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Using Business Management Flight Simulations as a Teaching Tool for Entrepreneurs

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Abstract: **Decision-making in entrepreneurship is often very risky because consequences of entrepreneurs' actions are visible only after longer time (months or even years). Ideal education tool in entrepreneurship would allow entrepreneurs to compresses time and space in non-risk environment and to gain experience and make mistakes without fear of real damage. Such tool would allow potential entrepreneurs to see the consequences of his/her actions in few minutes or hours, and to detect possible wrong presumptions about the real world venture capitalism. This paper argues that management flight simulation models could meet the educational challenge in entrepreneurship and allow entrepreneurs to avoid intuitively correct decisions that are actually not optimal. Paper will present the system dynamics model of supply and demand.**

1. INTRODUCTION

Decision-making in entrepreneurship is very complicated because costs of managers' decisions are visible only after longer time. For example, if new product is released it will take some time until it becomes accepted from the customer base. In addition, acceptance of new products industry is influenced to the great extent by the many factors. Some of them are relative price of the product compared to similar products, substitute products, attractiveness of marketing campaign compared to competitive products, sales – promotion, word of mouth, friendly salesman, etc.

Entrepreneurs would benefit from more effective education that would improve the quality of the decisions making. The purpose of this article is to describe and demonstrate applicability of system dynamics models as decision and learning support tools for entrepreneurship organizations that permit controlled experimentation and enhance understanding of reality.

2. USING SYSTEM DYNAMIC MODELS AS MANAGEMENT LEARNING TOOLS

System dynamics is a powerful tool that enhances learning about company, market and competitors, portrays the cognitive limitations on the information gathering and processing power of human mind, facilitates the practice of considering opinions, and supports building of "What if" scenarios.

Over the past thirty years, the growth of computer technology has facilitated the wide application of system dynamics modeling as sophisticated tools for simulating business environments and situations. The basic goal of management simulation games is to apply experiential learning to the commercial world. They are designed in order to allow the player to experiment with the model on a compressed time basis while reducing costs and personal risk.

The participant is able to see the consequences of his/her actions in few minutes or hours. In real world such consequences are visible only after much longer time (months or years).

In order to achieve educational objectives, simulation should start with adequate briefing, which introduces the rules of the game and helps the players to vividly imagine themselves in described situation. Learning objective of the game should be clearly defined. For example, one of the learning objectives of Fish Bank Ltd. is to show how competitive behavior can destroy renewable resources (Meadows, 1989). Simulation games are equipped with different technology that could include game boards, sheets to contain with decisions or computer-based system dynamics models. Duration of play could be hours, or could be few minutes and different number of players could be involved. Important part of the game is debriefing, which helps players to construct their experience into knowledge that can be re-applied.

It seems that simulation games are very useful in helping players to learn, but according to the opinion of several authors there is still present a doubt that knowledge acquired can be applied in real work situation (Summers, 2004; Zapalaska et al. , 2008). The real payoff from simulation games can be achieved if attention is paid to number of possible difficulties and problems: (1) no clarity regarding learning objectives, (2) materials support an event without learning, (3) neglect of other teaching methods, (4) inappropriate emphasis on technology, (5) too many elements mixed, (6) inadequate briefing, (7) inadequate debrief, (8) offering operators too little training, and (9) under-estimating time and money needed to create materials.

There are numerous management games with high potential for application in entrepreneurship, and some of them will be described.

People Express Airlines was established in 1981. In only five years the company had grown to be the fifth largest airline in the United States (Sterman, 2001). Yet by September of 1986, People Express was nearly bankrupt, and was acquired at the last minute by Texas Air. The People Express Management Flight Simulator gives the players the opportunity to find out the reasons for the failure. Each simulated time period the player has to make strategic and operational decisions on: pricing, marketing efforts, hiring policy, financing in the time of crises, financing in order to grow. At the end of the game players gain insights into difficulties of coordinating operations and strategy in a growth market and to understand the dynamic interactions among a firm, its market and its competitors.

Beer distribution game, originally called the "production-distribution game", is played on a board that portrays the production and distribution of beer. Each team consists of four sectors: Retailer, Wholesaler, Distributor and Factory arranged in a linear distribution chain. The goal of the game is to meet customer demand and order enough from your supplier to keep your inventory low while avoiding costly backlogs (Sterman, 1992).

CreditSim is a powerful tool to study dynamics and explore possible options using all financial statements to improve results. It allows the player to overview on how the business can develop in time. Trough the analysis of scenarios, managers can assess upcoming decisions like, a price increase, the purchase of fixed assets, a decrease of raw material or increase of labour costs, and, a new invoicing or credit management strategy (Melse, 1997).

Professional Services Microworld will be described in detail (Strategy dynamics, 2001). The game is designed in order to experience the challenges of a professional service organisation named the Partner team with the aim to grow the business in size and reputation over 30 years, creating wealth for the firm's partners. In order to achieve this objective, player

will try to manage the growth of professional staff (consultants, assignment managers and partners) to match growth of the client-base.

3. CASE STUDY OF USING SUPPLY AND DEMAND MODEL IN THE CLASSROOM

Last year I taught Economics and I tried to explain relation between supply, demand and price. Somebody asked me what is the practical use of the analysis of the demand and supply curves, and in few moments whole class was discussing how equilibrium price is determined. Our intuitive answer was that supply and demand curves are useful in long term. The reason is that when supply or demand changes equilibrium price is disturbed and oscillations occur. For example, when demand is higher than supply, price will increase. But, producers will react and produce more goods that will increase supply more than demand. Customer will not buy all the products offered on the market and excess supply will again lower the price. But, we could not agree on how equilibrium price will be again achieved because we were discussing supply as if it is determined with production, and we did not take into account inventory. Finally, we have agreed that equilibrium price is achieved only in long term, and that in short term price, demand and supply oscillate around it. If we had system dynamics model presented in the paper we could confirm our hypothesis and enhance our analysis by taking inventory into account. Ffective decision-making contributes to better performance of entrepreneurs. It is important that entrepreneurs understand that although demand depends on a number of exogenous factors, there are also variables that entrepreneurs can control like price, service quality and advertising.

3.1. Supply and demand system dynamics model

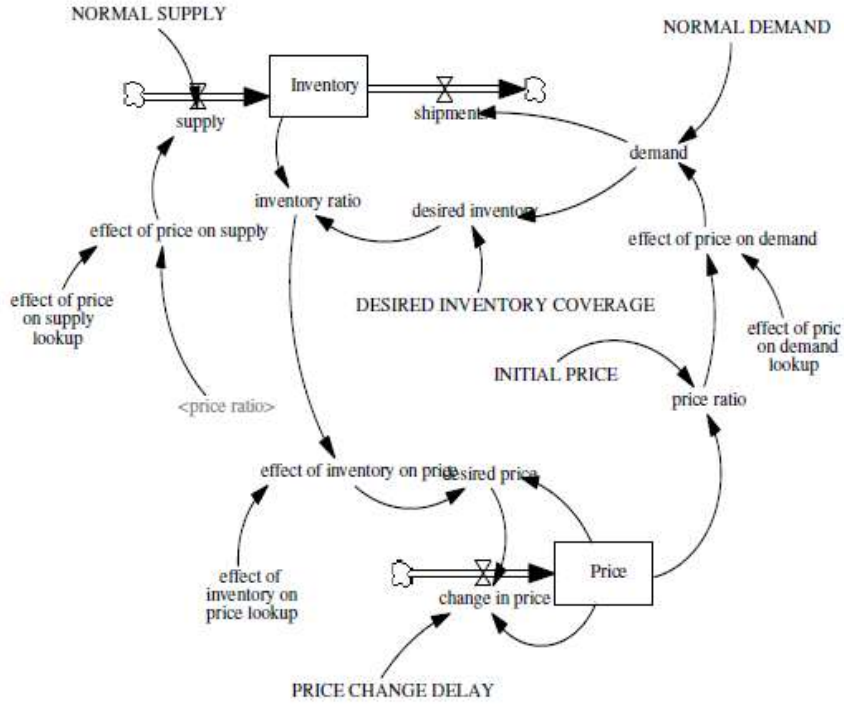

Figure 1: Supply and demand system dynamics model

Model contains number of feedback loops in the model:

- positive feedback loop 1 – As Price increases, change in price also increases, which in turn increases Price.
- positive feedback loop 2 – As Price increases, desired price increases, which increases change in Price and finally Price increases.
- negative feedback loop 1 – As Price increases, price ratio increases, which increases effect of price on supply. This is the reason why supply increases, which also increases Inventory. As Inventory increases, inventory ratio also increases, effect of inventory on price decreases, which decrease desired price and change in price. Finally, Price decreases.
- negative feedback loop 2 – As Price increases, price ratio increases, which decreases effect of price on demand. Therefore, demand decreases, which is the reason why desired inventory decreases. As desired inventory decreases, inventory ratio increases, which decreases effect of inventory on price and desired price also decreases. Finally, Price decreases.
- negative feedback loop 3 – Increase in Price increases price ratio which decreases effect of price on demand. This is the reason why demand decreases, which decreases shipments. Inventory and inventory ratio increase. Therefore effect of

inventory on price decreases, which decreases desired price and change in price. Finally, Price decreases.

3.2. Model equations

In this part of the paper model equations will be presented. Equations are automatically generated by the software Vensim that has been used for designing the model for supply and demand.

change in price=(desired price-Price)/PRICE CHANGE DELAY

Units: $/shirt/Week

Change in price is determined by the difference between desired price and current price and number of weeks needed to change the price.

demand=NORMAL DEMAND*effect of price on demand

Units: shirt/Week

This is the rate at which consumers wish to purchase clothing from the suppliers.

desired inventory=demand*DESIRED INVENTORY COVERAGE

Units: shirt

Desired inventory is how much inventory the suppliers would like to have. It is calculated as how many weeks worth of demand they would like to store in inventory.

DESIRED INVENTORY COVERAGE=4

Units: Week

Number of weeks of demand that suppliers would like to keep in inventory.

desired price=effect of inventory on price*Price

Units: $/shirt

This is the equilibrium price as set by the inventory ratio. The actual price will reach this value after a delay specified by the price change delay.

effect of inventory on price=effect of inventory on price lookup(inventory ratio)

Units: dmnl

When the ratio of inventory to desired inventory is greater than 1 price increases, an opposite.

effect of inventory on price lookup
([(0.5,0)-(1.5,2)],(0.5,2),(0.6,1.8),(0.7,1.55),(0.8,1.35),(0.9,1.15),
(1,1),(1.1,0.875),(1.2,0.75),(1.3,0.65),(1.4,0.55),(1.5,0.5))

Units: dmnl

Lookup function for the effect of inventory on price.

effect of price on demand=effect of price on demand lookup(price ratio)

Units: dmnl

Demand for shirts depends on price of the product. When the price is higher, demand is lower and opposite.

effect of price on demand lookup

([(0,0)-(4,2.5)],(0,2.5),(0.33,1.754),(0.67,1.281),(1,1),(1.33,0.789),

(1.67,0.614),(2,0.491),(2.33,0.386),(2.67,0.316),(3,0.246),(3.33,0.175),(4,0.175))

Units: dmnl

Lookup function for effect of price on demand.

effect of price on supply=effect of price on supply lookup(price ratio)

Units: dmnl

Supply of shirts depends on price. When price is higher, more shirts are produced, and opposite.

effect of price on supply lookup

([(0,0)-(4,2)],(0,0),(0.33,0),(0.67,0.702),(1,1),(1.33,1.193),(1.67,1.351),

(2,1.474),(2.33,1.561),(2.67,1.649),(3,1.702),(3.33,1.754),(4,1.754))

Units: dmnl

Lookup function for the effect of price on supply.

INITIAL PRICE=15

Units: $/shirt

Initial price at which consumers were willing to buy number of shirts equal to normal demand, and firms were willing to produce number of shirts equal to normal supply.

Inventory= INTEG (+supply-shipments, desired inventory)

Units: shirt

Inventory is the stock of produced clothing in the company's warehouse.

inventory ratio=Inventory/desired inventory

Units: dmnl

Ratio of inventory to desired inventory.

NORMAL DEMAND=57

Units: shirt/Week

Number of shirts that consumers are willing to purchase at initial price.

NORMAL SUPPLY=57
Units: shirt/Week
Number of shirts that firms are willing to produce at initial price.

