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Computer Aided Consulting for ICT: An Innovative Approach for Developing Countries

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Abstract

Most of the developing countries need to rapidly launch several ICT (Information and Communication Technologies) services especially in healthcare, education, economic development, public welfare, and public safety. Unfortunately, the failure rates of ICT projects are very high in developing countries (around 80%) due to skill shortages and re-invention of the wheel. To compound the problem, these segments also lack the financial resources to hire expensive consulting services with appropriate know-how. This paper describes an innovative computer aided consulting environment that is addressing this perplexing dilemma, accelerating the adoption of ICT services, and providing entrepreneurship opportunities in developing countries and underserved sectors in developed countries.

Keywords

Computer aided planning, Gamification, Innovation, Entrepreneurship, Developing countries, Patterns

1 Introduction

There is a tremendous demand for new ICT (Information and Communication Technologies) services and improvement of existing ones, around the globe -- especially in the developing countries. The ICT services, also known as eServices, are especially needed to support healthcare, education, economic development, public welfare, public safety and other vital sectors. However, almost all ICT service providers are struggling to do more with less. Specifically, how to offer more ICT services to more customers, businesses and government agencies with less money, time and staff. In addition, many ICT projects fail, i.e., they are never used by the intended users (the well known Standish Group Chaos reports indicate failures in the 50% to 65% range).

The situation is worse for developing countries (out of the 193 countries recognized by the UN, almost 150 are considered developing, with 52 in the least developed category). This large underserved sector (around 70% of the world population) has higher failure rates (around 85%) and also lacks financial and human resources. This is very unfortunate because this sector can neither afford expensive trial and error approaches nor hire good and expensive consulting firms that charge around $250,000 per assignment. The core problem is the re-invention of the wheel throughout the Learn-Plan-Do-Check life cycle. The needed know-how exists. *The challenge is: how to specialize this knowledge to different types of ICT services for different countries and then to transfer it to all users rapidly, economically and globally.*

This challenge cannot be addressed by the commonly available computer aided software engineering environments, known as Integrated Development Environments (IDEs), that quickly generate code. Unfortunately, too much attention is being paid to IDEs such as Rational Rose, Visual Studio and the like but almost no attention is being paid to the Integrated *Consulting* Environments (ICEs) that could systematically guide the users throughout the Learn-Plan-Do-Check cycle for different ICT services in different countries. To search for such an ICE, we reviewed 20 consulting organizations, including ours, and found that there is a need for a paradigm shift from computer aided software engineering to computer aided *consulting* which concentrates on ICE instead of IDE (see Section 2). To address this need, we initiated research into a comprehensive ICE that could support a highly effective and inexpensive computer aided consulting practice with initial focus on SMBs (Small to Medium Businesses). This research has now been extended to developing countries with very encouraging results.

The research approach and conceptual ICE model are explained in Section 3. The main output of this research is the SPACE (Strategic Planning, Architectures, Controls and Education) environment that is part of the United Nations eNabler Project. Simply stated, SPACE simulates a team of consultants (experts) that collaborate with each other to solve complex ICT problems. A theoretical model of SPACE is presented in Appendix A. Section 4 presents a quick overview of how SPACE has been and is currently being used in developing countries such as Cambodia, Camaroon, Nepal, Nigeria, Liberia, Macedonia, Myanmar (formerly Burma), Rwanda, and Southern Sudan on projects that range from simple eService to inter-agency and inter-country communications. Section 5 concludes this paper by outlining future areas of work.

2 Relation to Existing Work: Quick Analysis of ICT Consulting Models

ICT consulting is possibly a highly effective approach to address the aforementioned challenge, i.e., how to specialize the needed knowledge about different types of ICT services for different countries and then to transfer it to all users rapidly, economically and globally. Figure 1 shows a simplified view of existing ICT consulting models that could be used to address this challenge.

