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### **A PROCESS APPROACH TO INNOVATION**

#### **1. INTRODUCTION**

Design, implementation and management of real life systems and processes functioning in information and knowledge rich environments of our “knowledge based society” requires, among others, greater understanding about the role of innovation in systems operation and business management and processes. Today, a growing complexity of information and knowledge flow is a characteristic of the majority of industries and markets. Systems also operate in changing environments surrounded by numerous uncertainties and disturbances. Difficulties arise from unexpected tasks and events and from a multitude of possible failures and other interactions during the attempt to control various activities in dynamic environments. Innovation is one of the most important aspects to be considered in modern intelligent systems development, and is expected to solve unforeseen problems, even on the basis of incomplete and imprecise data, information or knowledge. This is a new paradigm which creates enormous challenge for economics, management, and engineering in the new millennium. To meet this challenge, the authors propose a systemic, process based approach to the issue of innovation.

Innovation is the driving force for today’s businesses and is vital for their survival. The existing business players seek in innovation new ways to strengthen their position, new players seek in innovation ways which could help them to become a star company. We all want to be innovative, but how can it be done and supported? There is “know how” needed some procedure, or guidance that would instruct step by step how to do things to be innovative. When we have such procedures, and act upon them, we can gather the experience related to this area, put these pieces of experience together and convert it into knowledge that may lead to yet new innovations.

This article is an introduction to the above idea of catching innovation and developing a knowledge base related to it.

## 2. A DEFINITION OF INNOVATION

The word “innovation” is very popular, you can find more than 3000 different book's titles containing this word on Amazon site. On other hand the term “innovation” is problematic to define precisely [Rogers 1998:8].

The classic definitions of innovation include<sup>1</sup>:

- the process of making improvements by introducing something new,
- the act of introducing something new: something newly introduced (The American Heritage Dictionary),
- the process of translating new ideas into tangible societal impact (Krisztina Holly, Vice Provost, University of Southern California, and Executive Director of USC Stevens Institute for Innovation),
- the introduction of something new. (Merriam-Webster Online),
- a new idea, method or device. (Merriam-Webster Online),
- the successful exploitation of new ideas (Department of Trade and Industry, UK),
- change that creates a new dimension of performance Peter Drucker [Hesselbein 2002],
- A creative idea that is realized [Johansson 2004],
- "The capability of continuously realizing a desired future state" [Kao 2005],
- "The staging of value and/or the conservation of value." [Montano 2006].

Those definitions help a lot, but how innovation differs from creativity, invention or science? The easiest way to answer this is to compare one term to another [Kotelnikov]:

- Creativity is coming up with ideas.
- Innovation is bringing ideas to life.
- Invention is the creation of a new concept.
- Innovation is reducing that concept to practice, and making it a commercial success.
- Science is the conversion of money into knowledge.
- Innovation is the conversion of knowledge into money.

## 3. A PROCESS APPROACH

A process is a naturally occurring or designed sequence of changes of properties or attributes of an object or system<sup>2</sup>. A process approach is about states, flows, tasks and actions, those elements are used for modelling selected part of the world. This approach is used for modelling business and for simulating business [Szuwarzyński 2003:75]. There are well known graphical notation that can handle a formal notation of a process such as Petri nets, the UML (Unified Modelling Language) activity diagram or the BPMN (Business Process Modelling Notation). A Petri net (also known as a place/transition net or P/T net) is one of several mathematical representations of discrete distributed systems<sup>3</sup>. The main drawback of Petri nets is lack of tools that can