Price= INTEG (change in price,INITIAL PRICE)
Units: $/shirt
Current price of shirts in the market.

price change delay=15
Units: Week
Number of weeks at which price changes to desired price.

price ratio=Price/INITIAL PRICE
Units: dmnl
Ratio of price to initial price.

shipments=demand
Units: shirt/Week
Number of shirts shiped per week is equal to the demand.

supply=effect of price on supply*NORMAL SUPPLY
Units: shirt/Week
Number of shirts produced each week.

3.3. Lookup functions

Lookup functions explain the relation between two variables that are nonlinear. On Fig.2. there is a relation between inventory and price, which indicates the lower price in case of higher inventory. On Fig.3. there is a relation between price and demand, which indicates the higher price in case of higher demand. On Fig. 4. there is a relation between price and supply, which indicates the lower price in case of higher supply.

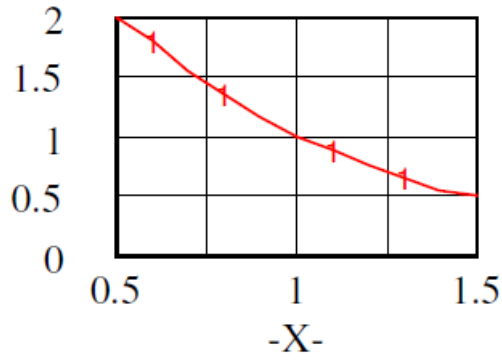

Figure 2: Effect of inventory on price lookup

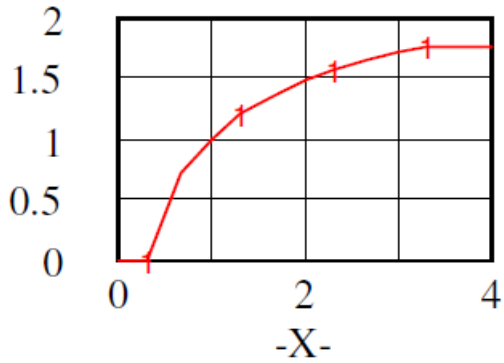

Figure 3: Effect of price on demand lookup

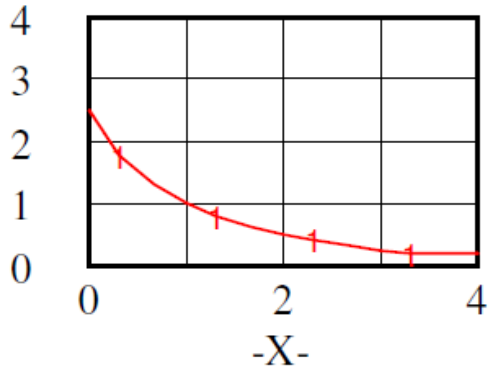

Figure 4: Effect of price on supply lookup

3.4. Experiments with the model

In this part of the paper experiments with the model will be presented in case of four scenarios: (1) increase in demand, (2) different values of desired inventory coverage, (3) different values of price change delay, and (4) damped and sustained oscillations.

Increase in Demand

If we want the system to be in equilibrium inventory should be 228 shirts. Initial price is 15$, and at that price demand is equal to supply which are 57 shirts. Desired inventory coverage is 4 weeks, and therefore inventory should be 228 shirts. Price change delay does not have any effect on value of inventory needed for equilibrium.

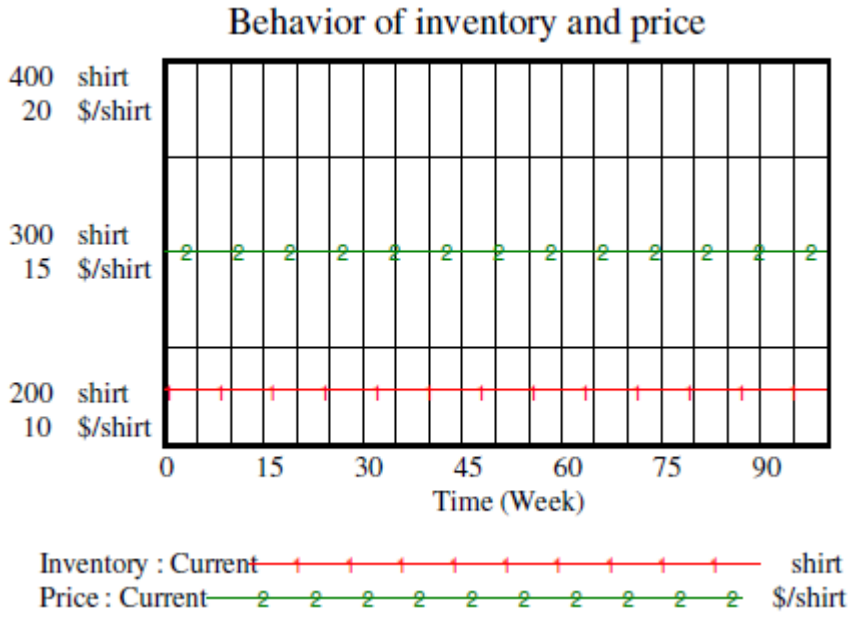

Figure 5: Behavior of inventory and price in equilibrium

If demand increases permanently for 10 articles per week, new equilibrium value for price is $16.97, and equilibrium value for demand is 61.36 shirts per week. Therefore, equilibrium value for inventory is 245.44 shirts, and it is four times larger than demand because desired inventory coverage is still 4 weeks. Before inventory reaches equilibrium value it will exhibits sustained oscillations.

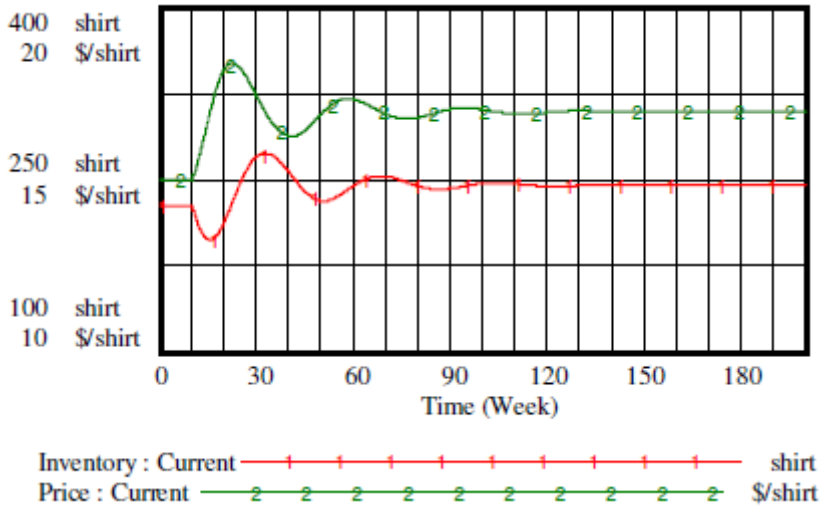

Figure 6: Behavior of inventory and price after increase in demand

Desired Inventory Coverage

Value of desired inventory coverage influences inventory equilibrium level, amplitude of oscillations, and period of oscillations. For shortest desired inventory coverage, inventory equilibrium level is lowest, amplitude of oscillations is smallest, and period of oscillations is shortest. For longest desired inventory coverage opposite occurs.

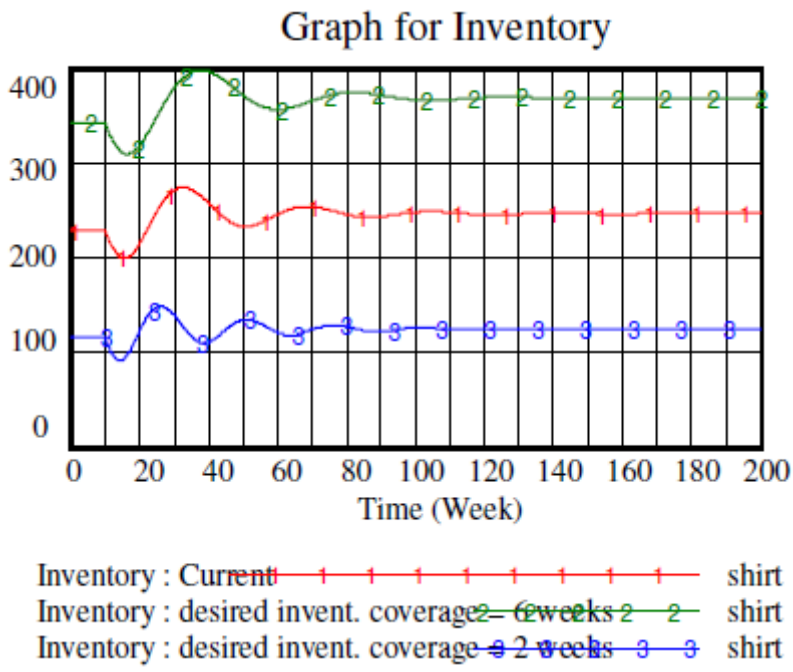

Figure 7: Behavior of Inventory under influence of desired inventory coverage

Price Change Delay

When system is in equilibrium, value of price change delay does not have any effect on price and inventory. Change in price is calculated as the ratio of difference between desired price and current price and price change delay. When system is in equilibrium Price is equal to desired price and difference between them is 0. Therefore, change in price is always 0 despite of value of price change delay.