- <u>Body Shop Model</u> in which all of the work is done by the consultants. Virtually no automated assistance is used. This model, typically used in small consulting firms or new divisions of larger consulting firms, is very flexible but is too expensive and does not scale well for remotely located SMBs and enterprises in developing countries (it is difficult for a consultant living in Manhattan to offer consulting services to a company in Cambodia).
- <u>Directory Assisted Model</u> in which a directory of consultant expertise (who knows what) is maintained so that the customer questions can be directed to the right consultants. Directories are typically updated as the consultants gain more experience and training and may also contain FAQs (Frequently Asked Questions). This model, typically used in larger consulting firms is also very flexible but is too expensive and not suitable for the underserved sectors because almost all the work is still done by the consultants.
- <u>Knowledgebase (KB) Assisted Model</u> in which the actual knowledge of the consultants (e.g., presentation slides, analysis reports, proposed solutions, meeting minutes, etc) are maintained in a knowledgebase for reuse among consultants. This model, typically used in large consulting firms, is very flexible and gives the consulting firm a competitive

edge due to high reuse of the knowledge. However, it still does not help the underserved sectors because this knowledge is a highly protected intellectual property of the firm that is not freely available to the underserved sectors.

- Integrated Consulting Environment (ICE) Model in which the firm relies primarily on the knowledgebase plus decision support and expert systems tools and games for *directly* delivering consulting services to remotely located users. This model, explained later in this paper, is an innovative approach because the users themselves can develop solutions, albeit partially, and the remaining work (if any) is done by the consultants. This is especially of significant value to the developing countries and other underserved sectors for rapid and inexpensive remote delivery of ICT consulting services to minimize errors, retries and failures.

These consulting models are not mutually exclusive – a consulting firm may use a mixture of these models based on the expertise of its available consultants, the location and type of customers, and financial considerations. In addition, these models are not restricted to ICT – consulting firms in manufacturing, construction, transportation and other sectors also could follow similar models.

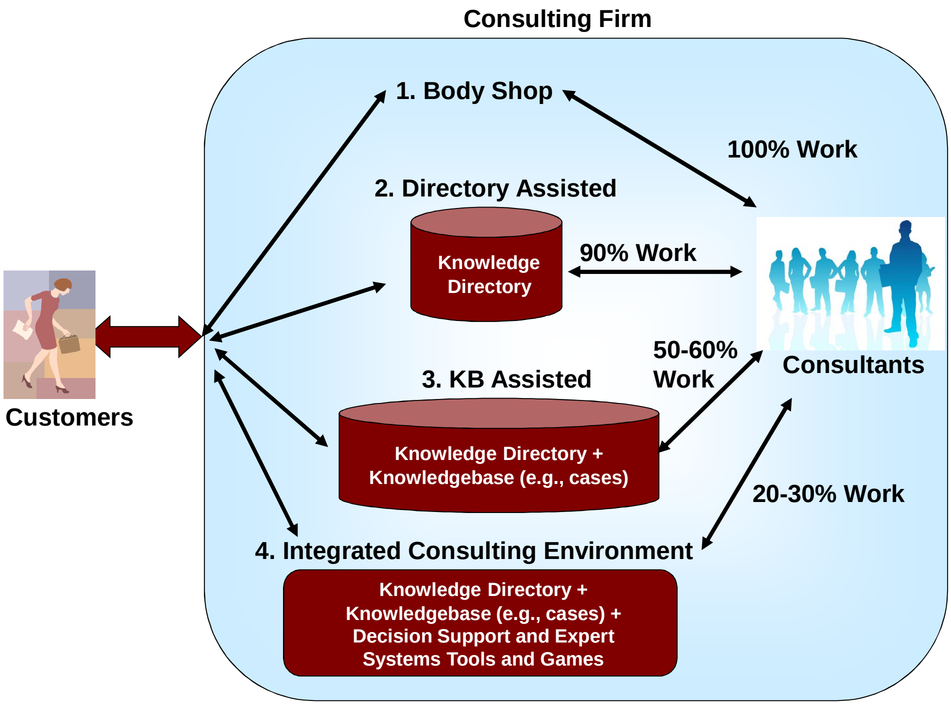

Figure 1: Models of Consulting in ICT

This analysis has shown us that the ICE-based consulting approach is most suitable for the underserved sectors but is not being used because virtually no ICE has been reported in the commercial or academic literature. In addition, an integrated *consulting* environment, the focus of this research, differs from the commonly available integrated *development* environments such as Rational Rose and Visual Studio (see Table 1).