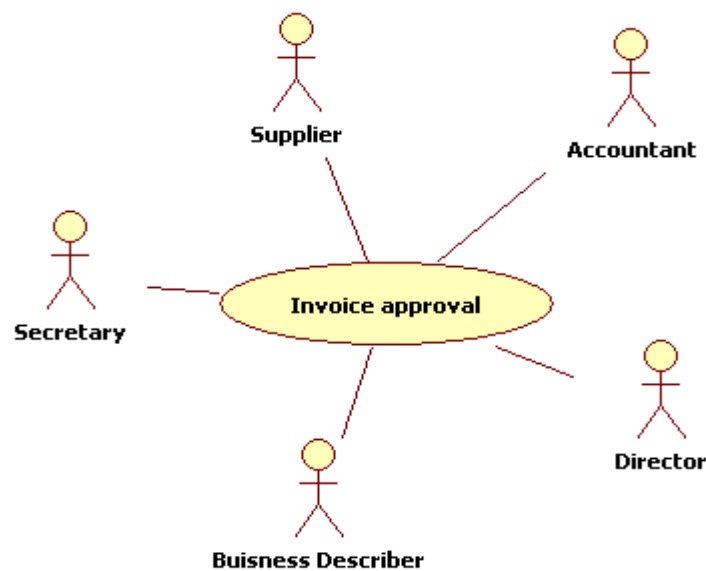
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<sup>1</sup>Innovation from Wikipedia, <http://en.wikipedia.org/wiki/Innovation>.

<sup>2</sup>Process (disambiguation) From Wikipedia, [http://en.wikipedia.org/wiki/Process\\_%28disambiguation%29](http://en.wikipedia.org/wiki/Process_%28disambiguation%29).

<sup>3</sup>Petri net From Wikipedia, [http://en.wikipedia.org/wiki/Petri\\_net#Main\\_Petri\\_net\\_types](http://en.wikipedia.org/wiki/Petri_net#Main_Petri_net_types).

collate those net with necessary extensions like Petri time extension. The activity diagram from UML is much more suitable for modelling processes, but it still lacks clear distinction between human tasks and computer actions. Business Process Modelling Notation is de facto a commercial standard from Object Management Group<sup>4</sup>. The BPMN is specially design for business analysts more flexible then UML activity diagram, and well supported by workflow application. There are solutions that can deploy BPMN diagram on server and make from it working application. In practice there is no need to use other diagrams for modelling business processes. We can see it on simplified example of business process used for approving incoming invoices to a company. Assuming that we have different five actors in the object-oriented approach we will start modelling with the UML use case diagram.

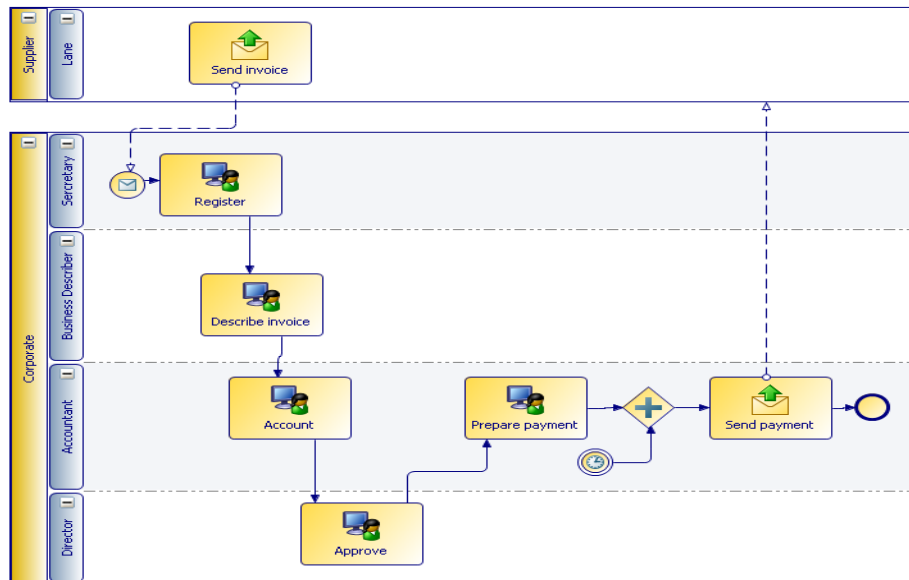


Source: own.

**Figure 1. Invoice approval – use case diagram**

Next steps in the object-oriented approach will build the whole multilevel model with different diagrams, which is not necessary in the process approach. We need to model only one diagram and it may look like this:

<sup>4</sup>Object Management Group/Business Process Management Initiative, <http://www.bpmn.org>.



Source: own.

