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Incorporating Evolutionary Acquisition into Interdisciplinary Research Project Management

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Abstract. What should be done when interdisciplinary research involves systems development? This work proposes an answer that involves Interdisciplinary Research Project Management and Evolutionary Acquisition. The former is a strategy to increase productivity of interdisciplinary research through Project Management concepts and Problem-Based Learning; the latter is a system development methodology. Hence, this paper aims to provide a methodology for systems development that use or involve interdisciplinary research; the methods are Interdisciplinary Research Project Management, Project Based Learning and Evolutionary Acquisition; and the main result is summarized in a diagram where Evolutionary Acquisition is incorporated into Interdisciplinary Research Project Management.

Keywords: EA-IRPM, evolutionary acquisition, innovation, interdisciplinary research, IRPM, methodology, problem-based learning (PBL), project management.

1. Introduction

The words productivity, education, management and innovation, are a daily reality in academic world. Professors and students are demanded to increase production, while education is a demanded activity. Consequently, to manage has become a necessary quality and to innovate an expected result. In order to raise results, an approach to innovation in interdisciplinary research that promotes education has been presented in [1], the IRPM – *Interdisciplinary Research Project Management*. However, what should be done when the interdisciplinary research involves systems development?

IRPM may be combined to other strategies [1], in particular to a system development methodology. Therefore, to answer the proposed question, this work presents a way to incorporate a system development method – *Evolutionary Acquisition* [2], into IRPM. This combination has been used by NDS – "Núcleo de Desenvolvimento de Software" (Software Development Nucleus), at UFT – Federal University of Tocantins, Brazil. Three examples of its use are an academic project management system [3], a Medicine 2.0 architecture for managing transplantation patients [4], and a social network web portal to provide free Internet access for public schools' communities [5].

As far as the author knows, some strategies for interdisciplinary research have been proposed, but they are restricted to specific fields. A framework for using TRIZ in a co-disciplinary design environment of electromechanical products was proposed in [6] by de Vries *et al.* For a clinical service organization, King *et al.* in [7] proposed a framework of operating models for interdisciplinary research programs. In an agricultural research context, Nuijten in [8] proposed a combination of natural and social sciences research styles. A systematic framework for supporting cross-disciplinary efforts was proposed in [9] by Wild. Further, Wilson in [10] exposed the interdisciplinary research and publication opportunities in information systems and healthcare.

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It is also desirable to incorporate interdisciplinary research experiences into teaching activities to: promote the transition from undergraduate modules to postgraduate research when applied in both levels, as highlighted in [11]; be useful for training undergraduate students in interdisciplinary methods, which is an objective in [12]; and help faculty for "a new way of working and thinking" to do interdisciplinary research, as a necessity exposed in [13]. IRPM may facilitate these three aspects.

The author organized this paper in accordance to the IMRAD structure: introduction, methods, results and discussion; which is adopted as part of the Uniform Requirements for Manuscripts Submitted to Biomedical Journals of the International Committee of Medical Journals Editors, 2008 update. The author believes that adopting this structure would help search engines in international databases to store and to retrieve information within research papers in order to facilitate meta-analyses and systematic reviews.

2. Methods

In this section is presented the main methods that support the proposed interdisciplinary system development methodology: IRPM – *Interdisciplinary Research Project Management*, and EA – *Evolutionary Acquisition*. *Project Management* concepts and *Problem-Based Learning* (PBL) are within IRPM.

2.1. Interdisciplinary Research Project Management

IRPM is a strategy for an interdisciplinary approach to a real problem using Project Management concepts [14] and a problem-based learning approach [15], [16]. IRPM's schematic is present in Figure 1, but first let us briefly review the Project Management phases:

1. Initiation: to determine project goals, deliverables and process outputs, to document project constraints and assumptions, to define strategy, to identify performance criteria, to determine resource requirements, to define the budget and to produce a formal documentation.
2. Planning: to refine project, to create a work breakdown structure, to develop the resource management plan, to refine time and cost estimates, to establish project controls, to develop the project plan and to obtain the plan approval.
3. Execution: to commit resources, to implement resources, to manage progress, to communicate progress and to implement quality assurance procedures.
4. Control: to measure performance, to refine control limits, to take corrective action, to evaluate effectiveness of corrective action, to ensure plan compliance, to reassess control plans, to respond to risk event triggers and to monitor project activity.
5. Closing: to obtain acceptance of deliverables, to document lessons learned, to facilitate closure, to preserve product records and tools, and to release resources.