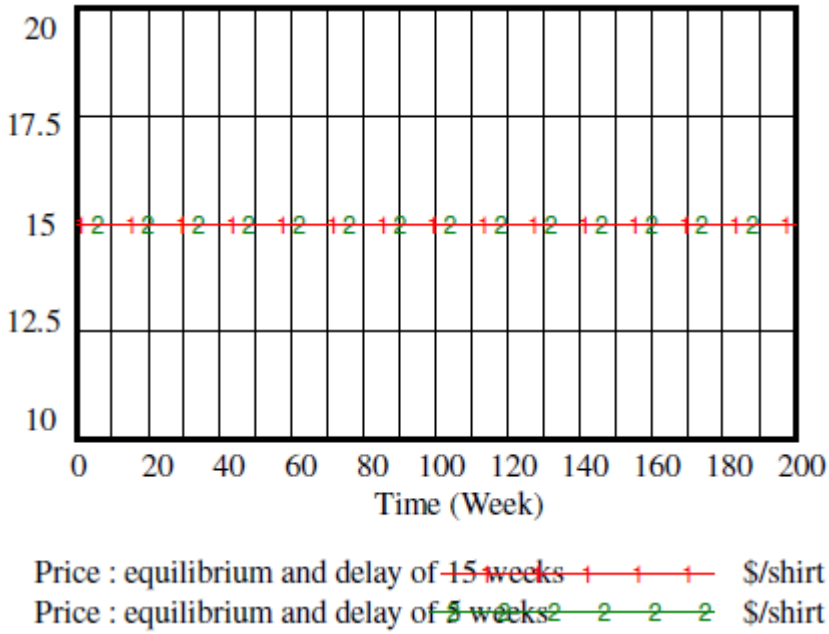

Figure 8: Graph for price when system is in equilibrium

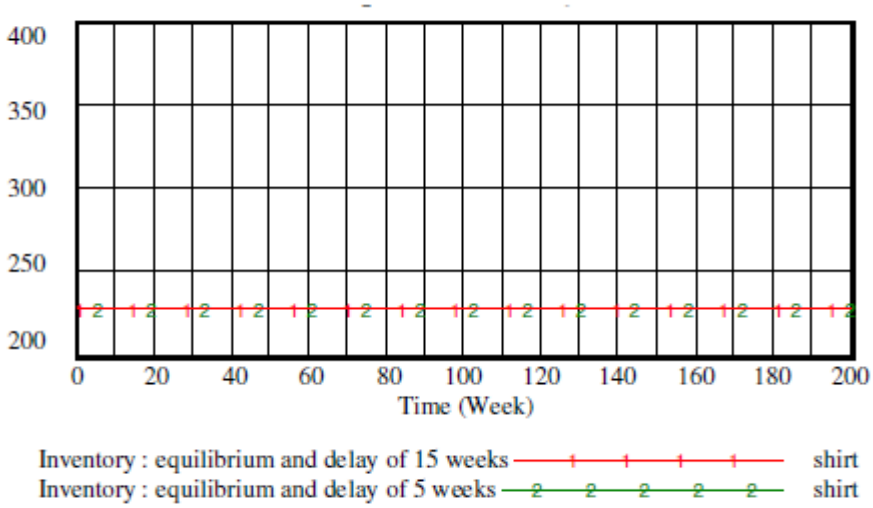

Figure 9: Graph for inventory when system is in equilibrium

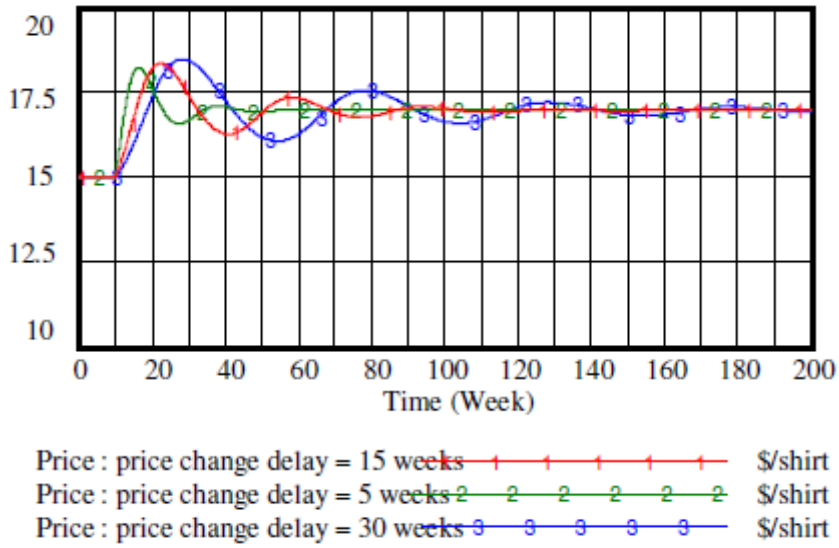

Figure 10: Behavior of price in case of price change delay

One would expect the system to reach equilibrium more quickly when the price change delay is equal to 15 weeks. For example, if current price is $10 and desired price is $25, and if price change delay is 15 weeks, after first week price would change for $1 ((25-10)/15=1). If price change delay is 30 weeks, after first week price would change for $0.5 ((25-10)/30=0.5). Therefore, when price change delay is shortest, system will reach equilibrium in shortest time, and period of oscillations would be shortest. Opposite happens when price change delay is longest.

Damped and Sustained Oscillations

In order to generate sustained oscillations, system must be a negative feedback loop and must have at least two stocks. If model has sustained oscillations generic structure with an additional feedback loop damped oscillations occurs. This is what happens in the Economic supply & demand model.

Negative feedback loops 1 and 3 are essential to the behavior of the model. Therefore, I wanted to compare what happens with model behavior if negative feedback loop 2 is removed. According to the graphs of the model behavior, when negative feedback loop 2 is removed (desired inventory is defined as constant and set to 228 shirts) model exhibits sustained oscillations.

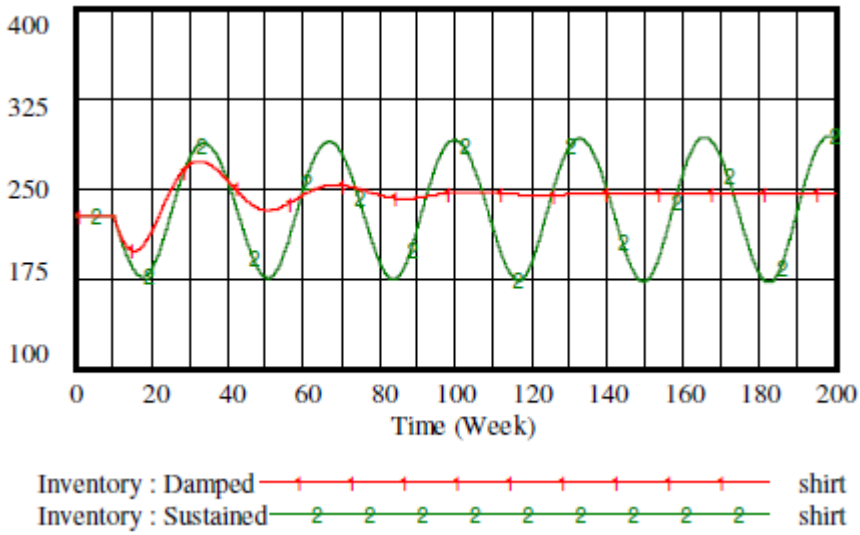

Figure 11: Behavior of Inventory under damped and sustained oscillations

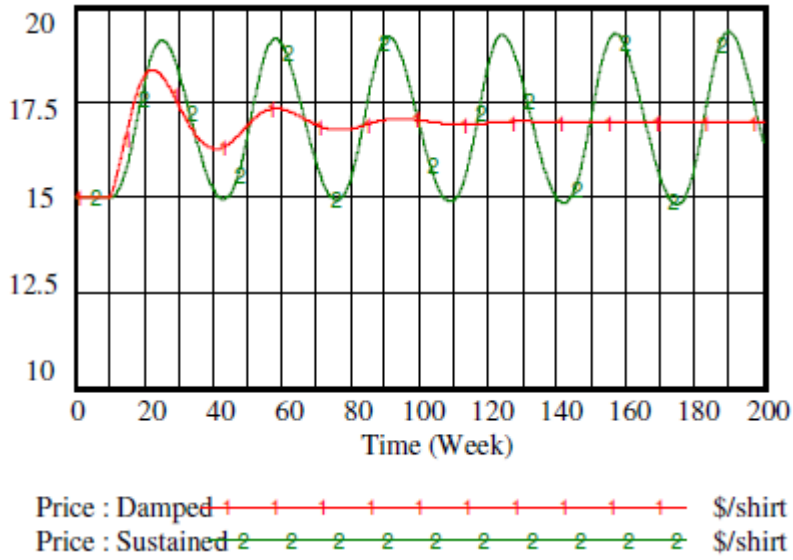

Figure 12: Behavior of Price under damped and sustained oscillations

4. CONCLUSION

Management flight simulators are designed in order to initiate active, student-oriented learning which is especially important in entrepreneurship education. Entrepreneurs seek information that is useful in achieving a goal of the game, and during that process their

understanding of the system increases. Therefore management flight simulators could be useful in education of entrepreneurs.

Case study of using supply and demand model in the entrepreneurship class is presented. In addition, many equilibrium models contain feedback loops. For example, when Fed enlarges money supply, interest rates decreases, which in turn decreases costs of investments. Therefore, firms increase investments and people buy more houses. But, savings decrease partly because some is invested and partly because of lower interest rates. Lower savings could in the long run increase interest rates and investments would again decrease. Also, higher money supply could also increase rate of inflation, which also influences investments and savings. In the long run, increase in money supply would only result in higher rate of inflation and production and investments would return to the initial level. It would be interesting to design such model that could be useful in education and analysis of monetary policy.

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Model Driven Architecture is a Complex System

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Abstract: **An abstract formalization of the software development life cycle (process) in the theory of complex systems and complexes is considered. The formalization highly depends on so called reference set, which is a basis of bundle of the life cycle into a set of structures, e.g., various software model representations. An example, which appears to be a generalization of Model driven architecture (MDA), is considered, as well as the present approaches and technologies for the software development if the proposed model implied.**

1. INTRODUCTION

Any software development life cycle consists of distinct stages and involves various agents (manages, software developers, users, etc.) and technologies, such as mathematical modeling, information representation modeling, information processing and visualization, user interfaces. At the very beginning the problem stated represents an ideal object, which is specified during the stages as various linguistic, mathematical and information models. At the stages of implementation the models are represented as algorithms and data structures, which are realized as program objects and components. At the testing and deployment stages the software is used by testers and users. In the general case new ideas and problems affect the life cycle at any stage. For example, new requirements are analyzed on the basis of the obtained experience and new software life cycle is constructed; new implementation technology implies reconstruction (translation) of the source code into new language and corresponding data structures adaptation; the user's suggestions of the user interface modifications imply data structure and source code reconstruction.

Various combinations of stages form a number of life cycle schemes, such as waterfall and spiral models, 'V'- model, agile and extreme approaches, iterative and incremental development, and various improvement models [1]. All the approaches use models of various degrees of abstraction and formalization. We consider a general case of life cycle as a process of adaptation of new ideas, requirements and specifications implies modification of all the models (formalized and implied). Thus, the software development process is represented as propagation of the modifications.

The problem we consider in the paper is to construct an approach to describe the process of the modification propagation as a basis of a corresponding instrumental environment. The necessity of the modification propagation results from application of the theory of complex systems and complexes to software life cycle.

2. THE THEORY OF COMPLEX SYSTEMS AND COMPLEXES [2]

Complexes (compositions) and systems of compositions (configurations) X_i are formed from combinations of various elements, components, systems, complexes, systems-complexes. Configurations X_i are different kinds of complex system's polymorphism. The universal structure X contains all X_i, and in this case it is analogous to notion of set of all subsets or category of all the subcategories. The connections between compositions are represented by means of mapping (morphism) $F_{ij}: X_i \to X_j$. The composition connected with morphisms (represented a category in the mathematical sense) form a complex. The comparison of the two compositions X_i and X_j, namely $\Delta X_{ij} = X_j \backslash X_i$, shows the dissimilarity between j-th composition and i-th one. For example, let X_i, X_j be different UML models of software before and after adding a new structure, so ΔX_{ij} reflects a complex of the current development step. If X_i, X_j are two UML models of different software systems, then ΔX_{ij} fixes, in particular, their structural dissimilarity, and F_{ij} is a comparison relation. The structure ΔX_{ij} is also a composition and belongs to the set of all the comparisons ΔX. The set F is a set of all possible mappings F_{ij}.

There are also a reference set of comparison I; it is the interval [0, 1], which is a metric linearly ordered inductive continuous bounded above and below set of points. The one-to-one correspondence of compositions and reference set points is denoted by relation (↔), for example, $I \leftrightarrow I$ means that each point I turns into itself; $X \leftrightarrow I$ means that any composition from set X is one-to-one corresponded to a definite point of the interval [0, 1]. In the latter case I is a bundle (fibration) basis of X, in other words the differentiation X onto compositions is conducted by means of comparing them with points (numbers) from the interval [0, 1].

The axioms of complex systems' theory are to compare compositions and their connection functions with an identification index of an order and together.

$$\mathbf{1)}\ X \leftrightarrow I;\ \mathbf{2)} F \leftrightarrow I\ \mathbf{3)}\ \Delta X_{ij} \leftrightarrow F_{ij} \quad (1)$$

The axioms 1 and 2 transfer all the order properties of the set I to the sets of all compositions $X_i \subset X$, their comparisons $\Delta X_i \subset X$, and mappings $F_{ij} \subset F$. This also implies that all the combinations are toposes, i.e. they are linearly ordered structures with the individual measure from I. By means of I the structures, their comparisons and mappings are one-to-one connected to each other.

$$X \leftrightarrow F \leftrightarrow \Delta X \leftrightarrow I \quad (2)$$

This emphasize a necessary moment of complexing, the complexes, their comparisons and mappings are equivalent (identical in the sense of dialectical logics), and have the single identification index in I. The complexes are self developing systems, where each alteration is based on its structure $\Delta X \leftrightarrow X$. Complexes are static formations; the transitional states with partially formed connections cannot be related to them.

Complexes are linear sequences of morphisms (categories)

$$\cdots \to X_i \to X_j \to X_k \to \cdots \quad (3)$$

the contained compositions form homologous series of comparison, as each composition has a measure from I, this series is also homotopic. Homologo- homotopic series form

comparisons and mappings. All the elements of the series are functionally similar, that's why they can be considered as series of analogs.

Any fragment of a homological series $X_i \to X_j$ is a complex, which corresponds to a complex of comparison of the dissimilarities $\Delta X_i \to \Delta X_j$. Consequently, a similarity of the structure implies similarity of modifications and vice-versa. Therefore, observed similarity in the structure must be caused by similarities of the processes and their models. The search of structural and dynamical similarity is the main subject of the theory of complexes.

2.1. Application to Software Life Cycle

In the field of software development the theory could be implemented in various aspects. If we choose the reference set I as detail level of software model representation, then 0 could mean a completely abstract level (just an idea), and 1 denotes completely realized software complex. Further, X_i will correspond to informational models of various abstraction. For example, X_0 is the original idea, X_1 is a textual representation of the requirements, X_2 is an UML model, …, and at the end of the interval, e.g., X_9 is a completely realized software system. The configurations $X_0, X_1, \dots, X_9$ correspond to points $i_0 = 0, i_1, \dots, i_9 = 1$ (for each $i_k < i_{k+1}, k = 0,1, \dots, 9$) of the interval [0, 1].