**Figure 2. Invoice approval – BPMN diagram**

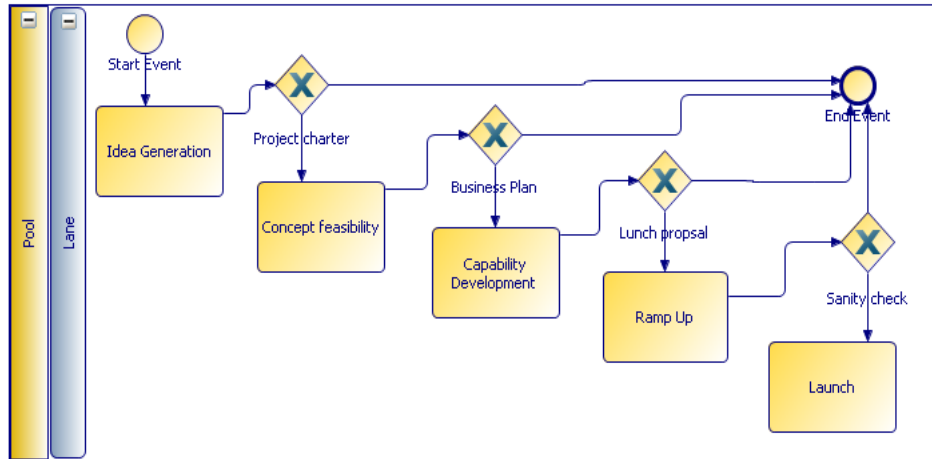
Business Process Modelling Notation use common known pictograms for task, actions, decisions, flow, events and messages. It is easy to figure out, how it works. Supplier at first must send us an invoice by e-mail, mail or something. We do not take a part in sending us invoice, so it is external and asynchronous to us, for that purpose we use a messages a dash line on the diagram. Next we have to do something with this received invoice, it could be done manually by registering it in our system, on diagram it is the first top-left soft polygon with a monitor and human on it. When we finish our registration we point this invoice for checking to the right person – a business describer and for that we use thin line with arrow for direction. When finally we have prepared payment we have only to wait to the latest possible moment the pay date for that we use time based event – pictogram with double circle and a clock inside it. The join node waits both for the prepared payment and the time event, when they are together flow goes to the task which sends the payment by sending a transfer to our supplier after that our process is over. We can all above read from one diagram that can describe all needed aspects to achieve a business goal from business analyst's point of view.

#### 4. ENFORCEMENT OF INNOVATION AS A BUSINESS PROCESS

Regardless of topology, technology and the capability that a concrete organization has, the enforcement of innovation is a business process [Reimer, Karagianis 2006].

This process can be totally undefined, partially defined or well defined. Using this approach, the knowledge about the enforcement of innovation can be described as an ability to defining the process including steps, decisions and flow. Except the extreme class of totally indefinable innovation processes, there is a possibility of defining at

least a part of the whole process. Those innovation's processes can be very similar to software development processes. For example the most classic waterfall equivalent may look like that:



Source: own.

**Figure 3. Innovation process – BPMN diagram**

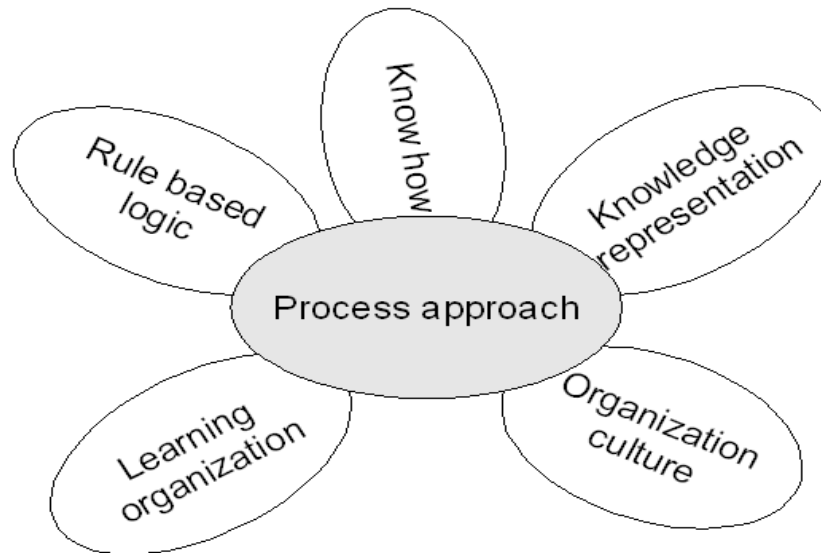
The waterfall concept is only one option, we can use more iterative life-cycles taking examples again from software development, so we can have innovation processes like incremental, iterative, agile, or V – model live cycle model. There is a lot common between deploying innovation and developing new software. New software is usually an innovation itself, but there are also lots of differences because innovation process affects much more life cases and situations than production process of anything including projects that change our world. For sure we should look at innovation processes and try to learn how to be innovative.