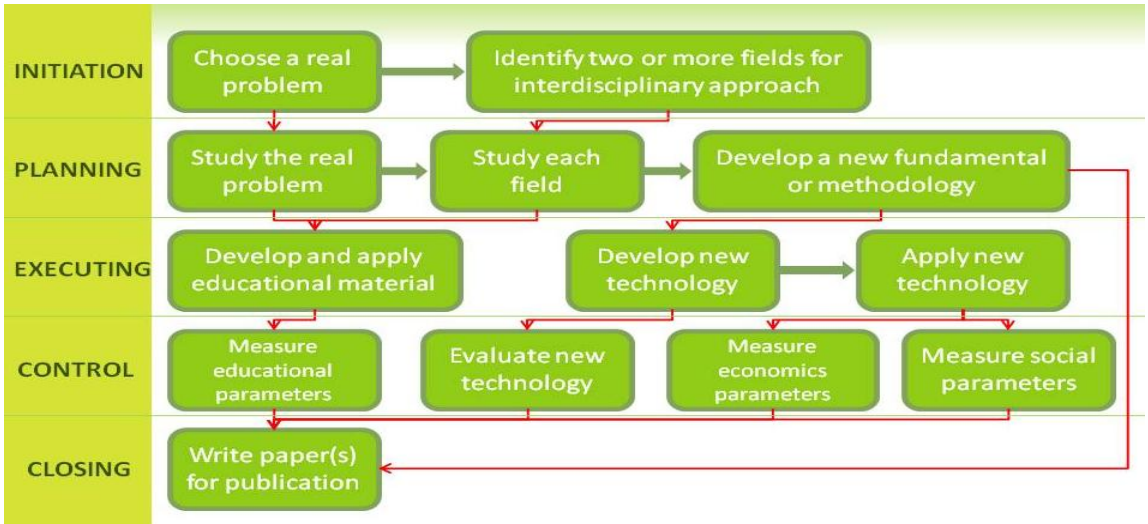

Fig. 1: The Interdisciplinary Research Project Management model.

In IRPM, Initiation phase begins with choosing the real problem to solve and identifying at least two fields for an interdisciplinary approach. These fields are necessary to: document the real problem constraints and assumptions; define strategy; identify performance criteria; determine resource requirements; define budget; and produce formal documentation. Planning phase consists of refining project and analyzing the real problem by use of the chosen fields. These studies may produce a new fundamental or methodology. Therefore, in Execution phase, even if new concepts are not obtained, an educational material may be prepared and used in class for a *Problem-Based Learning* approach, which according to Savery in [15] is

> *an instructional (and curricular) learner-centred approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem.*

Still in the Execution phase, if a new fundamental or methodology was developed, then a new technology may be implemented and used. Moreover, if in Planning phase controls were established then educational, technological, economics and social parameters may be available for measurement, allowing Control phase to be performed. Finally, after analyzing measurements, papers should be written as part of Closing phase.

2.2. Evolutionary Acquisition

Our system development methodology is the *Evolutionary Acquisition*, which is represented in Figure 2 [2]. It starts with the requirements analysis. After defining the "general" requirements for the system and the "specific" requirements for the core, the concept of operations must be elaborated. Then together with a requirements analysis of user feedback, technological opportunities and threats evaluation, the preliminary system architecture should be developed. From the system architecture a core should be produced. New definitions and developments with an operational test may result in a new version of the core. Then with experience and use, new refinements and updates of requirements may be identified that may be used to develop a new core.

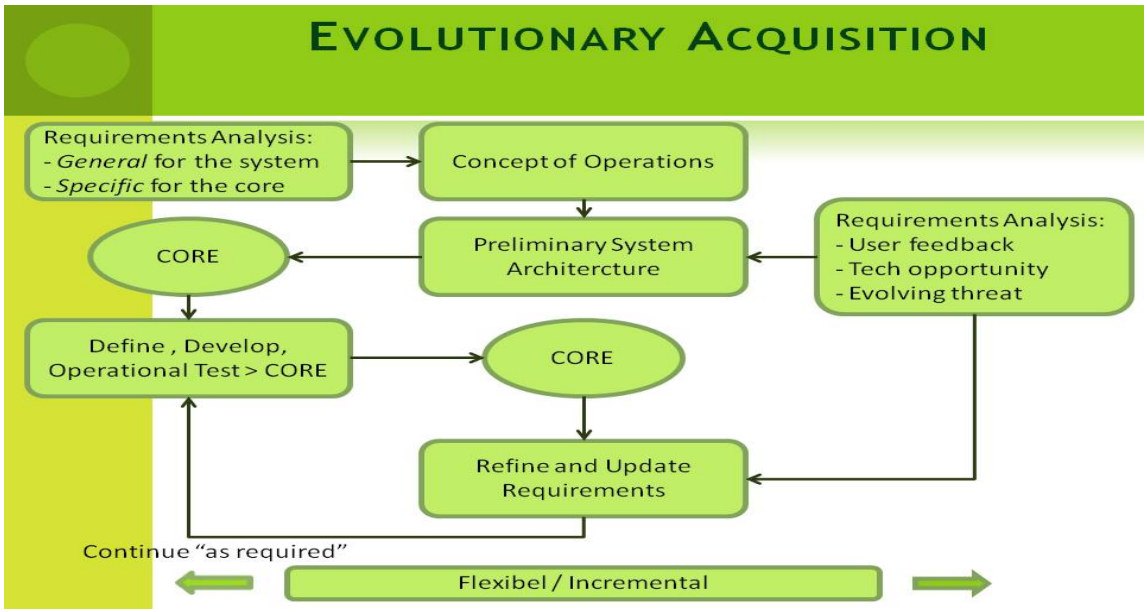

Fig. 2: The Evolutionary Acquisition diagram.

