A Web System for Farming Management

Glaubos Climaco, Fernando Chagas, Valéria M. Silva, Gentil V. Barbosa, and Patrick Letouze

***Abstract*—This paper presents a web system for farming management that implements a conceptual framework for modeling the production system at a farm scale. The web system supports the design of the production system, which is logically split in three parts: the decision support sub-system the technical sub-system, and the bio-physical sub-system. Additionally, the web system was designed using interdisciplinary research project management (IRPM) concepts, with an architecture known as Model-View-Controller (MVC), that is, it was developed applying the MVC Evolutionary Acquisition IRPM.**

***Index Terms*—Agribusiness, IRPM, production system, web system.**

I. Introduction

Farming systems are demanding innovative design to increase production, and given the complexity of intervention, their modeling is requiring: the representation of the biophysical, technical, and decision processes involved; and the evaluation ex-ante of the impacts of technical or organizational innovations that are difficult to measure experimentally [1]. Hence, a modeling framework was proposed by Gal *et al.* in [1] that focuses first on the field and herd level where biotechnical models associating biophysical processes with technical interventions are conceived.

The framework's aim is to support farmers in the design of their production systems at the farm level. However, poor farming families or communities usually do not have the means or knowledge to make use of such framework. In that case, governmental intervention may be required. This is the case of the state of Tocantins – Brazil, especially in the regions called "territórios da cidadania" (citizenship territories).

A possible solution for governmental intervention is a web-based system that supports the interaction between the farming family and the technicians specialized in the innovative design of farming systems. In particular, this work presents such web-based management application focusing on Gal *et al.* in [1] on designing dairy farming systems.

This web system was developed by NDS – Software Development Nucleus of UFT (*Universidade Federal do* Tocantins – Federal University of Tocantins), and it is called EESTO (http://comp.uft.edu.br/eesto). Hence, it was employed NDS' standard strategy for developing interdisciplinary research web-based systems, our previous work, the MVC Evolutionary Acquisition IRPM [2], which intends to provide adaptability to the research [3].

The pattern Model-View-Controller (MVC) [4], [5] separates the business logic – Model, the user interface – View, and the user input – Controller. Consequently, it provides a way to split functionalities to independent development, testing and maintenance. That is, the Model represents the application data and business rules that command data access and its modification, which also keeps business state and provides to the Controller the ability to access encapsulated functionalities. The View displays the system's state and the Controller sets the application behavior. Hence, the MVC pattern is suitable because it has been widely adopted to develop web services [6], and because the biophysical, technical, and decision processes involved are part of the business logic.

Our research methodology, the Interdisciplinary Research Project Management (IRPM) [7], makes use of project management concepts [8] and combined with the Evolutionary Acquisition [9] forms another previous work, the Evolutionary Acquisition IRPM (EA-IRPM) [10] to provide interdisciplinary systems architecture the ability to evolve, which is an important feature for systems to accommodate future changes [11], while promoting the increase of scientific results. The EA-IRPM was previously employed to develop a social network to provide free internet access for public schools' communities [12] and the MVC Evolutionary Acquisition IRPM was implemented as a web-based academic project manager [13].

The authors 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 authors believe 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.

II. Methods

A. Tools and Techniques

The system's architecture adopts the MVC pattern, and Java is the object-oriented programming language, see Table 1. Moreover, Javaserver Faces is the standard for building the user interface [14], PrimeFaces is the source for Javaserver Faces components [15], Glassfish is the application server [16], and Netbeans as development environment (IDE) [17].

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Then Scrum was the process of iterative and incremental strategy for an agile software development [18]; Hibernate is the employed object-relational mapping library for the Java language [19]; Spring: security framework 3 is the framework for access control and authentication [20]; Maven is the tool used for management and automation of projects in Java [21]; Prettyfaces is the system's filter-based servelets extension with support to JSF to create URLs [22]; and PostgreSQL [23] is the relational database management system.

TABLE I: TOOLS AND TECHNIQUES

Field of expertise	Tool or Technique
Software architecture	MVC
Programming language	Java
Server	Javaserver
Application server	Glassfish
IDE	NetBeans
Development	Scrum
Object-relational	Hibernate
Application framework	Spring: security framework 3
Build automation tool	Maven
URL rewrite filter	PrettyFace
Database	PostgreSQL

B. *MVC Evolutionary Acquisition IRPM*

The Interdisciplinary Research Project Management (IRPM) [7] is an approach for conducting interdisciplinary research of real problems using Project Management concepts [8] and problem-based learning [24]. Evolutionary Acquisition (EA) is a system design methodology [15] and MVC is a software architecture pattern [4],[5]. Their integration is called MVC Evolutionary Acquisition IRPM and to explain it, this subsection starts with explaining IRPM followed by Evolutionary Acquisition resulting in EA-IRPM, and in the sequence, MVC Evolutionary Acquisition IRPM.