IDE (Integrated Development Environment)	ICE (Integrated Consulting Environment)
Intended for software developers	Intended for IT managers, planners and consultants
Focus is on development	Focus is on finding a solution (buying, renting, and outsourcing)
Result is code generation	Result is management plan and document generation
Mainly a technical service	Mainly a knowledge service
Results are of value to technical staff	Results are of value to management plus technical staff

Table 1: IDE Versus ICE

3 Research Approach and the Conceptual ICE Model

3.1 The Research Agenda

Our goal is to develop an integrated *consulting* environment (ICE) that can specialize the needed know-how for different situations in all phases of ICT life cycle and then transfer it to all users rapidly, economically and globally. We wish to take advantage of the research in integrated intelligent systems where a collection of intelligent systems (e.g., expert systems) collaborate with each other to solve real life problems [Ferguson and Allen 1996]. We want to simulate a team of experts that solves complex ICT problems. In particular, an ICE should capture the following attributes of *good* consultants:

P1: They have specialized know-how about business as well as technical issues
P2: They heavily rely on *inferences and observations* to reach conclusions instead of asking too many irrelevant questions
P3: They use *patterns* to utilize the best practices and successful experiences instead of every possible point in the solution space
P4: They produce documentation that can be used by the clients to understand, communicate and implement the recommendations.
P5: They collaborate with each other and the customer to solve complex problems (e.g., collaboration between a network expert, a security expert and an IT manager to develop a secure network).
P6: They provide a combination of expert advice, decision support, and intelligent assistance as needed.
P7: They can provide 'quick and approximate' answers when needed and engage in detailed discussions and investigations where appropriate.
P8: They produce results quickly and correctly to respect the time constraints

These attributes, along with the challenges listed in Section 1, establish the main research agenda. The resulting SPACE environment has been developed by taking advantage of the latest thinking in patterns [Adam 2001, Alexander 1979, Buschmann 1996, Ferdinandi 2008, Gamma 1994, Hohpe 2003], knowledge services [Mentzas 2007], service innovation

[Chesbrough and Spohrer 2006], and intelligent integrated systems [Ferguson and Allen 1996]. Main results from this on-going research have been published [Umar 2005, Umar 2007, Umar 2008, Umar 2009, Umar 2011, Umar 2012] and more research papers are planned in the future as we gain more knowledge and insights.

3.2 The Conceptual ICE Model

Figure 2 shows the conceptual ICE model that we propose – it supports the entire Learn-Plan-Do-Check cycle. This conceptual model is the basis of the SPACE (Strategic Planning, Architectures, Controls and Education) environment that consists of the following components (shown in Figure 2):