The idea X_0 is explained by means of its terminological basis of formalization, and references to the software domain and problem stated. The reference could be an existing ontology or a textual representation of the problem. The dissimilarity ΔX_{01} denotes the additional information about requirements to the software under development. This is a result of the problem and domain decomposition. As X_1 one can understand as IDEF0 model extended with formal or informal specification of its structural elements. The morphism F_{01} is a creative function done by system analyst under restriction of some technique, e.g., SADT [3].

The dissimilarity ΔX_{12} denotes the result of system designer's activity F_{12} of conversion IDEF0 model with the requirements into set of UML diagrams. All ΔX_{ij} have their corresponding interpretations.

Theory's axiomatic basis here is realized as follows:

- Axiom 1 in (1) denotes, that any software system can be considered (modeled) at various abstraction levels denoted by I , and the inverse direction means, that for any set of models the bundle basis I could be constructed;

- Axiom 2 means that it is possible to develop software as model transformations and refinements, as well as having developed a sound in some sense software, then it has sound model set representation (formalized or just implied);

- Axiom 3 for each model specialization or transformation a set of methods (techniques, tools) to carry out the development could be found or developed, as well as methods and instrumental software used to develop software by means transformation of corresponding models.

The interpretation of the identity $X \leftrightarrow \Delta X$ means that the process of software development is based on its structure, ΔX results from testing and exploitation, and the software development is an improvement of the set of the models. The complex in this example

also form a homologous (homotopic, analog) series, in other words, one can make advantage of the same steps as in an early project using the same set of models X to develop new software.

There are various approaches to automatic transformation of the models in the field of software development, such as IBM Rational Unified Process, Model Driven Architecture (MDA) [4] and formal methods [5]. The approaches are aimed at automation of creative activity of designers and programmers and implemented in instrumental software. The software development tools having a model at input generate a model or source code, which also we consider as a model. Most of the transformations are formal and deductive; the MDA approach requires a Platform Model and a scenario to specify a variant of the transformation.

A translation of the properties of the theory of complexes to the processes of MDA-transformations results in following conclusions.

- In developing software any state of X, including $\mathbf{\Delta}X$ should be stored for later usage in transformation

- The stored results of the transformations should be analyzed to extract new knowledge about the transformation specific of the current task and also general templates about designing software.

- Complex $\mathbf{\Delta}X$ is of especial interest and subject of analysis. Namely, as transformation $X_i \rightarrow X_j$ corresponds to the dissimilarities $\mathbf{\Delta}X_i \rightarrow \Delta X_j$, then the instrumental software should correct all the models in X as soon as some $\mathbf{\Delta}X_{ij}$ has been fixed by a developer.

Thus, it is of purpose to construct instrumental software based on analysis of analogy and propagation of the modifications $\mathbf{\Delta}X$.

2.2. An Example Project

To investigate the possibilities of the software development approach we started a pilot project of notarial office automation. The task selected among stated as the development of the software is deeply depended on users' desire to change: creating instances of documents, correct errors, forming new document classes, composing new document workflows, as well as refinement of user interface aimed at raising the office productivity.

From the functional point of view the notarial office is primarily an organization for document preparation, storage, and retrieval; tracking of the individual's data is the secondary aim that allows producing the document more agile. There exist four user roles in the office; they are "secretary", who fills in the templates, "template modifier", who is an experienced user allowed to construct forms and describe new regular structures found in documents, "programmer", who understands information modeling and implements the routine tasks as program modules, and "notary", who validates and signs the documents. As usual the roles define the set of activities and responsibilities for corresponding users.

During the exploitation of the information system secretaries gain experience, and can evolve in template modifiers. Shifting a user from first role to another can be done as a result of his/her qualification assessment. The assessment can be performed by notary and programmer or by means of testing, for example, answering a set of tests and/or doing test exercises.

Each instantiation of a template can be considered as a copying a document in the storage and its refill with new data or even just an edition of the copy. Modification of the second kind can be interpreted in several ways. Firstly, as mentioned before, it is just refill of the template. Secondly, it is a template body text error correction or a further improvement of the document. Thirdly, the modification could touch the form structure giving rise a new template of existing kind (class), or form even a new class of templates, e.g., fixing some parameter or substructure.

The modification propagation process is based on a number of document models. Secretaries will fill in documents as HTML forms and edit the generated instances in a WYSIWIG HTML editor. HTML is widely used and support necessary level of the notarial document representation. There are many useful methods of HTML generation and modifications. The difference between documents of various versions is to be propagated to other models. Such models represent the document layout and presentation (CSS), structure of the document class (what parts should be presented in the document and in which order), structure of the form of the template, fixed data structures stored in a rational database, and so on. The structural models are based on corresponding ontologies, e.g., ontology of structure elements of a document, ontology for expression individuals' data, etc.

The system should control the process of the document designing in a dialog with user, acquiring the additional information on user's intention and acting in concordance. Complex problems are described by users as texts for programmers, who implements new features of the software after confirmation of the requirements.

3. IMPLEMENTATION TECHNOLOGIES

Since 2001 OMG exploits Model Driven Architecture (MDA) of software development. MDA [4] is a part of the model considered in the section 1.A. MDA exploits three levels of abstractions to represent software: CIM, PIM and PSM.

The Computation Independent Model (CIM) reflects software's external requirements – its interfaces. CIM hides structural elements, and can be used for define specifications and checking requirements.

The software designing technique of MDA is based on multistage transformation of Platform Independent Model (PIM) into a number of Platform Specific Models (PSM). PIM is a model of the software reflecting most of the structural and some semantic aspects of the software, but the model contains no information about implementation of the structures on the target program architecture. UML Class Diagram extended with some tag values and additional stereotypes is an example of PIM. The extension allows one to denote implementation hints for structures. PSM is a model, which can be implemented as source code of the subsystems, e.g., it could be a physical structure of a rational database, which is directly (deductively or by means of code templates) translated into DDL SQL-requests.

The transformation of the PIM into PSMs is carried out under control of a Platform Model (PM) and a transformation scenario. PM contains information and algorithms of PIM's structure analysis and generation of corresponding structures in PSMs. Sometimes PSM is understood as specified variant of PIM. The tag values and stereotypes are used to direct the transformation of a structure into desired frame.

PMs in most of commercial MDA systems have been implemented on the basis of algorithmic approach. They are not far from CASE systems translating UML diagrams into a source code by various plug-ins. The main idea of MDA is to allow developer to modify PM according his/her preferences and task properties. Our experience shows that usage of present logical languages and PMs based on formalized knowledge [6] allows us to affect the transformation in an efficient way by means of changing a rule set content.

We use [6] a logical approach to implement transformation. The source PIM is represented as XMIfile version 1.2. As it is a variant of XML, the file is parsed by means of libxml XML parsers into a tree. The tree encapsulated inside a LogTalk module, which processes queries to PIM structure. The transformation procedures and PM is represented as set of LogTalk modules connected with messages. Each module contains a knowledge base to recognize an aspect in the PIM and its derivate structures. The results of recognition form new facts about PSM. The transformation scenario is a set (sequence) of the leave modules, which generate source code and other data structures.

Thus, the generated PSM is represented as set of facts consisting of the subset describing the original PIM, which is obtained while querying the XML tree, and the subset describing the implementation aspects of the software under development. The resulting source code is generated by leave modules by means of templates, so the templates play the similar role as CSS in web, it represents PSM as texts of source codes.

Main advantages of MDA usage in the software development are as follows:

1. Design stage independence of the implementation platform; capability to replace the platform without redesigning PIM.

2. Formal definition of PM: programmers' knowledge is represented as rules and algorithms.

3. Raising the automation level of the life cycle: early stage modifications (design stages) are less expensive to implement in PSMs.

MDA is a great approach and successfully used in development complex software, but it has significant disadvantage, which we are to overcome:

1. Using the MDA in simple projects usually extends time of software construction, although obtained formal PIM and PM models when analyzed could be used in other projects;

2. Currently MDA is of little use in already constructed and implemented systems and systems based on stored data manipulation, e.g., existing informational systems, as modification of information data model results in database structure modification like adaptation to new data structures;

3. Modification of PIM and source code is ignored by the procedures of transformations.

The support of the above mentioned propagation of dissimilarities ΔX_{ij} and modeling whole life cycle's homology should overcome the disadvantages, and it means, in particular, that the instrumentation software should support the transformation in both directions.

4. SOURCES OF MODIFICATIONS

When a MDA tool generates a source code, the problem appears when the generated code was modified by a programmer. The modification can be easily lost because of likely following regeneration. One of the ways to conserve modifications is to represent the generated software framework as a library and allow programmers to inherit the code. Changing sources is useful because of programmer can more comfortable figure out the correct data types and names the entities “in place”, adjust the procedures to improve performance.

Controlling changes in source code can be realized through using version control systems that can efficiently compare the source code versions, and through developing compilers, which could be aware of the PSM and PIM existence. In the simplest case the difference of the versions is stored as a patch; the patch reapplied each time after the source code regeneration; conflicts are resolved interactively by programmer. Another way is to analyze both versions of the source code as parsing trees, the difference propagated into a PSMs’ and PIM’s versions. The propagation should be made under programmer’s supervision: programmer must supply the information on the meaning of the difference.

To support the propagation on the level of the source code one can take advantages of the literate programming tools and data formats, which can be thought of as a way of hypertext markup of the source code generated from PSMs. Literate programming is a way of source code construction, where the programmer mixes a task description and the task solution – the program – in the same source text file or a tree structure. The program is also constructed from structural parts. The literate programming transformational tools analyze the source structure and generate source code tagged as special cases of comments of the generated program to reconstruct the original structure in case of generated source modification. Some literate programming tools can generate a whole project from one tree (see for example Leo editor [7]) and track some source code modifications.

In MDA case the source structure is a PIM, transformation modules include data about original structure of the PIM as tags into comments of the generated source code. These tags are semantic marks of the source code intervals. In this case the difference of the source codes can be directly associated to the structural element of the source model.

The theory of complex systems states that $\Delta X \leftrightarrow X$. In our case this means, that the structures for the models representation can be used to represent the modifications, also the algorithms of transformations of the models can be used to transform of the modifications. The modifications can be represented in the similar way as patch files as groups <removed substructure/context of removal, added substructure>.

Another way of obtaining new information for models is the texts related to the software domain. New notions could be extracted by means of text analysis of new requirements, as the texts are based on the steady (in time) terminological basis, allowing human beings to understand each other. Texts contain artifacts referencing informational structures of the software, e.g., template word sequences denoting concrete user interface or data structures. There are approaches constructing formal taxonomies (ontologies) from analysis of appearance frequency of terms, see, e.g., [8]. The requirements contain both new restriction and new terms, which possible be a new classes or instances. Two versions of the ontology compared and the difference - new notions and classes shifting in the hierarchy - will reflect the new requirements.

Let us briefly consider a technique [8] for text analysis and thesaurus extraction. The technique's input is a set of texts and output is a thesaurus, where for all terms a subset of the source text set corresponding to the term is associated. The technique consists of four steps:

1. Construction of the stemmed word index of the texts' set.

2. Form a terminological basis as a set of terms; the terms are represented as a sequence of adjacent stemmed words.

3. Hierarchical clustering of the text set, where the texts are described in the space of frequencies of the terms (the sequences) appearance.

4. Association of the cluster nodes to the terms, as semantic value of the node, thus, forming a thesaurus.

Textual representation also used by programmers using revision control systems to describe work done. The description can be considered as a text block of corresponding literate programming source code. There are developer groups, which have agreements of tagging text with special words (such as “UPD:”, “TODO:”, “FEATURE:”) to define modification semantics more formally. Analysis of the descriptions allows one to connect ontological notions to source code components and functions of the new structures to its implementation.

The history of the development process is to be stored in a revision control system. Its branching structure will reflect the natural structure of the software development process. Comparing the branching structure with existing formal taxonomies gives rise of relation of the object classes to their implementation approaches. Open source distributed concurrent versioning system Git [9] has most powerful commit approach, which allows one to fix changes partially, and powerful branching model, merging, pushing/pulling changes, and repository cloning.

