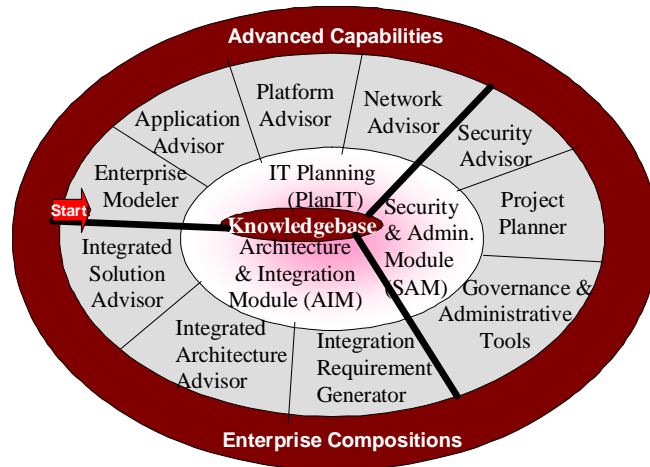
Playing Games and having Fun with PISA (three usage scenarios)
- **Learn the advisors:** What are they doing, how are they doing it? This helps the students to learn the decision making processes. The typical assignment is to ask the students to solve a problem by hand, then solve it by using PISA and then analyze the results and explain the differences.
- **Beat the advisors:** Have an advisor solve a problem, then do better than it and justify your solution. This is the typical computer chess model. The students are typically asked to solve a problem by using PISA and find weaknesses in the recommended solution and do a better job.
- **Extend the advisors**: The students can take the XML documents generated by the PISA advisors and perform additional analysis by invoking additional tools. For example, students have taken the outputs generated by the Application Advisor and ported into workflow tools, fed the output produced by the Network Advisor into the OPNet network simulation tool, and ported the outputs of many advisors to invoke Excel worksheets for detailed calculations and return on investment (ROI) analysis. This assignment is typically given as extra credit or special study.

GEZA (Global Entrepreneurial Zone for All)
What is GEZA: GEZA is a knowledge portal that provides a set of knowledge services, shown in the following figure, that cover different aspects of the entrepreneurial capabilities ranging from business solutions to international partnership and educational opportunities.

Main Features of GEZA (see Figure):
- Business Solutions for guidelines on how to develop business strategy, how to do business over the Internet, how to get funding, etc.
- SMB Yellow Pages, a comprehensive directory of SMB Portals, that contain extensive information on different aspects of starting, running and managing a business.
- Outsourcing Center that allows SMBs to advertise their services, provides matchmaking for buyers and sellers, and advice for outsourcing.
- International Center for doing business internationally (uses some UN resources)
- Education Center provides extensive information about educational opportunities for entrepreneurs
- IT Solutions provides computer aided consulting service through PISA .
- Industry Repository offers extensive information about different industry segments through PARIS

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Playing Games and having Fun with GEZA

We are developing an entrepreneurship game that heavily relies on the capabilities of GEZA to guide a startup through its first five years of operation. The user enters this game, chooses an industry segment, and lives through various events during the 5 year period. Based on the entrepreneurship models, the 5 year life is divided into the following 3 games:

- Year 1 Game: The user chooses an industry segment in which to start a business and spends most of this year preparing to form a company. The user is presented with a list of tasks (challenges) for year 1 and the user addresses these challenges as they are presented.
- Year 2 Game: The user will be presented with a starting condition (it may be that the company has gone out of business based on results from year 1). The challenges presented in this game will lead the user to solidifying the new company and establishing a market position – the main goal.
- Year 3-5 Game: The user is again presented with a starting condition (e.g., going out of business). If the company has survived so far, the user embarks on a series of tasks to make the company successful.   .

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## PARIS (Pattern Repository for Industry Segments)

What is PARIS: PARIS is a comprehensive repository of industry and business patterns that cover more than 20 major industry segments that include healthcare, transportation, telecom, manufacturing, retail, education and finance.