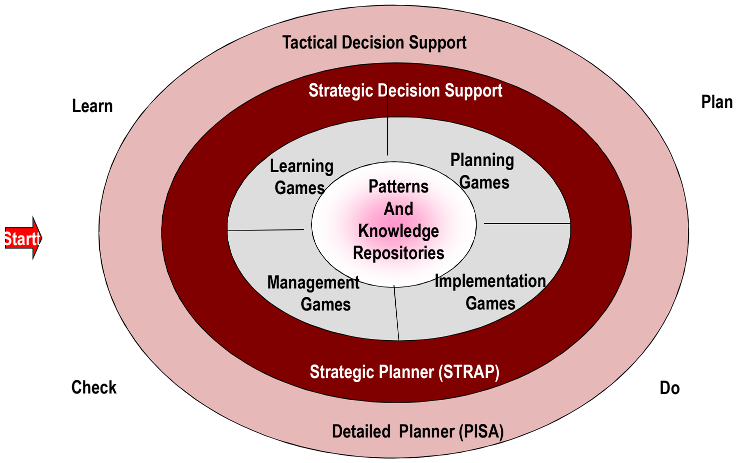

Figure 2: Conceptual View of ICE – The SPACE Environment

- <u>Patterns Repository</u> that captures the core knowledge needed by all SPACE tools. The pattern repository consists of industry patterns (e.g., health, education, public safety, public welfare, transportation), technology patterns (e.g., computing platforms, wired and wireless networks), operational patterns (e.g., security and integration patterns), and even country patterns (e.g., government patterns in different countries).
- <u>Games and Simulations</u> that support decisions in strategic analysis, mobile services planning, security planning, interagency integrations and health exchanges, application migration versus integration tradeoffs, risks and failure management, and quality assurance. We have developed 20 eBusiness and eGovernment games at the time of this writing.
- <u>Strategic Planner</u> is a strategic decision support tool for the IT officials in governments and the private sectors. It helps them to strategically plan, architect, integrate, and manage the needed IT initiatives quickly and effectively by using the best practices. The Strategic Planner consists of 6 Intelligent Advisors (expert systems) that collaborate with each other through the patterns and games.
- <u>Planning, Integration, Security and Administration (PISA)</u> is a detailed decision support tool that can be used to quickly build real life business scenarios and then guide the user through IT planning, integration, security and administration tasks by using best practices and patterns. PISA consists of 9 Intelligent Advisors (expert systems) that collaborate with each other through the patterns and games.

Initially, SPACE consisted of only two collaborating advisors (network planner and security planner) that assisted the users in network security planning. At present, SPACE has evolved into a very strong ICE, consisting of 24 collaborating advisors and 20 games, that simulates a very strong consulting practice. Please note that the pattern repository is at the core of the entire SPACE environment – the patterns are used in all games as well as detailed and strategic planning advisors. A theoretical model that shows how the key components interact with each other is given in Appendix A. Extensive information about SPACE can be found at the website (www.space4ict.com).

3.3 The Usage Scenarios

SPACE (Strategic Planning, Architecture, Controls & Education) is being used as a Computer Aided Consulting environment where SPACE does 60-70% of the work and a consultant/expert does the other 30%. Specifically, the user develops the enterprise architecture reports, strategic plans and solution sketches in less than an hour. This does 60-70% of the work, the remaining 30-40% is done by local experts and/or the users themselves. This model, similar to the well known legalzoom.com model, is illustrated below. In addition, SPACE is being used as an educational tool. This fits well within the scope of computer aided consulting because good consultants are good problem solvers and teachers.

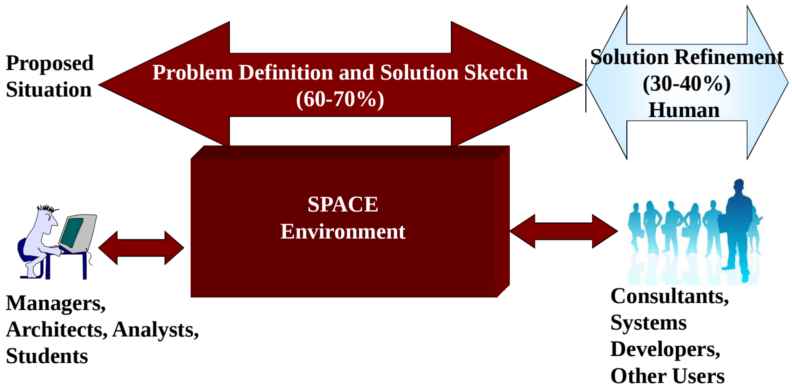

Figure 3: Conceptual View of SPACE as ICE

Specific examples of SPACE as an ICE are:

- Online Education: The customer uses SPACE games and planning tools for hands-on experiments and self-assessment in a series of short online-courses. These courses cover important topics such as strategic planning, integrated architectures and management of ICT services.
- Collaborative Problem Solving: The customer develops a solution sketch by using SPACE and the consultants finalize the solution. This is especially suited for developing countries and small to medium businesses because it dramatically cuts down time and

cost. The customers spend only 30% of the time and cost as compared to the typical consulting assignments.

- SAAS (Software as a Service): The customer develops a solution by using SPACE and, if needed, uses his/her own time and staff to enhance/customize the solution. This is especially suited for people who are experts in the field and/or have access to local experts. A consultant may also use SPACE as a SAAS for improved efficiency.

3.4 Supporting Different User Modes – Tradeoffs between Accuracy and Effort

A major challenge in building a *usable* ICE is that the participants in an IT project (mangers, analysts, consultants, marketing professionals) have to make different decisions with different goals under different time constraints. Managers, for example, frequently need rough information that can be obtained quickly to make decisions and cannot wait for more accurate information that may need a great deal of time and effort. On the other hand, technical experts and consultants frequently need very detailed information for sophisticated analysis and simulations. We have exploited behavioral research in accuracy versus effort tradeoffs [Burton 1993, Todd 1992] to please different audiences (Figure 4). Two results from this research are of direct value to us: a) the use of a decision aid is of value if it results in effort savings but not necessarily improved decision performance and b) the impact of the decision aid is more pronounced in cases with a larger number of alternatives to choose from.