3. Results

The incorporation of EA into IRPM is presented in Figure 3. It shows that the diagram of Figure 2 may be inserted into phases Planning, Executing and Control of Figure 1. In Figure 3 RA means Requirements Analysis of: (1) general for the system and specific for the core; and (2) user feedback, technological opportunities and evolving threat. Hence, in Planning phase, more specifically after studying the real problem through the lens of the interdisciplinary fields chosen in the Initiation phase, the attempt to develop a new fundamental or methodology consists of generating the preliminary system architecture. That is, beginning with RA 1, and then elaborating the concept of operations to build the preliminary system

architecture considering RA 2 if available. Then Executing phase starts with the development of a new technology, which consists of implementing the core from the preliminary system architecture followed by new definitions and developments to perform operational tests. Afterwards, the new technology is applied in a real life situation, i.e. the core should be put in production. Control phase is about refining and updating requirements, which implies in evaluating technology, measuring economic and social parameters, and verifying users' feedback, technological opportunities and evolving threats, that is, RA 2.

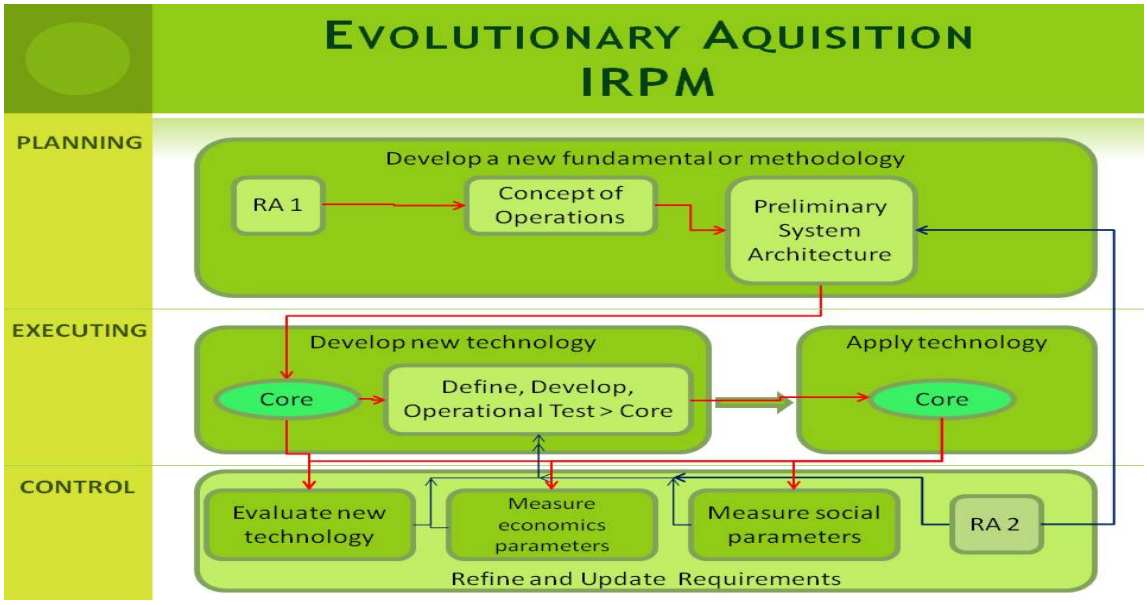

Fig. 3: The insertion of the Evolutionary Acquisition into the Interdisciplinary Research Project Management model.

4. Discussion

Competition in academic environment is increasing, especially with regards to results. While professors feel under pressure, students might feel neglected. Additionally, students may think that the University is lacking real life experiences, which might have a negative impact in their professional formation.

IRPM intends to provide the strategy that satisfies both needs. It satisfies professors because it should increase interdisciplinary research results, and it satisfies students because it gives them real problems in a *Problem-Based Learning* (PBL) way. Also, if it is used in class, then the results may be publishable, once more increasing production. Further, to transmit a real experience of interdisciplinary research to students may contribute to their professional formation, because science is becoming more interdisciplinary in accordance to Porter and Rafols [17]. Hence, it might be part of their future work.

When the interdisciplinary research involves systems development, it is possible to combine a methodology for system development and IRPM, as claimed in [1]. In particular, *Evolutionary Acquisition* is the technique employed. Their combination was shown through block diagrams in Figures 1 and 3. These diagrams are easy to understand such that students may also profit with their use in a classroom environment when applying PBL. Finally, this work intends to support the development interdisciplinary systems providing a clear strategy and techniques for future references.

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