Main Features of PARIS (see Figure):

- Overviews, examples, specializations and sources of information for each industry segment.
- Business process patterns, requirement patterns and information model patterns in UML.
- Interfaces to support PISA advisors and GEZA services.
- Support business games and simulations.
- Support academic and professional training courses.

Playing Games and having Fun with PARIS

- In its final stages of development, PARIS currently provides extensive support to PISA and GEZA.
- A series of business simulations, games and courses are being developed based on this repository. Examples include workflows in different industry segments, establishing telecom services for educational institutions and "virtual internships" for students.
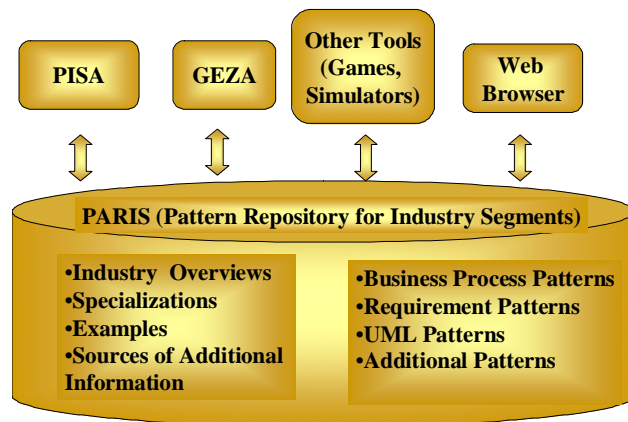
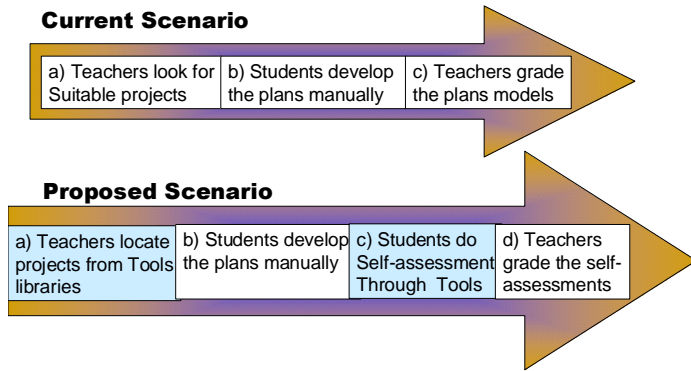## Using Computer Aided Consulting in Classrooms

It is very difficult to teach ICT leadership courses without good tools that allow the students to build different business scenarios quickly and experiment with them to gain management and technical insights. The CACIT tools (PISA, GEZA and PARIS) fill this role very well – they collectively allow the students to create the model of a company and then, depending on the type of course, quickly develop and experiment with a series of plans for entrepreneurship, enterprise applications, computer and communication platforms, security and business continuity, SOA-based integrated architectures, and B2B trade. The following figure shows two usage scenarios:

- **Current Scenario:** a) teachers look for projects that will best "test" the student's understanding of the concepts, b) students develop the plans, and c) teachers grade the plans.
- **Computer Aided Consulting Scenario**: a) teachers use the CACIT library of projects that can be customized by the teachers, b) students develop the plans by hand, c) students do a "self assessment" exercise to develop the plan by using the appropriate CACIT tools, and compare/contrast their plan

against the output produced by the tools, d) teachers grade the assignment based on the assessment report.

So far, PISA, GEZA and PARIS have been used very effectively to support the following courses (more are being investigated -- suggestions and ideas are welcome):

- **Strategic IT Planning: S**tudents build a model of a company and then build an IT plan for this company by using PISA. They also develop project plans by using the PISA Project Planner. They learn a great deal by developing different project plans and then comparing and analyzing them against the plans they develop on their own.