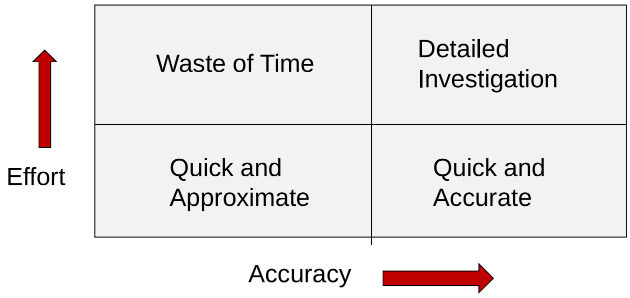

Figure 4: Accuracy Versus Effort Tradeoffs

We want to develop an environment that saves effort but also improves decision quality to satisfy different users and to comply with research objectives (P6, P7, P8). Specifically, our design takes into account the tradeoffs between accuracy and effort, as displayed by the four cells in Figure 4:

- **High effort, low accuracy (waste of time);** This is avoided by not asking any unnecessary questions because the user effort is measured in terms of number of times a user has to provide input. The formal model, described in Appendix A, shows that less than 10 parameters impact all stages of the planning process. These parameters are captured in the first interview to minimize user inputs.

- **Low effort, low accuracy (quick and approximate)**: This is explicitly supported by using an 'Express mode' where an advisor behaves as an expert system and uses patterns to produce quick but approximate recommendations,

- **<u>High effort, high accuracy (detailed investigation)</u>**: This is supported through an 'Explore mode' where an advisor behaves as a decision support system and allows the users to explore and modify/extend the recommendations for a more customized solution.
- **<u>Low effort, high accuracy</u>**: We are attempting to support the highly desirable goal by improving patterns to produce quick and accurate answers. Since we use patterns heavily to provide defaults, the quality of these defaults can be improved by gradually improving the pattern repository.

4 Key Results: Computer Aided Consulting in Practice

4.1 A Closer Look at SPACE as ICE

ICE is envisioned as an online service, displayed in Figure 5, that is conducted in collaboration between suppliers and consumers. In the current situation, IT consultants and marketing professionals spend a great deal of time and effort (60 to 70%) defining the project, documenting the present method of operation (PMO), and preparing rough plans for future method of operation (FMO) based on discussions with the customers. The documents are sent to the IT managers and other stake holders to verify that the information captured is correct. This goes through a few iterations (typical clock time may be more than a month). The balance of the time is spent refining implementation plans for FMO. In the proposed model, the *user* (e.g., IT manager) defines the project (step 1) and quickly creates well documented PMO-FMO plans by using an ICE (step 2). The user then asks a consultant to review and refine the documents – this happens collaboratively between the consultants and IT managers (steps 3 and 4). This computer aided consulting scenario supports P2-P6, A major advantage of this scenario is a dramatic decrease in time (it can reduce time by 60-70%), cost reductions and improvement of results.