IRPM's schematic is present in Fig. 1, and for a better understanding of it, let us review the Project Management phases [8]: (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.

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 through studying the chose fields. These studies may produce a new fundamental or methodology. Then 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, or else the new technology may be implemented and applied. 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.

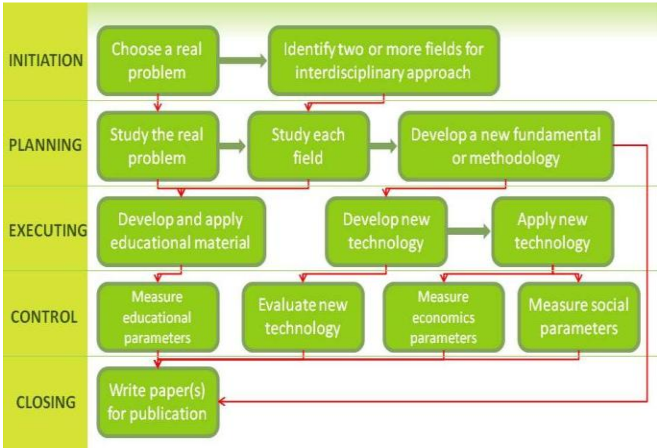

Fig. 1. IRPM – Interdisciplinary research project management.

Evolutionary Acquisition starts with the requirements analysis [9], see Fig. 2. After defining the "general" requirements for the system and the "specific" requirements for the core, the concept of operations is elaborated. Then together with a requirements analysis of user feedback, technological opportunities and threats evaluation, the preliminary system architecture is developed. From the system architecture a core is produced. New definitions and developments with an operational test may result in a new version of the core. Then with experience and use, new requirements refinements and updates may be identified and used to develop a new core, or improve it.

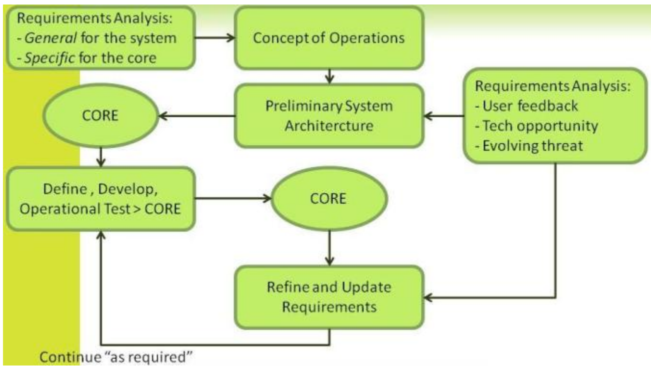

Fig. 2. The evolutionary acquisition model.

Additionally, Evolutionary Acquisition separates the core of the system into blocks. A particular block can have several releases. If the system is a software, then software engineering techniques may be applied.

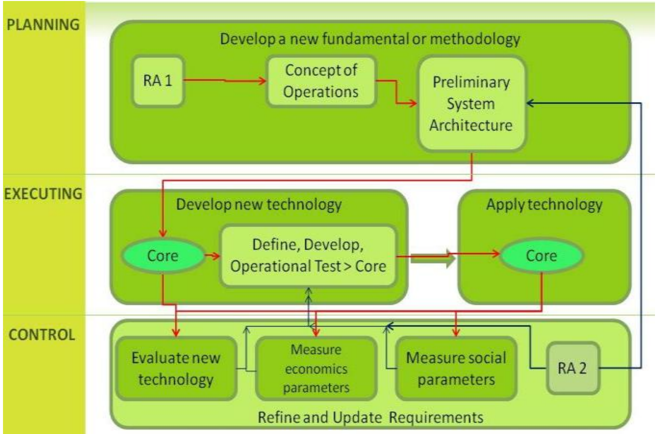

Fig. 3. The incorporation of the Evolutionary acquisition model into the interdisciplinary research project management diagram.

The incorporation of Evolutionary Acquisition into IRPM is presented in Fig. 3. It shows that it is inserted into phases Planning, Executing and Control, where 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 the attempt to develop a new fundamental or methodology consists of generating a preliminary system architecture beginning with RA 1, and then elaborating the concept of operations, and when available, also considering RA 2. Executing phase consists of implementing the core from the preliminary system architecture followed by new definitions and developments of operational tests. Afterwards, the system is applied in a real life situation. 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.

The Model-View-Controller (MVC) pattern is a software architecture [4],[5]. It intends to separate the business logic – Model, the user interface – View, and the user input – Controller. As a consequence, it provides a way to split functionalities to independent development, testing and maintenance. Basically, the Model represents the application data and the business rules that command data access and its modification. It also keeps business state and provides to the controller the ability to access encapsulated functionalities. The View displays the system's state and the Controller sets the application behavior.