Current Scenario

a) Teachers look for Suitable projects	b) Students develop the plans manually	c) Teachers grade the plans models

Proposed Scenario

a) Teachers locate projects from Tools libraries	b) Students develop the plans manually	c) Students do Self-assessment Through Tools	d) Teachers grade the self-assessments

- **Information Security, Controls and Governance: S**tudents develop the model of a company, develop its application and network plan and then build a security solution by using the PISA Security Advisor (SA). They also use the PISA Project Planner to develop an IT governance plan. In particular, they run different attack trees by using SA to understand risk analysis.
- **Computing Networks (Data Communications): S**tudents are first asked to design a network advisor and then compare and contrast their advisor with the PISA Network Advisor. They are also asked to survey the literature and find two more network advisors. They learn valuable lessons by comparing and analyzing the design of their own advisor with PISA and other advisors. The students, if needed, can also use the XML-based network plan to invoke network simulators like Opnet..
- **Systems Analysis and Design**: Students develop the model of a company, develop its application plan and then work with PISA-AIM to develop detailed requirements, architecture and integrated solution of chosen applications. For example, different groups in a class choose different application areas (e.g., procurement, CRM, supply chain management, and business intelligence) and then try to integrate their solutions. This turned out to be a really fun exercise.
- **Enterprise Architecture and Integration Using SOA**: An example of such a course is the "Architectures for Globally Integrated Enterprises" course that won the 'Best Course Proposed' Award from IBM in December 2007 (see www.ngesolutions.com/pisa/documents page to download the course description). Students develop the model of a company, develop its application plan and then work with PISA-AIM to develop detailed SOA-based architecture and integrated solution of chosen applications. Students develop a multi-phase SOA architecture using PISA by transitioning enterprise applications gradually to PISA.
- **Entrepreneurship**: The students play games in the life of a startup for the first five years. The game briefly described previously, guides the students to develop a business plan, seek funding, form partnerships, establish links with offshore sites, and investigate international business opportunities.
- **Business Modeling and Analysis:** The students develop detailed understanding of an industry segment by developing enterprise models, selecting enterprise applications, investigating business solutions, and exploring outsourcing options. The students heavily use industry patterns and business process patterns.

The following table shows how these courses are currently using the PISA, GEZA and PARIS services.

Concluding Comments and Future Directions

A research project focusing on Computer Aided Consulting has produced innovative services that can play the dual role of educating the ICT leaders as well as helping them solve practical real life problems in planning, integration, security, management and entrepreneurship. Results have shown that these tools greatly help in teaching difficult to explain concepts in difficult to teach courses. Encouraged by the results, we are aggressively adding more capabilities to the computer aided consulting services, forming partnerships with universities and SMBs around the globe, offering more courses through these services

and developing business games and simulations. Our long range goal is to form a powerful computer aided consulting institute that can be used in developing as well as developed countries.

Course Title	PISA Services Used	GEZA Services Used	PARIS Services Used
Strategic IT Planning	Enterprise Modeler, Application Advisor, Platform Advisor, Network Advisor	Outsourcing Center, Business Solutions	Business Process Patterns
Information Security, Controls and Governance	Security Advisor, Governance Advisor, Business Continuity Planner		Business Process Patterns, Business Continuity Patterns
Computing Networks (Data Communications)	Network Advisor, Advanced Capabilities Module for Network Simulations		Network Patterns
Systems Analysis and Design	Enterprise Modeler, Application Advisor, Integrated Requirements Generator,	Business Solutions	Industry Overviews, Business Process Patterns
Service Oriented Architecture (SOA)	Integrated Requirements Generator, Integrated Solution Advisor	Integration Planning	SOA Patterns, B2B Patterns
Entrepreneurship	Enterprise Modeler, Application Advisor, Platform Advisor, Network Advisor	Business Solutions, IT Solutions, Outsourcing Center, International Yellow Pages	Industry Overviews
Business Modeling and Analysis	Enterprise Modeler, Application Advisor	Business Solutions, IT Solutions, Outsourcing Center, International Yellow Pages	Industry Overviews, Industry Examples, Business Process patterns

Acknowledgements

Selected References

[1] Adams, J., et al, *Patterns for e-Business: A Strategy for Reuse*, IBM Press, October 2001.
[2] Alexander, C., *The Timeless Way of Building,* Oxford University Press, 1979
[3] Alexander, C. et al , *A Pattern Language*, Oxford University Press, 1977
[4] Boehm, B., and Abts, C., "COTS Integration: Plug and Pray". *IEEE Computer*, Vol. 32, No. 1, 1999, pp. 135-138.
[5] Buchanan, R. & Soley, R., "Aligning Enterprise Architecture and IT Investments with Corporate Goals. Meta Group/OMG white paper. http://www.omg.org/registration/META-OMG-WP-Public.pdf, 2002.