User interfaces are also the sources of the modifications as they are parts of the software reflecting all structures of the software projects. The main role of the user interfaces in the software development process is adaptation to the software structures and user requirements. So, the allowing user to modify the user interface will result in the new set of modifications related to layout of the widgets, grouping the common components, and fine adjustment of the behavior of the widgets.

5. CONCLUSION

Software development life cycle has been considered as subject of the theory of complex systems and complexes [2] implying that the software development is a natural process. The life cycle is represented as system of models and morphisms between them. Analysis of the theory’s properties realization in the model shown, that the present instrumental software productivity could be extended by means of developing techniques for analysis of the passed life cycle stages, analysis and propagation of modification of the models.

In the last section of the paper we considered some existing sources of modifications in the framework of Model Driven Architecture (MDA) and software utilization, for example, joining the code generation stage of MDA and compilation stage of programming language allow one to propagate modification of previously generated source code to the abstract models of the software; extraction formal taxonomy from analysis of textual representations of users’

requirements and logs of concurrent versioning systems [9] allows one to figure out new notions from new requirements.

For some tasks appearing in the paper a variant of the solution is presented as a methods or informational technology. The problem of the software development history analysis is not considered and is a subject of further investigation, as well as implementation of the considered ideas as an open-source MDA software development tool.

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IS/ICT of an SME in Auto Transport Services

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Abstract: **This paper presents a model of an information system, developed within an integrated model (IM) of information system (IS) and process structure of an enterprise specialized in road transport of goods and passengers by motor vehicles. IM approach is important because of the increasing dependency between services and information and communication technologies (ICT) in this industry. Implementation of GPS/GPRS technologies are elaborated within IS/ICT system development. Besides, IM approach is a holistic approach that involves three important dimensions of contemporary enterprise: process orientation, IT support to operations and quality system requirements. Applied object-oriented analysis of main processes of an auto transport enterprise resulted in the design of common conceptual model of enterprise information system. Experimental research on the implementation of IS model of Transport services process in an SME was also conducted and results are presented in this paper. The research confirmed managerial value of IS model as a tool that provides data and information needed for real time management of transport services business process (BP).**

1. INTRODUCTION

Integration of the core business processes in an enterprise becomes the key success factor in modern business environment. Process oriented enterprise is a highlighted characteristic of a modern enterprise that ensures greater flexibility, comparing to functional organizational structure recognized by management and administration hierarchy. Process modeling of Quality Management System (QMS) defined by ISO 9001:2000 (updated version from 2008) contributed to a strict definition of end-to-end processes of product or service realization (from customer demand to the delivery of product/service to a customer) and strict definition of performance measurement of processes and enterprises as such. Information system/ information and communication technologies (IS/ICT) are inevitable component of modern enterprises and a foundation of completely new enterprise business concepts. This specially relates to service oriented enterprises [1].

It is well known that service sector is widely present in GDP structure of developed countries, and lately, the same trend is noticed in the economies of developing countries [2].

ICT also contributed to connecting “end-to-end” transport process that spread over different enterprises, thus supporting the concept of sustainable development (in the sense of availability to maintain the balance among three areas: economics, ecology and social) [3].

This paper presents a model of an information system, developed within a business integrated model (IM) of information system (IS) and process structure of an enterprise, specialized in road transport of goods and passengers by motor vehicles. IM approach is important because of increasing dependency between services and information and communication technologies (ICT) in this industry. Identified “end-to-end” processes: Transport services; Technical maintenance and Calculation of income and cost per vehicle are the most important processes for the management in an auto transport enterprise. This is

because services cannot be stored in a warehouse and one of the key success factors is a high level of vehicles' availability [4].

Experimental research on the implementation of transport business process in an SME (small and medium enterprise) was also conducted and results are presented in this paper.

Project results are applied within Autotransport doo, Kostolac (further in text referred to as: Autotransport) [5].

The research confirmed managerial value of IS model within IM model as a tool that provides data and information needed for real time management of maintenance services business process (BP).

Besides Introduction section, this paper includes the following sections: IM model and approach (consideration of a problem and solution directions; developed model of integration), IS model (logical architecture of the IS), IS model implementation of Transport services process (experimental research in an SME), Future trends and further research and development (R&D) and Conclusion.

2. INTEGRATED MODEL AND APPROACH

It is important for a service oriented SME to integrate customer relationship management (CRM), resource management, service providing and financial management into a unified management process. All these processes generate and use large sets of different data to facilitate efficient enterprise's operations and development. Integration of BP and IS has to be achieved.

Research on the relation between a process structure and IS within the development of an IM of an enterprise that provides services in road transport, is conducted on characteristics of an enterprise which scope of services include following services: services of public transport of passengers and goods and other services for which, own heterogeneous fleet is used; services of public transport of goods with own resources and subcontracting of services in the same domain.

IM approach is a holistic approach that involves three important dimensions of contemporary enterprise: process orientation, IT support to operations and quality system requirements. IM is an integration model of BP and IS which shows that BP and IS interact to realize business goal. This is illustrated at the Fig. 1 [1,6].

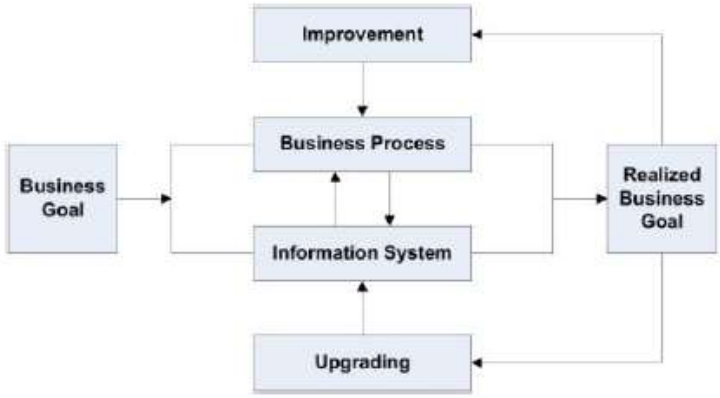

Figure 1: Global business integration model

3. IS MODEL

Information system modeling is an activity which products are models – various views on IS development. Modern IS are being developed by applying object-oriented method. Object-oriented modeling and Unified Software Development Process [1], present a development process of software-intensive systems, and enable achieving a stable architecture that allows iterative and incremental system development. Therefore, with the implementation of additional functionalities, the system is being upgraded without significant change in its architecture. So this object-oriented IS development approach is appropriate for IM development and implementation.

As it was previously said, IM approach is a holistic approach that involves three important dimensions of contemporary enterprise: process orientation, IT support to operations and quality system requirements. Applied object-oriented analysis of main processes of an auto transport enterprise resulted in the design of the common conceptual model of enterprise information system.

The group of main processes that contributes to the mutual goal is defined as a scope of a single IS. Logical architecture of an IS of auto transport enterprise (ISAT) consists of following constitutive subsystems [1,7] with studied relations (Fig. 2, [1]): S1 – Customer Requirements Fulfillment and Service Realization System, S2 – Integrated Logistics Support System, S3 – Vehicles Incomes and Costs Calculation and Analysis System, S4 – Financial Resources and Analysis and Documentation Management System, S5 – Information System Management, S6 – Top Management Decision Support System, S7 – Service Design and Development System, S8 – Document Publishing and Management System, S9 – Services Measurement and Analysis System, S10 – Human Resources Management (HRM) System.

System for Customer Requirements Fulfillment and Service Realization System – S1. The purpose of this system is to ensure efficient communication with customers and processes of an auto transport enterprise (AT) in order to ensure that the customer receives correct information on possibilities and commercial conditions of AT for fulfillment of its order, status of realization of its order and solving potential problems (customer complaints) and to provide

with data and information necessary for efficient realization of customer order and ensuring the quality of service, in accordance with expectations of both customer and AT. This system includes information support to transport services realization process.

Integrated Logistics Support System – S2. The purpose of this system is to provide necessary and sufficient data and information for the realization of processes "service sales" and "service realization" at any moment of their realization. Data and information include documents (licenses, travel orders…), physical subjects (drivers, vehicles, equipment…). To realize these requirements quickly and correctly in modern business environment is possible only through modern IS/ICT systems, i.e. application software. It should be pointed out that in this system, the most important is information support to technical maintenance process [4,8].

Vehicles Income and Costs Calculation and Analysis System – S3. The purpose of this system is to provide with calculation and analysis on income and cost of vehicles, in the shortest period, after realization of single transport service. So this system supports the process of calculation of income and cost per vehicle.

Financial Resources and Analysis and Documentation Management System – S4. The purpose of this system is to provide with accurate data on financial means of AT in every moment and to provide with accurate processing of financial documentation and automated bookkeeping in accordance to the legal framework in this field. This is how the enterprise ensures the efficient management of income, control of costs and makes other important decisions based on which the financial conditions for the successful management of AT are ensured.

Information System Management – S5. The purpose of this system is to administer ISAT and should provide with accurate data on components of the entire ISAT during its development and exploitation, to preserve system's integrity and ensures the availability, security and protection of data, as resources of AT.

Top Management Decision Support System – S6. This system provides executive management with data and information necessary for identification of operational and business problems, based on enterprise and process performance indicators and for making operational and tactical management decisions.

Service Design and Development System – S7. The purpose of this system is to ensure intensive communication with environment and provide data (external and internal) in order to identify needs for new service, its economic justification and making conditions for realization of that service within AT.

Document Publishing and Management System – S8. The purpose of this system is to ensure managing of selected set of documents that are relevant for achieving AT's business goals and to ensure electronic publishing and distribution of relevant information on the matter. System should also enable efficient issuance of other relevant information form ISAT system. This system provides support to the QMS.

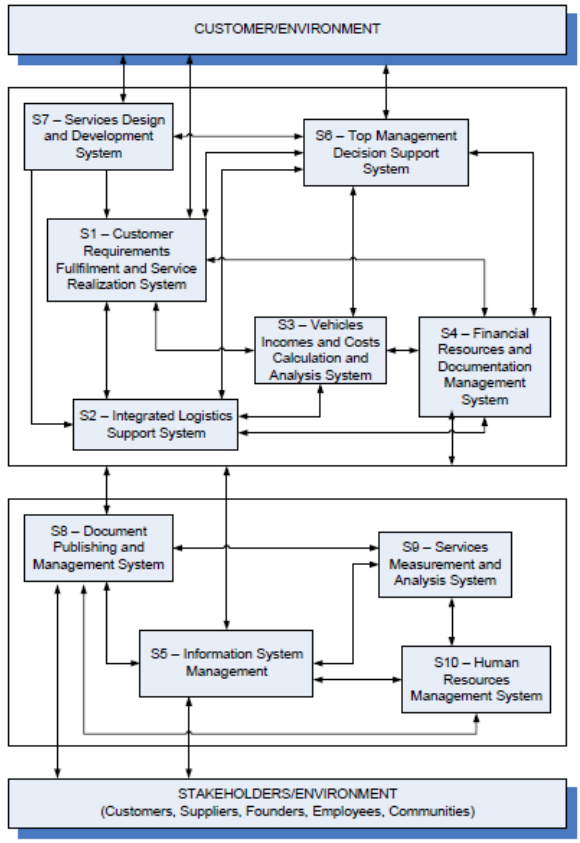

Figure 2: Logical architecture of ISAT

Services Measurement and Analysis System – S9. The purpose of this system is to contribute to the improvement of AT's services based on the measurement and analysis of realized services of AT (in accordance with QMS requirements), from the view of AT's business goals achievement.

Human Resources Management System – S10. The purpose of this system is to support HRM through ensuring that the staff is educated and skilled for assigned positions, as well as to organize further education during the employment. System needs to enable noting and keeping track of all relevant business data during the employee's engagement, analysis of elements of specification of positions and elements of improvement of effectiveness and motivation of employees.

Systems that are defined like this, in the IM's planning phase, support main business processes and main information flows between them, and are the basis for the planning of development and implementation of ISAT application software [1,5], based on defined business goals and priorities. ISAT logical architecture defined like this, with methodological and technological solutions in design and implementation of software solutions, ensures ISAT's flexibility and interrelation between business goals and IS goals, with regards to the IM approach and model depicted at figure 1.