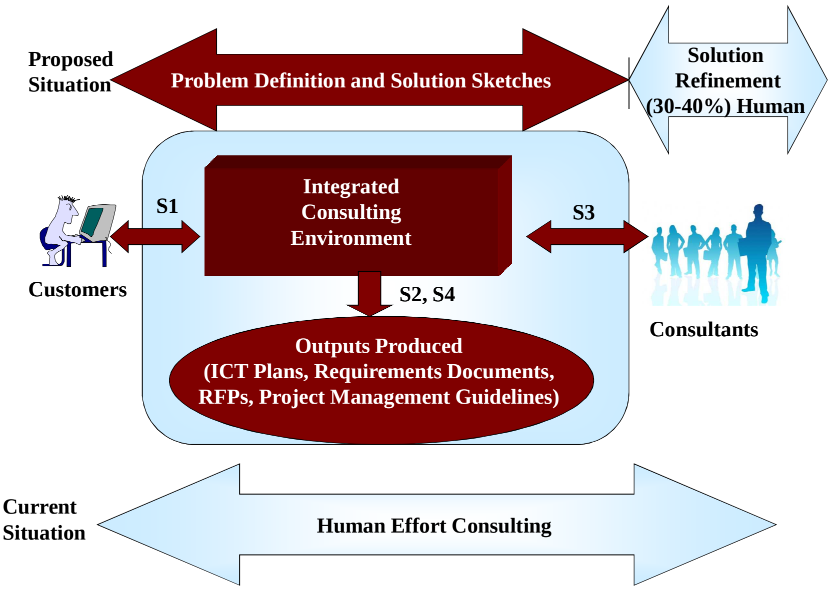

Figure 5: Detailed View of SPACE as ICE

Discussions with more than 30 representatives from developing countries, consulting organizations, technology providers, small to medium businesses have revealed several variants of the scenario presented in Figure 5. Examples of some of the scenarios that have already been used are discussed in the next section.

4.2 Main Results and Specific Examples

SPACE (Strategic Planning, Architecture, Controls & Education) is being used as a Computer Aided Consulting environment where SPACE does 60-70% of the work and a consultant/expert does the other 30%. Key benefits of the model are:

- Significant time reduction (from 3-5 months to 3-5 days)
- Significant cost reduction (by 60 to 70%)
- Error reduction through consistent usage of best practices and enforcement of industry standards
- Usage by remote customers, especially in the developing countries, to receive quality consulting services anywhere
- Rapid replication of knowledge gained and best practices
- Continuous staff training through use of best practices and education of customers through hands-on experiments.

Specific examples of the practical use of SPACE are (please see [Umar 2011, Umar 2012] for more examples):

- Mobile health clinics (MHCs) for remotely located populations that need urgent help. MHCs are the *primary* healthcare method for countries like Southern Sudan. Special considerations are also needed for mobile clinics in the Far East where remote populations can be reached only by boats.
- Provide entrepreneurship opportunities for young entrepreneurs in Nepal, Nigeria and Rwanda who are establishing computer aided consulting businesses by using SPACE.
- Actively work with UN-based programs such as Infopoverty and worldwide charity programs such as United Methodist Communications to rapidly establish digital and "smart" community centers around the globe.
- Support for university courses in gamification. For example, two graduate courses (Strategic Planning and Gamification, and Gamified Entrepreneurship) at Harrisburg University are being supported by SPACE.
- Online education for primary school teachers to address the urgent need of improving primary school education and also online education of the government officials in Cambodia, Myanmar and Niger to properly plan and manage ICT projects.
- Support social welfare projects such as ICT-based assisted living facilities in Central Europe. These facilities are being developed to support aging populations that choose to move to developing countries for economic reasons.

- Mobile computing apps, especially location based services, to support large numbers of users that need wireless access to existing eGovernment and eBusiness systems such as online purchasing, customer relationship management and portals.
- Economic development, especially entrepreneurship networks between startups and financiers. This includes entrepreneurship centers with focus on micro finance in countries such as Nepal and Camaroon.
- Help Nepal to develop a detailed plan for a digital city in Hetauda County. The plan was generated to obtain public acceptance and funding.
- Help charitable organizations such as the United Methodist Communications to develop Digital Community Centers for impoverished populations around the globe.
- Support of mobile services in the public safety sector for emergency response units and law enforcement for an island in the Pacific.
- Information exchange networks between different government/business agencies for industrial growth in countries such as Macedonia.
- NIEM (National Information Exchange Model)-based interagency communications that interconnect the individual government agencies.

In addition, we are actively engaged in the following educational and capacity building assignments:

- Users play simple games to gain insights into wireless planning, enterprise architecture (EA) blueprints and interagency communications and then use the Planner.
- Users develop their own future configurations by using SPACE and examine how different products could fit into their future plans.
- Marketing professionals use SPACE to illustrate, in real-time, how their products could be useful to a particular customer. A SPACE tool goes beyond the typical Powerpoint presentations to a collaborative experimentation session between marketing professionals and potential customers.
- Universities and corporate training courses in strategic IT planning, mobile computing, enterprise architectures and integration, SOA, business modelling, and entrepreneurship. For example, a graduate level program at Harrisburg University of Science and Technology has been launched to educate ICT leaders in the public and private sectors. This program heavily relies on the SPACE concept and computer aided consulting paradigm.