## 5. A PROCESS APPROACH AND KNOWLEDGE MANAGEMENT

A process approach is one of the options how to implement knowledge management including two aspects: how to perform and how this approach refers to elements of knowledge management. This section describes process approach as part of KM (Knowledge Management) and not KM as a process. A process approach can cover most part of KM; it can be seen on this figure:

- Rule based logic is used in process approach for making decision where to go next including a path and an addressee. It is considered a best practice to move those rules to special component called rules engine to evaluate and manage them [Blanvalet et al. 2006:64].
- Know how in process approach is a process definition included in a model providing step by step guide how to achieve a goal.

- Knowledge representation is served by formal persistent process notation like XPDL (XML Process Definition Language) or BPEL (Business Process Execution Language) they are both XML (Extensible Markup Language) based.



Source: [Palmer, Henschen 2005].

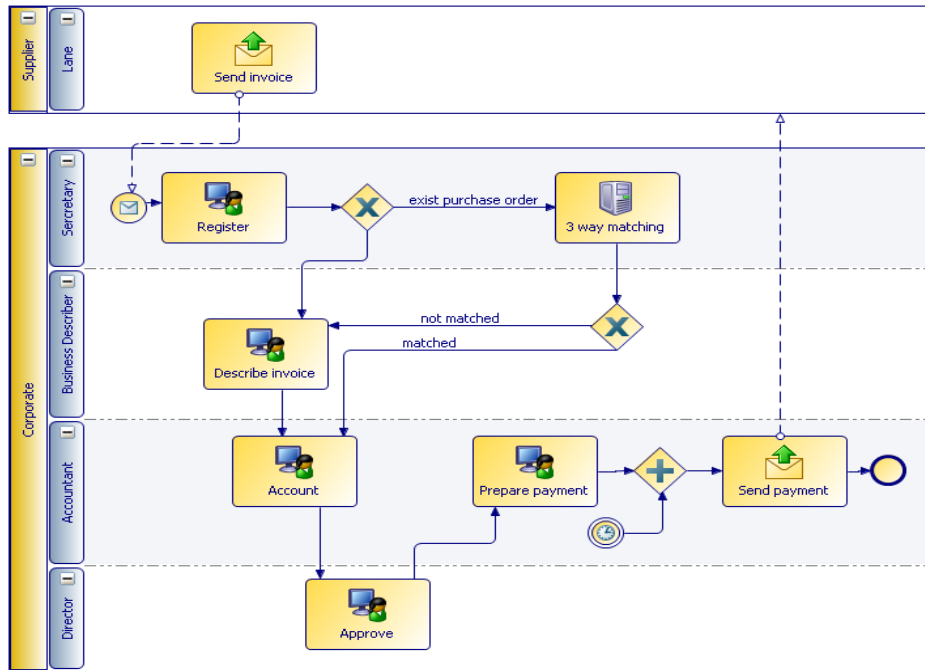
**Figure 4. Process approach and knowledge management**

Organization culture – a way things are done around here [Kaye, Little 2002:74]. Organization culture influences business process.

Learning organization is achieved by improving business processes that allow organization to be smarter.

## **6. SAVING INNOVATION – A PROCESS IMPROVEMENT PERSPECTIVE**

Improvement of business process is for sure an innovation. Changes in business process can be considered as changes between two versions of process. When for process is used formal notation especially based on XML it is easy to compare those versions with CVS (Concurrent Versions System) for example. Backing to our invoice approval process it can be improved by reducing waste, in this case is unnecessary work of business describer. Assuming that organization use a purchase application that generate purchase orders that contains all information needed for accounting, but that is not sufficient for payment because the for that the goods should be in a inventory. In other words there is three way matching needed for an invoice, a purchase order and an inventory receipt it all can be done by computer and business process will look like that:



Source: own.