The idea of incorporating MVC into Evolutionary Acquisition is presented in Fig. 4. The core architecture of the web service is a modified MVC pattern that is connected to the Requirement Analysis – RA2 of Fig. 3, through the user feedback, which should be an independent database system. The letter links means: A – to query the model state; B – to notify view of change in model state; C – state view; D – user actions/commands; E – invoke methods in the models public APIs; F – output to user; G – input from user; H – to report problem/suggestion/requirement (psr).

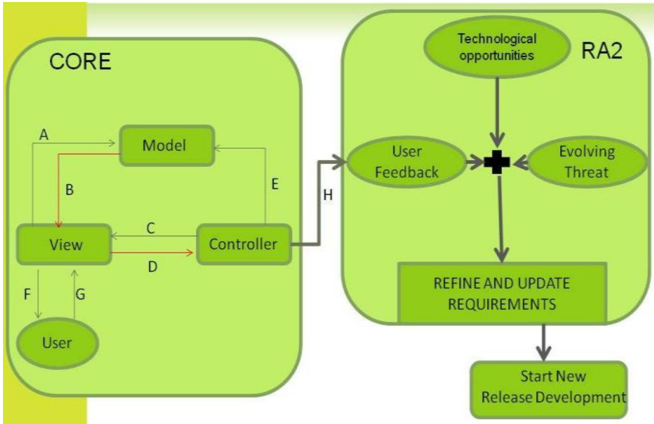

Fig. 4. The model-view- controller evolutionary acquisition.

The connection between web services' core and Requirement Analysis occurs in the following way: (1) user identifies a system's psr; (2) then user access the view to report psr, for instance, by pressing a specific button available in the user interface; (3) View queries Controller state about psr; (4) Controller notifies View of change to psr state; (5) View displays psr state to user; (6) user reports psr through View; (7) View transmits user's report to Controller; (8) Controller accesses users' feedback database system to report psr; (9) refinements and update requirements are defined using users' feedback, technological opportunities and evolving threats considerations; (10) a decision to start a new release may be taken. Hence, MVC is also incorporated to the Evolutionary Acquisition IRPM, which is presented in Fig. 5. It is worth noticing that a new release may imply in a change in the system's architecture or a new block release. The decision of releasing a new version of the core or a block is not automatic, and considerations of technological opportunities and evolving threats are still independent parts, that is, they are not necessarily part of the users' feedback database system.

Hence, MVC Evolutionary Acquisition IRPM presents evolution as an important factor in interdisciplinary web services systems. Actually, according to Breivold et al. in [11] "the ever-changing world makes evolvability a strong quality requirement for the majority of software architectures", that is, MVC Evolutionary Acquisition IRPM intends to increase productivity and to facilitate software evolution.

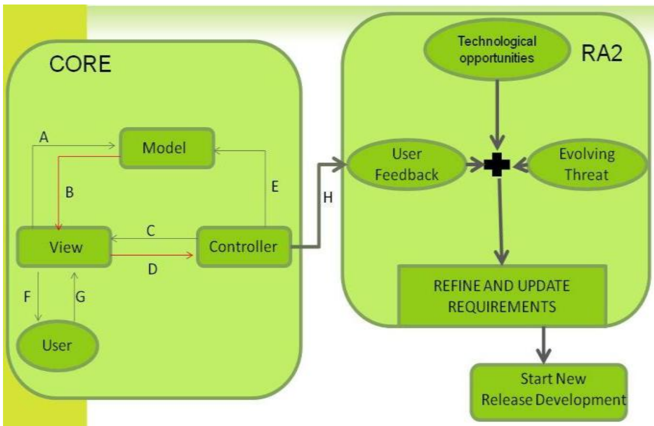

Fig. 5. The MVC evolutionary acquisition IRPM.

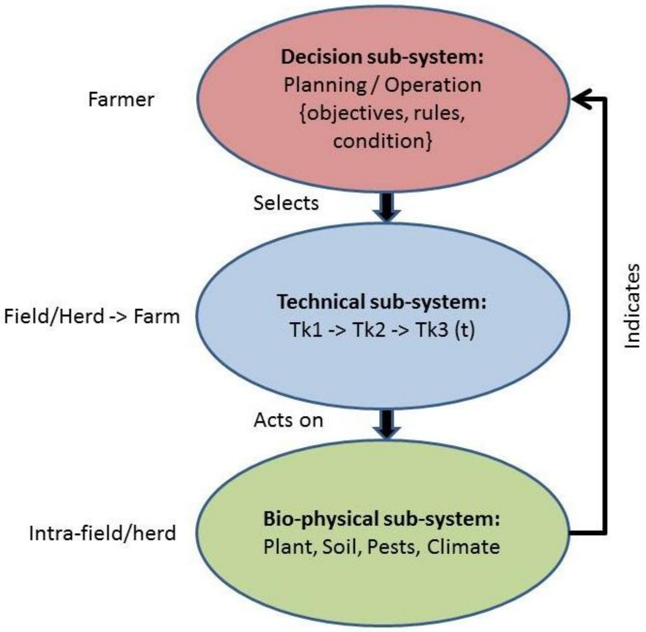

Fig. 6. Schematic representation of the agricultural production system framework.