5 Conclusions and Future Directions

We have learned several invaluable lessons in this project. The key positive finding is the significant reduction of time (from 3-5 months to 3-5 days) and increased chance of success due to repeated use and refinement of know-how. Our long range goal is to make the SPACE environment a very powerful tool through continuous discovery and refinement of its capabilities by working with the users. Some of the future directions are:

- Provide deeper and broader knowledge support by expanding the capabilities of the patterns repository. In particular, we want to expand the intelligence capabilities of the inference engine by improving the reasoning and learning features through extensive use of Smart Data and Semantic Web concepts.
- Significantly expand the games and simulation capabilities. Most of the SPACE advisors at present are implemented as Web Services so that they can be invoked from another advisor or from a game. We are especially investigating how large number of games can be developed based on the pattern repository and SPACE advisors.
- Explore new areas of work in ontologies, government patterns, patterns languages, case based reasoning and similarities for governments and countries.

Acknowledgements

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Appendix A: The Formal Model

Figure 6 shows a formal view of how a few "Intelligent Advisors" collaborate with each other to support the Enterprise Modeling, Application Planning, Integration Planning, Network Planning, and Security Planning activities in a usage scenario (a detailed description of this model can be found in [Umar and Zordan 2009]). The main inputs of this model are:

- **Enterprise parameters** ***E*** = *{E1, E2, E3, .. E9}* where *E1* = company type (e.g., healthcare), *E2* = company size in terms of number of employees, *E3* =company distribution (e.g., local, regional, international), *E4* =reliance on the Web to conduct business, *E5* = reliance on mobility to conduct business, *E6* = number of participants (supply chain depth) involved in a single typical transaction, *E7* = transaction activity (transaction volume x transaction value), *E8* = Trust model underlying the transactions, and *E9* = level of bonding (collaboration) among business partners. These core parameters, the only inputs required from the user, impact all stages of the model (see discussion below). Thus by specifying or changing these few parameters, the planner can quickly investigate a new business scenario by generating application plans, computing configurations and network plans.
- **Patterns** *BPP* (Business Process Pattern), *AP* (Application Pattern), *PP* (SOA Pattern), *NP* (Network Pattern), and *SP* (Security Pattern) that provide generic sketches in different stages of the model (see Figure 6). These patterns are customized to produce a company scenario specific solution. The planning knowledgebase contains these patterns and COTS database needed to support the model. As shown in Figure 6, customization of patterns is based on the enterprise parameters *E*, stage specific inputs and *PM*s accumulated in the knowledgebase.
- **Stage specific user input parameters *U* = *{U1, U2, U3, U4, U5}*** that are provided by the user in different stages of the model (see Figure 6). These parameters are used to provide the stage specific information, if needed. SPACE automatically provides a set of reasonable defaults for these parameters based on patterns. Thus, if the user is in a hurry, a default solution sketch can be created extremely quickly (within 15 minutes). However, the user may override the default parameters for more customized analysis. For example,

network pattern *NP* of a home office consists of a DSL/cable modem plus a wireless-wired router. If a user does not specify any stage specific parameters in network planning, then this pattern is used as a network plan. However, if a user indicates no wireless access, then the wireless router is removed.