**Figure 5. Improved invoice approval – BPMN diagram**

Of course not all invoices will match exactly an existing purchase order, but probably in most cases yes, so by automatic task in process, there is saved time of business describer the asset that organization can not buy.

## 7. SAVING KNOWLEDGE FORM BPMS

Business Process Management System (BPMS) - a nine step model enables companies to model, deploy and manage mission-critical business processes that span multiple enterprise applications, corporate departments [Rathor]. In this chapter BPMS is meant as computer added system that allows deploy modelled processes, execute and monitor them. In good practise it should be software that supports BPEL or XPD L process execution notation – both are XML based and are considered as a standard. The BPEL is meant to be used in service orchestration, but XPD L is designed for manual processes automation where human interaction is involved. This software can be considered as software engine like database engine but instead manipulating on data they manipulate process tasks, actions, flows, rules and messages.

In knowledge terms BPMS knows how to do things, how the things are at the moment, and was by extended logging. Those features can help with providing useful data that can help solve one major problem for applying machine learning algorithms in software engineering is unavailability and scarcity of software data, that is, data for training the model [Twala et.al 2007:266].

In the process approach information is stored usually in chronological order and includes information about the doer and case indicator, by those pieces of information it is possible to reproduce preformed actions, decision made, and who exactly preformed tasks and what was the actor role in this particular process. Log files from BPMS are used mostly for measuring user performance and detecting bottle necks in process for optimization, additionally to find the one responsible for action or decision. This information can be converted in knowledge base, because the main problem with BPMS log files are their large size, but nowadays computers with modern databases can manage such amount of data easily. It can be excellent experience database with strong relation to explicit knowledge that is in process definitions, rules, flows. Considering together definition and revision information give us opportunity to analyze “How things are done” and it is a great input for case based reasoning. Case-based reasoning involves reusing previously identified solutions to solve new problems and is often used in expert systems, as well as in other types of systems [Coppin 2004:495]. All that is needed for possible implementation is provided from BPMS, the case classification can be mapped on processes definitions and examples are provided by log's files.

In process oriented organizations knowledge that can be acquired from BPMS may be converted into even more advanced experience knowledge structure that is called Set of Experience Knowledge Structure (SOEKS) [Sanin, Szcerbicki 2006:40-55]. Set of Experience Knowledge Structure is a structure that can be source and target of multiple technologies. It is utilized in the operation of the Knowledge Supply Chain System (KSCS) supported by OWL ontology [Sanin, Szcerbicki 2007a:209-223]. The KSCS performs by manipulating SOEKS to keep formal decision events and to help managers in the daily operation of decision-making. SOEKS comprises variables, functions, constraints and rules associated in a DNA shape allowing the construction of Decisional DNA [Sanin, Szcerbicki 2007b:475-494]. Such Decisional DNA can be developed for the area of innovation opening the possibilities of sharing innovation related knowledge among different technologies, areas, processes and enterprise.

## **8. ADVANCES IN PROCESS DESIGN**

Business process can be modelled in many ways; the granularity can be different in terms of size of tasks, actions, division processes into sub processes. There are some universal good practices like stay close to standards, which helps to be independent form specific solution supplier. Using for example XPDL standard as process definition allows using free open source software for small or medium business and when company grows it is possible to harmless roll out on a commercial enterprise solution. The second important thing about design business processes is thinking about enterprise even delivering temporary solutions, because a temporary solution often become more permanent then everything else. It is connected with human nature that is afraid of change, and pragmatic short term rule: “better is the enemy of good”.



In modern software nowadays are two main domains where process approach is the best practise. The first is developing new value by providing more complex solution; it is used in service oriented architecture (SOA). In SOA the business needs should be satisfied by maximum reuse of existing software components. The second is to provide long term human machine conversion that is needed for carry businesses out. It should take more then a day or when many tasks must be performed in specific order by different people. This application is called a workflow. When we have one step processes like simple selling or service with one time contact then using a workflow is a bad idea. The main rule is that process definition has to have internal states, besides its start and end points.