C. General Structure of the Framework for Modeling Production Systems at the Farm Scale

According to Gal *et al.* [1] the agricultural production system is a combination of productive activities at the farm level that use available resources. Its management includes a range of decisions regarding crops and livestock structuring activities, allocating resources to individual operations over time and space. Decisions are made on interconnected time scales: strategic (several years), tactical (seasonal), and operational (daily/weekly). For instance, a rainfall is an unpredictable event that may induce periodic adjustments on a daily basis, though still following the tactically planned operations for the following season.

The conceptual framework is represented in Fig. 6. The crops and livestock system is divided in three sub-systems: biophysical, technical and decisional). The first is defined by the interactions of elements such as water, soil, climate and pests. The second is a combination over time and space of techniques applied sequentially by farmers to the biophysical system from the field/herd to farm level to accomplish production objectives. The third represents how farmers select and implement their technical interventions. Hence, this framework may be applied to analyze a production system's operation and to evaluate ex-post its outputs; also, it may be used to assist farmers to design their production system [1].

III. Results

The new web-based system is called EESTO (http://comp.uft.edu.br/eesto) and it can be used to support Gal *et al.* modeling production system at the farm scale.

Basically, it has four user's classes: the system's administrator; the production system coordinator; the technician; and the farmer. More classes can be implemented, but in an ex-ante evaluation, it is an unnecessary feature.

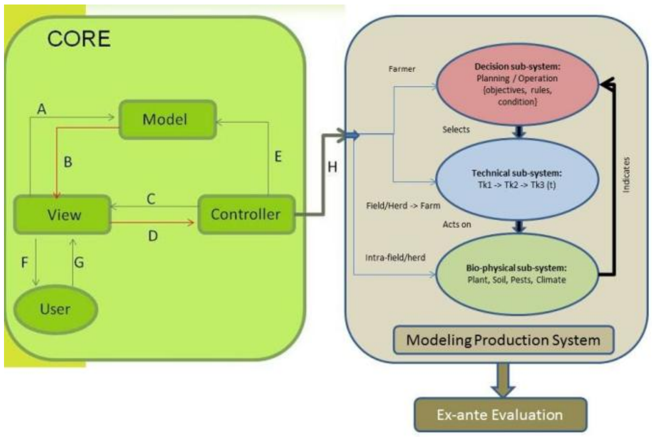

Fig. 7. EESTO diagram for its supportive use for modeling production systems at the farm scale.

The EESTO web system is represented in Fig. 7, and in comparison to Fig. 5, the RA2 system becomes the modeling production system at the farm scale. Coincidentally, the RA2 system also has three categories, so it is sufficient to map each RA2's category into the production system, that is, the user feedback becomes the decision sub-system, the technological opportunities becomes technical sub-system, and the evolving threats becomes the bio-physical sub-system; to refine and update requirements is equivalent to modeling the production system; and to start a new release development means the ex-ante evaluation.

Two examples of the EESTO interface are provided in Fig. 8 and Fig. 9. The first is an example of the administrator's screen for inserting production associations and regions; and the second is an example of the coordinator's screen for his/her own evaluation of production systems initial proposal's evaluation.

Fig. 8. EESTO administrator's interface.

Fig. 9. EESTO coordinator's interface.

IV. Discussion

This work is part of a project that intends to support small farmers in poor regions of Brazil called “territórios da cidadania” (citizenship territories). Specifically, it intends to aid government agencies related to the agribusiness to support the development of these economically endangered communities by providing the proper guidance to design and manage their production system at farm scale.

The goal is to increase production using resources available on the farm or supplied by the environment, eventually also provided by the government. The expected result is to achieve sustainable development outcomes that can benefit the entire local population, particularly the poorest, while limiting ecological impacts.

In order to accomplish this, the conceptual framework divides the farm structure organization in three sub-systems: the bio-physical, the technical and the decision support. The sub-systems are mapped into the MVC Evolutionary Acquisition IRPM software architecture, which is suitable to interdisciplinary research with an evolutionary acquisition approach using project management concepts.

The system plays a role as an interface between government and specialized technicians and farmers. In that way, technical support and guidance could be provided in a long distance form or reducing on site activities. Furthermore, to improve support, future works includes not only the simulation ability into the system, but also risk assessment to prevent critical events, and optimization functionalities for maximizing results.

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