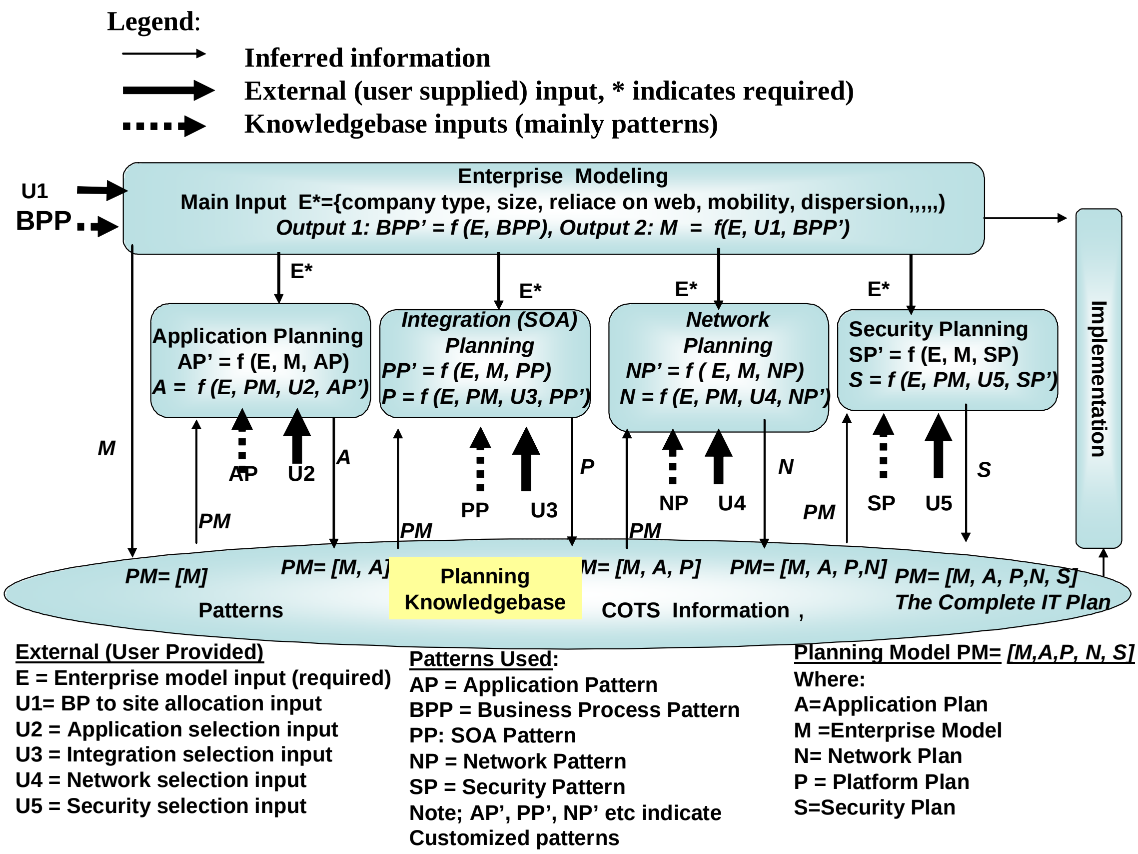

Figure 6: Formal View of the ICE Model

To explore the theoretical basis, it is instructive to examine the following abstract relationship that holds in all stages of the model as shown in Figure 6:

$$O_j = f\,(E, PM_{j-1}, U_j\,, P_j\,) \text{ for } j = 1 \text{ to } 5 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

This relationship shows that the output O_j in stage j is influenced by some core parameters (*E*), accumulated knowledge PM_{j-1} in the planning knowledgebase from the previous stages, stage specific inputs U_j and patterns P_j. The main output produced by this model is the **planning model *PM*,** a set which consists of several subsets where each subset represents results of a planning stage. In the beginning, *PM* is a simple sketch that is successively enriched as the user progresses through different stages of the proposed model, i.e., at the end of stage j, $PM_j = \{PM_{j-1}, O_j\}$ where O_j is the output produced in stage j. Basically, *PM* is a set which consists of several subsets and each subset is created by and maintained by an advisor. At the conclusion of a user interview, a complete plan is contained in the *PM*, i.e., *PM = {M, A, P, N, S}* shows the final plan where *M*, *A*, *P*, *N* and *S* represent the enterprise model, the application plan, the platform plan, the network plan, and the security plan, respectively. Given the inputs *E* that represent enterprise parameters, *U* that represent stage specific information and the patterns *(BPP*, *AP*, *PP*, *NP, and SP),* Figure 6 shows the relationships that are used to gradually create a final IT plan *PM = {M, A, P, N, S}*.

Specifically, given basic information about a business many inferences about the business processes, applications, networks, platforms, architectures, security, and performance can be reached. These inferences do not lead to complete solutions but instead produce sketches that are refined through additional questions by the various advisors. For example, the computing platforms as well as computing networks generated above are refined through additional questions. Finally, there is a need for collaboration between the solutions generated. For example, the network solution and the computing platform solution are used as an input to the Security Advisor to develop a security solution.