[6] Burton, F. et al, "An Application of Expectancy Theory for Assessing User Motivation to Utilize an Expert System", *Journal of Management Information Systems*, Vol. 9, Issue 3, 1993, pp. 183-199.

[7] Buschmann, E., et al, "Pattern-Oriented Software Architecture, Vol. 1, John Wiley, 1996.

[8] Carter, S., *The New Language of Business: SOA and Web 2.0*, IBM Press, 2007

[9] Chesbrough, H. and Spohrer, J., A Research Manifesto for Service Science, Comm of ACM, July 2006, pp. 35-40.

[10] Cooper, A., *The Inmates Are Running the Asylum : Why High Tech Products Drive Us Crazy and How To Restore The Sanity*, Sams Books, 1999

[11] Fox, M. and Gruninger, M., "On Ontologies and Enterprise Modeling", *International Conference on Enterprise Integration Modeling*, 1997

[12] Drucker, P., "The Next Society", Nov 1st 2001, The Economist.

[13] Gamma, E., et al, *Design Patterns*, Addison Wesley, 1994.

[14] Hevner, A., March, S.T., Park, J., and Ram, S., "Design Science Research in Information Systems", *MIS Quarterly*, Vo. 28, No. 1, March 2004, pp. 75-105

[15] Kidd, P., "Next Generation Enterprise Model", Revised September 2000, http://www.CheshireHenbury.com

[16] Lindström, Å., Johnson, P., Johansson, E., Ekstedt, M., Simonsson, M. "A survey on CIO concerns-do enterprise architecture frameworks support them?", Information Systems Frontiers, 8(2), 81-90, 2006.

[17] Mentza, G. et al, "Knowledge Services on the Semantic Web", Comm. Of ACM,, Oct. 2007.

[18] Todd, P. and Benbasat, I., "The Use of Information in Decision Making: An Experimental Investigation of the Impact of Computer-Based Decision Aids", *MIS Quarterly*, Vol. 16, No. 3 (Sep., 1992) , pp. 373-393

[19] Umar, A., and Missier, P., (1999), "A Framework for Analyzing Virtual Enterprises", *Research Issues in Data Engineering (RIDE) Workshop on Virtual Enterprises*, March, Sydney, pp. 31-38-

[20] Umar, A., "IT Infrastructure to Enable Next Generation Enterprises", *Information Systems Frontiers Journal*, Volume 7, Number 3, July, 2005, pp: 217 – 256. of Next Generation Enterprises

[21] Umar, A., "Decision Support for Enterprise Integration", *EDOC (Enterprise Distributed Object Computing) Conference*, Enschede, Holland, Sept. 2005b

[22] Umar, A., et al, "Computer Aided Consulting for SMBs", *IRMA (Information Resource Management Association) Conference*, May 2005c

[23] Umar, A., "Intelligent Decision Support for Architectures and Integration of Next Generation Enterprises ", *Informatica*, V. 31, No. 14, pp. 141-150., 2007

[24] Umar, A. and Subrahmann, "Ontology-based Network Planning", *International Journal of Business Data Communications*, Sept 2008.

[25] Umar, A., and Zordan, A., "Enterprise Ontologies for Planning and Integration of eBusiness*", IEEE Transactions on Engineering Management*, May 2009, Vol. 56, No. 2, pp. 352-371.

[26] Umar, A. and Zordan, A., "Integration Versus Migration Issues in Service-Oriented Architectures", *Journal of Systems and Software*, Vol. 28, 2009b, pp. 448-462.

[27] .Zha, X. and Howlett, R. (Eds.): *Integrated Intelligent Systems for Engineering Design*. Frontiers in Artificial Intelligence and Applications 149 IOS Press 2006, ISBN 978-1-58603-675-1

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