Key concepts of ISAT domain model are: Transportation service, Business partner, Suppliers contract, Client service contract, Travel order, Vehicle, Employee, Travel order calculation, Invoice for client, Monthly calculation on income and costs per vehicle, Spare part, Warehouse, Vehicle maintenance. For example, Travel order class, is responsible for providing with all data input for travel documents and travel documents itself (electronic and/or print paper form) for available vehicle from the class Vehicle and driver's availability from the class Employee [1,7].

4. IS MODEL IMPLEMENTATION OF TRANSPORT SERVICES PROCESS

The application of developed IM approach and model itself is realized in the enterprise for transport services and maintenance of motor vehicles Autotransport, Kostolac, Serbia (further referred to as ATK). It is a „spin-off" enterprise, established within a process of restructuring of the Electric Power Industry of Serbia, by separating organizational divisions that were providing support to core business processes in the field of transportation of passengers, goods, materials and freight, back in 2003 [6,8].

Defined priorities in business and IS development are aligned, aiming at creating a common ground for integration of CRM, resource management, service realization and financial management into a unified management process in order to reduce costs and increase income of this SME.

In ATK, the organizational structure follows the streamline business processes, in which, the data on business objects, activities and documents are available through IS and a modern ICT infrastructure. It is a dynamic component of a modern enterprise and enables flexibility and agility, which for an SME in service sector means "survival" and development.

It is observed those actors' responsibilities in business processes increase when business process is supported by IS. Transport services process is a business process of high priority for the IM realization in an SME in auto transport for the following reasons [6]:

- enterprise makes revenue with transport services,
- this process realizes contact with a customer and it remains in contact with a customer during service realization,
- this process must "know" how many resources are available (relation with Maintenance process) when accepting a customers' request and whether it needs to rent resources through outsourcing,
- this process must perform a service,
- this process must gather data for the calculation of cost of realized service.

Aiming at realization of business processes based on the quality principles and requirements, following documents are being defined and implemented through the application software [6,8]:

- input documents (e.g. Contract with customer, Order receipt)
- business documents relevant for the process (e.g. Travel order for a vehicle, Shipping document),

- reports and overviews - data on request (data on Key Performance Indicators (KPIs) and other data for management in real time).

Based on the direct insight into status of realization of a service (from the request to completion of transport service realization), realized vehicles and drivers schedules and insight into status of available resources (fleet), with flexible selection of vehicles and drivers, one can efficiently manage the process of realization of transport service for every customer.

KPIs in realized IM Transport Service (for e.g. data for KPI - Increased vehicle productivity or Reduced fuel consumption per vehicle) are components of set of data and information for making business decisions for operational and top management of the enterprise. The focus is on KPIs, data sets from processes in real time, that management uses for decision making and its availability through the application Management, so called "managers' application" (for example) [6,8] include:

- (current) availability of vehicle fleet in the ATK,
- (current) availability of drivers and working machine operators in the ATK,
- mileage and work expressed in motor-hours (for working machines) from the beginning of current year,
- number of opened travel orders for vehicles on a given date.

Elaborated implementation of IM and ISAT at the ATK has characteristic that ISAT applications are integrated at data level they reflect, but also at the level of business processes they support. To that effect, the correlation within application software for business processes Transport service realization, vehicle Maintenance (with vehicle fleet) has been provided. Key performance indicators of Transport services process and Maintenance process - vehicle productivity (in terms of number of tones transported multiplied by the number of kilometers) and availability of a single vehicle and vehicle fleet as a whole are available to the "owners" of stated processes and to the top management of the enterprise.

Experimental research on IS model development and implementation, based on IM model of Transport services process simultaneously and synchronized with vehicle Maintenance in the ATK – this SME had confirmed managerial value of IS as a tool that provides data and information needed for real time management of transport services business process.

5. FUTURE TRENDS AND FURTHER R&D

It can be expected that new technologies in transport industry, new business models in services industry in general and IT services in specific, will be developed further, with the stress to the following:

- IM and software tools for faster implementation of changing business processes in service-oriented architecture (SOA) environment,
- IM models and process "outsourcing" – the transport companies shall be connected to the extranet business networks,
- IM and business integration aspects research, having sociological aspect added to organizational and technological aspects of business integration.

IT development and IM research directions in the auto transport industry will refer to: application software (in the domain of predictive analytics and transport simulation); different location software (based on GPS/GPRS technology implementation, e.g. an example at Fig. 3) and the increased presence of RFID devices and software; IM maintenance and "Software as a Service" business model in cloud computing environment [9].

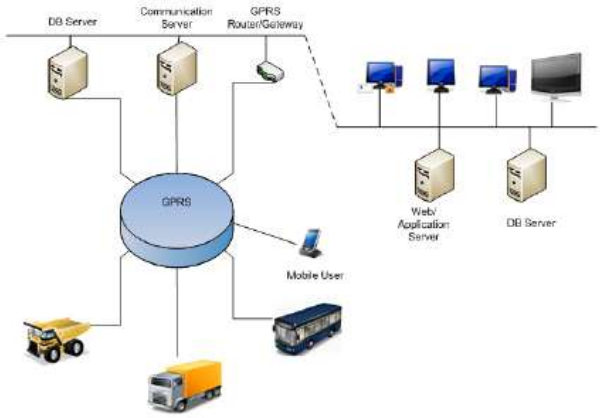

Figure 3: Integration of new technologies into IS/ICT system of an SME

6. CONCLUSION

Transport services' system with ISAT includes business processes with integrated operational activities supported by application software through which the business documents are generated. This approach provides: data on realized events (activities) regarding transport services operations to be stored in databases, as well as data on vehicle maintenance operations and management. From that point data become available to the management in real time (e.g. vehicle and fleet productivity as KPIs of fleet effectiveness, as well as vehicle and fleet availability as an indicator of vehicle maintenance process performance, and availability of a certain vehicle for transport services).

Some of, already achieved, effects of data analysis obtained from IS for transport services management system relate to the introduction of new services and increase in enterprise income. Besides, transparent data on service realization increase confidence that customer has in a transport operator and improve cooperation between drivers and supporting staff during service realization.

Presented Transport services system of motor vehicles with modeled business processes and IS, i.e. conceptual solution of the system, can be applied in other transport companies because it is based on business process management approach and object-oriented IS.

7. ACKNOWLEDGEMENT

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Machine Learning Algorithms for Business Decisions

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Abstract: **This paper presents most often used machine learning algorithms for business decisions support. Machine Learning algorithms, particularly decision tree generating algorithms and reinforcement learning algorithms can be applied upon data stored using XML technologies, in order to support business decisions.**

1. INTRODUCTION

The management and use of information, as an essential resource of a company, acquires new particularities deriving from its use in supporting decisions and from the continuous growth of the complexity of the decision process.

The decision process is a an assemble of activities driven by only one or several individuals facing an event that generates more than one acting direction, following the optimal direction, according to the value system of the decision makers.

This paper presents most often used machine learning algorithms that are used for business decision support.

2. DECISION TREES

Decision trees are an easy applicable for classification and prediction, the result being presented in a tree form with automatically set logic rules hierarchy by exploring a set of examples. The examples are similar to records with several attributes and the rules are being established by a detailed dividing of the assemble of examples, depending on the content of the attributes.

Building the decision tree begins from its root, which shows the available examples. The initial assemble is divided into intermediary nodes. Each node is being evaluated and is divided in other nodes if possible, until the terminal undividable nodes are found. When effectively processing data, the attributes are grouped in two categories: dependent and independent attributes. There is only one dependent attribute, also named target attribute, onto which we are searching for influences from the other attributes, the independent ones. From all the independent attributes we select the one that has the most powerful impact on the target field, the one that eventually supports the division of the record assembly into the most relevant sub-assemblies. For each of these subdivisions we re-perform the analysis, using the same target field but considering only the attributes that were left out in the previous steps, and seeking for new subdivisions.

After the tree construction, the new data can be included, at some amount of certainty, into one of the leaf nodes, depending on their attributes values, classifying them or being able to perform predictions regarding them.

3. DEVELOPMENT OF DECISION TREES

One of the most popular methods used in developing decision trees is CART (Classification and Regression Trees). This one starts with seeking out the independent variable which has values that allow the best division to take place. For this we move on to calculating a diversity index for the whole record assembly given an attribute. The procedure describes the parse of the independent attributes one by one and the evaluation of the diversity decrease obtained by the division one would make based on it. The variable that is retained as separation criteria is the one that produces the best results. We are actually looking for a binary tree. The attributes that have multiple values raise, in these conditions, a supplementary issue: regrouping the values as so the final division will lead to only two subdivisions.

4. THE C4.5 ALGORITHM

A more recent algorithm is C4.5 proposed by the Australian professor Quinlan. Unlike CART, which generates only binary trees, a node can have here a variable number of branches. Another difference would derive from the treatment of nominal variables, which will now have one branch for each possible value. The precursor of this algorithm, the ID3, developed by the same author, enjoyed a vast popularity and was used in various computer products. This one uses for an evaluation criteria of divisions the information gain obtained, as well as the uncertainty degree removed, concept that derives from Shannon's information theorem.

Because its usage comes in favor of numerous branches to which a small number of records from the example set will correspond, C4.5 uses the ratio between the total information gain obtained by the corresponding division and the information gain that is only due to the subassemblies count it generates. The tree pruning is also made in a different manner that the one CART practices; the analysis is based also on the teaching data, without having to invoke the test or evaluation distinct data.

In its informatics representation, the C4.5 can automatically generate rules. Beginning with the complete set, generated directly based on the tree, the application follows a generalization chain meant to decrease the rules count. For this purpose we remove certain conditions for each given rule and we verify how this maneuver increases the error rate. A series of other transformations can also be operated for this goal, as so, in the end, the rule count can be smaller than the leaf count.

Decision trees are a standard Data Mining tool and many of them are available in the C4.5 package. Decision trees are generally preferred due to the comprehensivity of their hypothesis and the efficiency of their learning and evaluation.

Decision trees are usually binary trees with simple classifiers associated to each internal node and with a classification associated to each leaf. In order to evaluate a T tree for an input x, the x attribute will be given to each classifier. The outputs of simple classifiers associated to the nodes determine a unique path from the root to a certain leaf of the decision tree.

Decision trees are generally understood through a descendant development procedure that begins with the root node and chooses a part of the data that maximize a cost function, usually a measurement of the subassemblies' "impurities" that is implicit defined in the moment of data partitioning. Afterwards the subassemblies are associated to two decision trees. The

procedure is recursively applied to the child nodes and the tree is being enlarged until a stop condition is met.

The C4.5 algorithm only generates binary trees, a node having a variable number of branches. C4.5 is able to automatically generate rules. Starting with the complete set of rules, generated directly on the tree's basis, there will be a generalization part, in order to reduce the number of rules. This way, for each rule certain conditions are eliminated and the increase of the error rate must be verified. A lot of other transformations can also be made in order to decrease the number of rules.

The steps of the C4.5 algorithm are presented as follows:

1) selects the attributes that have proven the most quantity of gained information

2) given two classes P and N:

a) given a set of examples S that contain p elements from the P class and n elements from the N class

b) the information quantity required to decide if a random example from S belongs to the P or N class is defined in relation (1):

$$I(p,n) = -\frac{p}{p+n}\log_2\frac{p}{p+n} - \frac{n}{p+n}\log_2\frac{n}{p+n} \quad (1)$$

3) assuming that by using an attribute A, a set S will be partitioned in the following sets {S1, S2, ...,Sv}

a) if S_i contains p_i examples from P and n_i examples from N, then the entropy or the necessary information for the classification of all the objects from all the S_i trees is (2):

$$E(A) = \sum_{i=1}^{n}\frac{p_i + n_i}{p+n} I(p_i, n_i) \quad (2)$$

4) the codification information gained on the A branch would be:

$$Gain(A) = I(p,n) - E(A)$$

C4.5 is an algorithm for the induction of decision trees, being, as mentioned before, an extension of the ID3 algorithm which unlike C4.5 solves some problems such as data extra-matching, treating continuous attributes and attributes with missing values, increasing the computational efficiency. The C4.5 generates a decision tree by recursively partitioning the data amount, using a depth-first parsing strategy. The algorithm takes into consideration all the possible tests for partitioning the data and selects the tests that will lead to the best information gain.