Taking care about clarity and well understanding process definitions should not be too large, in case of a very large business process, it ought to be divided into smaller sub processes.

Those pieces of advice are useful, but do not tell how to build business process in more engineering way. For that purpose examples, templates and patterns are more useful.

Examples are very good at familiarizing with problems and general ideas, but in real life problems there is no good way to find a matching solution from even largest collection of examples. Even though we find a matching example we have to analyze the whole process without a guide. Examples are best at seeing how the others do things.

Templates are ready to use application specific solutions that have to be customized to specific solution. They do their job into relatively simple business processes that deal with common organization activities. Templates save a lot of time and provide good standard solutions in non business specific areas. Templates can provide a guide how to apply them in concrete corporate and can be used by less experienced process developers. Delphi Group recently completed a survey of more than 100 firms engaged in either using or evaluating BPM (Business Process Management) solutions. Though responses varied, several key points emerged. Among these was a majority view that templates offer an effective means for accelerating BPM deployments” [Palmer, Henschen 2005].

**Table 1. Answers given to question: Can pre-defined process templates be used to accelerate BPM Deployments?**

30%	Yes, they are effective for transferring process knowledge
44%	Yes, assuming templates can be significantly customized
12%	Maybe, but only for simple processes like expense reimbursement
12%	Maybe, but only for standardized processes not unique to our firm
1%	No, there are no viable standardized processes
1%	No, there is no way templates would work

Source: [Palmer, Henschen 2005].

Process Patterns are considered as building blocks which are meant to help design business process. There are many types of process patterns the most generic are pattern

that base on GOF (Gang-Of-Four) patterns philosophy [Gamma et.al. 1995] and solve technical aspect like how to model something and what are the consequences of specific design. For sure high abstract patterns allow providing better design and understanding, they are high recommended for those who want become an expert from advanced designer. For less advanced designers domain specific patterns are more suitable they are similar to templates, but divided into smaller pieces. In authors opinion those patterns are most useful for process knowledge transfer. We can generally divide patterns catalogues into categories:

- Notation process patterns catalog useful when for changing notation for example : BPMN to UML Activity diagram [White].
- Generic patterns – like GOF pattern for common creation, structure, and behaviour in processes definitions.
- Domain specific patterns for specific propose like for service integration a SOA pattern catalogue [Johansson 2004].

The bottom line: When you want to see how look like business processes go to examples, when you have common back-office process to implement look for template. When you design new process use domain specific patterns if available. For process design review use generic business patterns.

## 9. CONCLUSION

A process approach have proved it's value in various management methods and methodologies, like PRINCE2, PMBOK, TQM, SixSigma, ISO 9000:2000 and nowadays is more and more popular in software engineering. There are more the 40 business process software engines<sup>5</sup>, those engines are mainly used in workflows and SOA platforms, almost every big player like IBM, BEA, ORACLE, EMC, TIBCO have their own solution. The process approach is very good in modelling business and with proper software allows automatizing and managing task, but the authors of this paper want to show another aspect of this approach - the knowledge management aspect. The knowledge is saved both in an explicit and an empirical way. A formal notation like BMPN or XPDL is used for explicit knowledge and an implementation specific format for an empirical data. In authors' opinion there are possibilities to manage knowledge saved both in process definitions and in empirical log files. For a process definition knowledge are useful process examples, general patterns, templates and domain specific pattern's catalogs. There always be need for more templates and domain specific catalogs for example it will be nice to have an innovation's patterns catalog or at least few new innovation's process templates. Such solution will be innovation itself, because it allows building processes quicker and better. On other hand a process approach can provide extended empirical information about how things are done in practice. That information deserves wider applicability then historical log; it seems to be possible after few extensions to BPMS loggers to save knowledge in structure like SOEKS. If this proposition is successful there will be an open way for building a decision support system upon that. In both cases a process approach does the job for innovation.

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<sup>5</sup>XPDL Support & Resources, [http://www.wfmc.org/standards/xpdl.htm#XPDL\\_implementation](http://www.wfmc.org/standards/xpdl.htm#XPDL_implementation).

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