Considering the entropy concept as the "impurity" of a set of training examples S, the efficiency of an attribute for classification of these examples can be estimated. The information gain measures the expected reducing of the entropy caused by partitioning the set according to the values of an attribute A (3).

$$IG(S,A) = H(S) - \sum_{v \in Val(A)} \frac{card(S_v)}{card(S)} H(S_v) \quad (3)$$

where Val(A) is the set of A attribute values, Sv is the subset of S for which the A attribute has the v value, and H(S) is the entropy of the set S with n classes, each with a pi appearance probability (4):

$$H(S) = \sum_{i=1}^{n} -p_i \log_2 p_i \quad (4)$$

Another important feature of the algorithm is the pruning of the decision tree, once the learning is done, meaning that the tests that are not really helpful for the decision problem are being eliminated. A later version of the C4.5 algorithms is the C5.0, used mostly in commercial systems.

5. REINFORCEMENT LEARNING ALGORITHM

Reinforcement Learning is a very interesting Machine Learning algorithm. The idea of Reinforcement Learning is very simple: an agent is exploring an environment and acting upon it, and in the end it receives a reward or a penalty. The agent will find out whether it acted correctly or not, without having the reasons explained.

In Reinforcement Learning, also called learning with a critic or rewarded learning, no hints are offered regarding the expectations; the only feedback is that the result will be categorized as correct or wrong. The situation is similar to the one of a critic that only claims that a certain thing is right or wrong, but doesn't explain it. Often the reward is being delayed.

The Reinforcement Learning algorithms are looking for a way of action in order to maximize the reward. The subject that has to learn isn't told the direction to action, as in most of Machine Learning techniques, instead it has to discover which action might bring the most efficient reward. In the most complex situations, the actions will not only affect the immediate rewards but also the future rewards.

The Reinforcement Learning technology is generally used for solving the so called Markov Decision Problems (MDP). The structure of a MDP consists in the following elements: the system's state, the actions, the transition probability, the transition rewards, a policy and a performance measurement mode.

The system's state is a parameter or a set of parameters that are supposed to describe the system. If a system's state is modifying in time, it is called to be a dynamic system. A dynamic system can be considered the queue formed at the cashier in a store. In this conditions, the x state, represented by the number of individuals that form the queue, becomes x+1, if a new individual is joining the queue, and becomes x-1, when an individual has paid and leaves the queue.

Actions represent situations in which a system may or may not fulfill one of the options it has available. We consider an action a to be selected in the state i, and let j be the next state. The probability of transition is expressed by p(i, a, j) which depicts the probability of transitioning from the state i to state j through action a.

The system will usually be rewarded when a transition from one state to another is performed, reward described by r(i, a, j).

The choice of the action in each state the system transitions through is established by a rule. In certain states no actions will be performed. The states in which decisions should be taken are naturally named decision states.

The rule for selecting an action must be designed as so it would be capable of selecting the optimal action, thus a means of measuring performance becomes available, means we shall define as the medium reward for a rule.

If we have a rule π then π(i) will be the selected action by this rule for the state i. Let x_s identify system state before the s-th transition. The next formula (Gosavi, 2004) will describe the medium reward for the rule π starting with state i, considering x1=i. The medium reward, ρ_i, expresses the sum of all immediate rewards divided to the number of transitions (k), calculated on a longer period of time.

$$\rho_i = \lim_{k\to\infty} \frac{E\left[\sum_{s=1}^{k}[r(x_s,\pi(x_s),x_{s+1})|x_1 = i]\right]}{k} \quad (5)$$

E – the medium value of the sum above

i – the initial system state

$\pi(x_s)$ – the action in state x_s

The limit in formula (5) is constant for any value of x_1 if the Markov problem satisfies certain conditions, thus we are going to have $\rho_i = \rho$ for any value of i. The goal of Markov's decision problem is finding a rule that will maximize the medium reward.

MDP can be solved through the dynamic programming method, which requires all the transition probabilities, p(i, a, j), and the rewards r(i, a, j).

The SMDP (Semi-Markov Decision Problem) variant requires an extra parameter that is the time span required for each transition. The duration of transition from state i to state j influenced by another state x will be expressed by t(i, a, j). For SMDP the medium reward within the given conditions, using an initial state i, is defined through the next formula (6).

$$\rho_i = \lim_{k\to\infty} \frac{E\left[\sum_{s=1}^{k}[r(x_s,\pi(x_s),x_{s+1})|x_1 = i]\right]}{E\left[\sum_{s=1}^{k}[t(x_s,\pi(x_s),x_{s+1})|x_1 = i]\right]} \quad (6)$$

6. THE Q-LEARNING ALGORITHM

An example of Reinforcement Learning is the socalled Q-learning algorithm, an extension of the traditional dynamic, which allows an agent to learn some rules from an arbitrary environment.

Q-learning eliminates the need of considering the maximum in a set of integrals, succeeding to map values (Q-values) from state/action pairs. Rather than associating the value of a function, Q-learning will use the so-called Q-functions. In every state there is a Qvalue associated with each action. This Q-value is the sum of rewards achieved for performing the associated actions and following the given rules. In the Q-learning context, the value of a state is defined as the maximum of a Q-value in the given state.

Having the estimated utility Q-function which describes how useful an actions is, given a certain state. Q(s, a) is the immediate reward achieved for performing an action that leads to a maximum usability of the resulting state.

The formal definition of the Q-function is the following:

$$Q(s,a) = r(s,a) + \gamma max_a(Q(s',a')) \quad (7)$$

Where:

$r(s,a)$ is the immediate reward;

γ is the relative value of the delayed rewards versus the immediate rewards (0 or 1);

s' is the new state following after action a ;

a , a' are the actions in states s and s' .

The selected actions are defined by the following function:

$$\pi(s) = \arg max_a Q(s,a) \quad (8)$$

Q-learning represents an algorithm without predefined learning rules. It can be demonstrated that for a sufficient amount of training under any rule ε-soft, the algorithm converges with a probability of 1 towards a small approximation of an action-value function for an random rule-target group. Q-learning teaches optimal rules even when the actions are selected from larger or even random rules.

7. CONCLUSION

In conclusion, from the point of view of storing data for using it in a decision support system, the XML format remains as elegant in structure as well as in utilization, but it is not recommended for huge amount of data; storage is possible in this case, but further processing of these data becomes way to difficult compared to the alternatives involving database systems. A problem in any given field of interest can be translated into a Markov decision process and solved using this technique. Reinforcement Learning is an extension of the classical dynamic programming and covers a set of problems it can solve. As opposed to the supervised learning, Reinforcement Learning does not require I/O data. It is foreseen that this kind of technology, combined with others, will be able to finally solve problems that could not be solved before.

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Technology Solutions to Support Implementation of the Serbian SME Development Strategy

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Abstract: **The growth and sustainability of SMEs are crucial to Serbia's economic and employment growth. In recognition of this, the Serbian Ministry of Economy & Regional Development (MoERD) has developed and put in place an excellent policy framework to support them. Inevitably, due to the magnitude of the task, there have been some difficulties with its implementation. Serbian SMEs need solid practical support quickly but the MoERD's support framework will take time to realise its full potential.**

This paper explores how the Serbian company Inteleksija, which is being formed by the author based on social enterprise principles, can rapidly adapt existing ready-made technological solutions to assist in the implementation of the MoERD policy within a very short timeframe. The paper will show how Inteleksija's partnership with three leading international service providers can deliver e-learning technologies to deliver entrepreneurship and best practice business training, managed service datacenters to provide technology support for SMEs and an hosted bureau service delivering Business Process Management training, consultancy and software tools adapted to meet the specific needs of Serbian SMEs.

Finally the paper shows how, with support from the Serbian Administration and academic community, these technology solutions can significantly accelerate implementation of the vital MoERD strategy.

1. INTRODUCTION

Over the last ten years, many excellent academic papers, government and industry white papers and EU reports have been written about the importance of supporting enterprises, especially SMEs, in order to create sustainable economic growth and more employment. Many of these papers address the need for governments and their associated agencies to provide a solid framework to support the development of SMEs.

A policy framework has been in place in Serbia for some time, and the most recent publication of it is the Strategy for Development of Competitive and Innovative Small and Medium-sized Enterprises 2008-2013, which was written by the Ministry of Economy and Regional Development (MoERD) and published in 2009. The excellent strategy document sets out a number of objectives to address this need.

This paper does not purport to be an academic paper. Its intended purpose is to supplement the excellent framework set out by showing how IT based services and best practice methodologies can provide practical solutions to some of the objectives of the Strategy.

The author, who lives and works in Serbia, draws on many years of hands-on experience creating and running a number of successful small and medium-size enterprises in a variety of industry sectors in the UK, Europe, the Middle East and India. He therefore has a practical view of how three key IT based services and best practices could quickly provide both the

existing SME community, and potential entrepreneurs from the student population, with vital tools and competencies to build and manage sustainable and successful businesses for the lowest possible cost and in the shortest possible time.

2. BACKGROUND TO SMES IN SERBIA

Although large enterprises are important to the Serbian economy, SMEs are the real giants, and it is clear that the Serbian administration has made substantial efforts over the years to encourage entrepreneurship and to support SMEs so that they can grow and thus create employment.

The 2009 EU SBA fact sheet reports that Serbian SMEs represent 99.4% of all registered businesses, 57.3% of employment, and 51.5% of value added.

	Enterprises			Employment			Value added		
	Serbia		EU-27	Serbia		EU-27	Serbia		EU-27
	Number	Share	Share	Number	Share	Share	Billion €	Share	Share
Micro	69.235	84,9%	91,8%	135.899	13,9%	29,7%	2	11,4%	21,0%
Small	9.421	11,6%	6,9%	184.747	18,9%	20,7%	3	16,9%	18,9%
Medium-sized	2.350	2,9%	1,1%	240.413	24,5%	17,0%	3	21,1%	18,0%
SMEs	**81.006**	**99,4%**	**99,8%**	**561.059**	**57,3%**	**67,4%**	**7**	**51,5%**	**57,9%**
Large	523	0,6%	0,2%	418.794	42,7%	32,6%	7	48,5%	42,1%
Total	**81.529**	**100.0%**	**100.0%**	**979.853**	**100.0%**	**100.0%**	**14**	**100.0%**	**100.0%**

Data refer to the non-financial business economy (NACE C-I, K) and represent estimates for 2008.
Source: Eurostat, elaborated by EIM for EU27 figures; Institute of Economic Sciences, Serbia for country figures.

Table 1. SMES in Serbia – basic figures

3. EUROPEAN CHARTER AND SME POLICY INDEX

The MoERD SME development strategy incorporates the European Charter for Small Enterprises and the associated framework takes into consideration the Small Business Act (SBA) and its related policy index. In June 2009, the OECD issued a report on the progress of the Charter.s implementation in the Western Balkans in the form of the SME policy index, which is an analytical tool that uses collaborative benchmarking to measure progress in the ten dimensions of the charter listed in table 2 below. These provide a useful framework for the purposes of this paper and also relate back to the five pillars of the Serbian MoERD Strategy which incorporates the SBA.

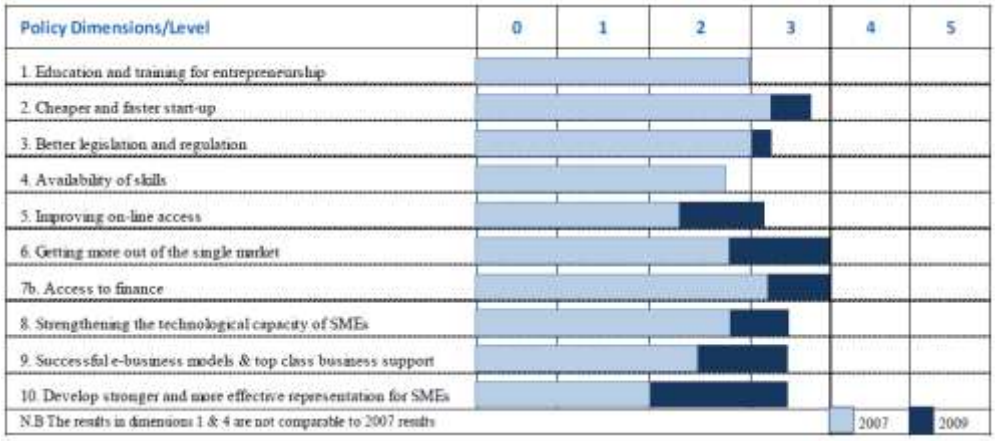


Table 2. OECD SME Policy index scored for Serbia per SBA charter dimensions 2009

The indicators are structured around five levels of policy reform, with level 1 the weakest and level 5 the strongest. The policy development path for each indicator is typically structured as follows:

Level 1: There is no law or institution in place to cover the area concerned;

Level 2: There is a draft law or institution, and there are some signs of government activity to address the area concerned;

Level 3: A solid legal and/or institutional framework is in place for this specific policy area;

Level 4: Level 3 + some concrete indications of effective policy implementation of the law or institution;

Level 5: Level 3 + some significant record of concrete and effective policy implementation of the law or institution. This level comes closest to good practices identified as a result of the EU Charter process and the OECD Bologna Process.

Table 2 above shows that Serbia has made good progress in implementing the policy with significantly increased scores across many of the 10 dimensions. Each of these is a major undertaking and fully implementing them and extending the full range of benefits to the SME community is at best a medium to long-term exercise, particularly regarding education and training, skills availability and strengthening technological capacity.

In these highly competitive and challenging economic times, many small and medium size Serbian enterprises are struggling to survive, and there are many would-be entrepreneurs in state universities and vocational schools who lack the basic financial awareness, competencies and basic business skills to successfully start a business and put in place the strategy, IT infrastructure and business processes so vital for sustainable growth. Despite the progress made, entrepreneurial education for students and relevant and practical help for the SME businessman is still too far away.

There are practical solutions that can be implemented immediately to fill these gaps, and these are described below and are referenced to dimensions 1, 4 and 8 of the OECD policy index.

3.1. Policy Dimensions 1 – Education and Training For Entrepreneurship

The Serbian Government has an excellent and comprehensive strategy for the development of competitive and innovative Small and Medium-sized enterprises. The most recent publication of the strategy states that the five pillars of the strategy to support SME development is based on the following three elements:[1]

1) Concrete priorities for SME development;

2) The approach adopted in the EU regarding SME support policy and the "Small Business Act" (SBA) for Europe

3) Implementation of the principles of the European Charter for Small Enterprises.

The European Charter principles relating to education and training for entrepreneurship state that:[2]

- "Europe will nurture entrepreneurial spirit and new skills from an earlier age.
- General knowledge about business and entrepreneurship needs to be taught at all school levels.
- Specific business-related modules should be made an essential ingredient of education schemes at secondary level and at colleges and universities.
- We will encourage and promote youngsters" entrepreneurial endeavors, and develop appropriate training schemes for managers in small enterprises."

Implementing each of these principles is a monumental task and whilst the MoERD strategy document reports that Serbia has made significant progress in recent years in developing a functioning framework for SME support, it also states that: [1]

"Whilst the framework exists, implementing the framework has not been coherent or sufficiently integrated and has not been properly funded through budget support."

An analysis of Serbian education statistics confirms the MoERD view that there is not yet enough specific business related training, particularly in the State universities which accounted for 80% of university students in 2009.

Institution Type	No of Institutions	No of Faculties	[1] Business Related Faculties	% of Faculties	Number of Students	% of Total Student Population	Business Related Students	Business Students as % Total Students
State Universities	6	80	5	6%	148,181	63%	19,971	13%
Private Universities	13	45	19	42%	38,927	17%	18,891	49%
State Vocational Schools	46	46	9	20%	41,876	18%	15,570	37%
Private Vocational Schools	16	16	8	50%	5,046	2%	3,013	60%
Grand Total	**81**	**187**	**41**	**22%**	**234,030**	**100%**	**57,445**	**25%**

1 Business related students include those that are on economics, organisational science, business administration and all other management and finance related courses
The raw data for this table was extracted from the Statistical Yearbook of Serbia 2010 and imported into a dbase, coded and analysed for the purposes of this report

Table 3: Analysis of business related studies in Serbian universities & vocational schools - 2009

The Serbian state education system is excellent and provides first class economics, organisational science, business and business management courses. However, in common with most other European universities, these only provide some business related knowledge to a small percentage of total students. Developing a new full time course for all students is likely to be a long and drawn out process that may still only provide specific entrepreneurial knowledge to a small percentage of total students.

Both the MoERD strategy and the EU SME policy framework states that general business knowledge needs to be taught at all school levels. Specific business modules need to be an essential part of secondary and higher education. Entrepreneurial spirit and new skills must be nurtured from an early age.

There is a simple, practical, tried and tested and cost-effective solution available in the form of e-learning, which can supplement existing business-related education by delivering a generic extra-curricula and internationally recognised and certificated course to all secondary and higher education students.

The e-learning platform and course content are common to policy dimensions 1 and 4 and are described in detail in section C below.

3.2. Policy Dimensions 4 – Availability of Skills

The principles of the SBA Charter for policy dimension 4 covering availability of skills states that: [2]

"We shall endeavour to ensure that training institutions, complemented by in-house training schemes, deliver an adequate supply of skills adapted to the needs of small business, and provide lifetime training and consultancy."

The MoERD strategy document incorporates this principle within Pillar 4 of its strategy which recognises that in a knowledge-based economy, the performance of business organisations depends on ensuring that all categories of employees possess current and up-to-date knowledge and skills.

Therefore, the new global knowledge and information-based economic system implies a strategic role for the training function, and has significant implications for the identification of training needs and the delivery of training. [3]

Nowadays, businesses must analyse their training needs in greater depth and train a larger number of employees with different backgrounds in terms of knowledge and experience, and they have to do so more rapidly than in the past, while attempting to reduce training costs to remain competitive in a complex and changing environment. For their part, employees also must be constantly in a learning mode, in order to increase their knowledge and improve their skills. As a result, training habits have to change, for both organizations and their employees. Thus many large enterprises have turned to e-Learning as a "best practice" aimed at providing adequate training to their employees so they can remain up to date and competent in their jobs. [4]

The same is true of all enterprises including SMEs. "Best practice" e-Learning provides an ideal low-cost and fast-track solution to deliver business knowledge and skills training for SME managers and employees. Such training is vital in order to support growth and sustainability of SMEs and will also greatly improve long term SME survival rates.

3.3. Accelerating the Implemention of the MoERD Pillar 1 and Pillar 4 Strategies using e-learning courses

Some definitions of e-learning such as „computer based training" or „distance learning" are misleading in the context of this paper. A better definition is the use of computer network technology to deliver information and instruction to individuals. E-learning allows

organisations to deliver training and education via the web, and provide relevant and targeted content anytime and anywhere, offering learners a customised and interactive experience.

A number of empirical studies concerning e-learning for SMEs show the following extensive benefits: [3]

- Flexibility – allowing the student and tutor to choose the course time and location
- Customisation – content can be adapted to suit groups‟ differing needs
- No time limit – each student can learn at his own pace
- Training material distribution – additional written materials are easily added
- Evaluation – real time progress evaluation and personalised tutor support
- Cost – no cost for transportation, meals, lodging, time away from work or additional tutors

Leading e-learning providers have developed hosted platforms with the capacity to deliver high quality content to many thousands of e-learning students concurrently. Their sophisticated Learning Management Systems (LMS) are easily integrated with any existing University SCORM based platforms - (Shareable Content Object Reference Model). Because they have been developed over time they can be offered at a very low cost. The business model for this service is high volume, low cost, and with a large enough volume commitment, these training courses can be offered for a very low unit cost per e-learning student without the need for any capital outlay.

There are a plethora of excellent e-learning courses available, but there are two initial course types most relevant to meeting the immediate needs of the entrepreneurial educational policy dimensions stated above. These are business basics and financial awareness courses for non-financial managers and the best practice PRINCE2 project management methodology.

1) Business Basics and Financial Awareness Courses

The Business Basics courses are relevant to all students as well as key non-financial employees in SMEs and covers key concepts of business basics. The training is aligned to business objectives and focuses on helping non-financial students, employees and managers understand the financial implications of their business decisions and actions on the organisations they work for.

The courses do not focus on providing accountancy training. They give a foundation in business and finance and provide the basic skills and knowledge of the dynamics of a business that entrepreneurs will need to develop their ideas into sustainable concepts.

These extra-curricular courses are already being used to great effect by students in other European business schools and institutions and by many thousands of SMEs, large enterprises and other organisations around the world.

2) Best Practice Training – PRINCE2 Project Management Methodology

The PRINCE2 project management methodology (as opposed to project analysis and scheduling tools) applies to the vast majority of business situations, and as such its importance cannot be over emphasised. Anyone who is involved in delivering a product or a service has either project managed, or been part of a team that manages service delivery or change. Project management skills are relevant to any future or present employee, and as around 60% of the

student population will work with SMEs, the vast majority of SMEs would benefit from students learning at least the basic methodology, principles and language of effective project management, in the form of the PRINCE2 foundation course.

PRINCE2 is one of the leading internationally recognised best practice methodologies. It is a structured project management method developed by the UK Office of Government Commerce (OGC) over many years. The training focuses on the methodology of project management rather than project scheduling, delivery and analysis tools. Its popularity throughout the world is largely due to the fact that it is truly generic: it can be applied to any project regardless of scale, type, organisation or culture. It is available in two forms; the foundation course, which provides the basic knowledge and terminology of project management, and the higher level practitioner course, which gives the full range of skills required to successfully manage large projects.

As with the Financial Awareness courses, PRINCE2 courses can be delivered in an hosted e-learning environment, allowing student and SME users to learn in an enjoyable and inspired way in as little as 10 to 20 hours. Both courses are excellent due to their high quality, ease of use and low delivery cost and they provide the student with an internationally recognised certification. Many European businesses now insist that their employees and sub contractors are PRINCE2 qualified.

These two courses, delivered in volume from a solid e-learning platform, can provide a fast and low-cost solution to assist in meeting the requirements of dimension 1 and 4 of the policy framework.

3.4. Policy Dimension 8 – Strengthening the technological capacity of SMEs

The principles of the SBA Charter for policy dimension 8 covering the strengthening of SMEs technological capacity states that: [2]

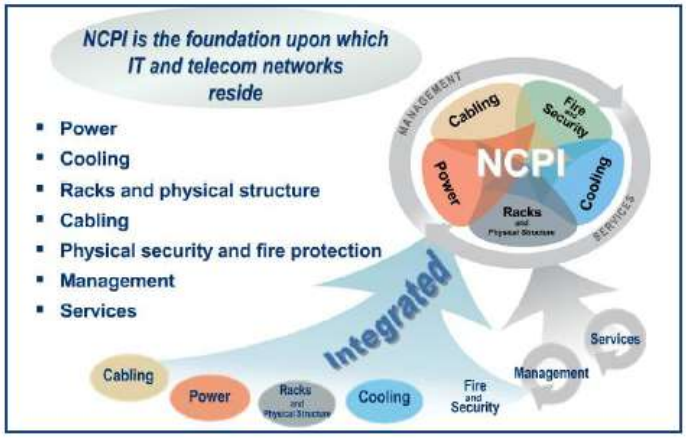
- We will strengthen existing programmes aimed at promoting technology dissemination towards small enterprises as well as the capacity of small business to identify, select and adapt technologies.
- We will foster technology co-operation and sharing among different company sizes and particularly between European small enterprises, develop more effective research programmes focused on the commercial application of knowledge and technology, and develop and adapt quality and certification systems to small enterprises. It is important to ensure that a Community patent is available and easily accessible to small enterprises.
- We will foster the involvement of small enterprises in inter-firm co-operation, at local, national, European and international levels as well as the co-operation between small enterprises and higher education and research institutions.
- Actions at national and regional levels aimed at developing inter-firm clusters and networks should therefore be supported, pan-European co-operation between small enterprises using information technologies enhanced, best practice in co-operative agreements spread, and small enterprises co-operation supported to improve their capabilities to enter pan-European markets and to extend their activities in third country markets.¨

The majority of business start-ups that fail do so within their first year, and depending on their sector, between 45% and 62% will fail within their first four years. A major contributory factor to this is a lack of stable IT platforms and sustainable business processes, both of which are essential to SMEs from day one to support their start-up and expansion. Often these vital foundations are the last thing to be considered, either because of high set-up costs coupled with a limited cash flow or in the rush to take the companies products or services to market as quickly as possible.

To improve survival rates and support SME growth, practical help can be provided in the form of provision of specialist datacenters offering a subsidised managed service to SMEs and the creation of a bureau service to deliver business process management (BPM) tools and consultancy adapted to meet the needs of SMEs, particularly High Growth SMEs (HGSMEs).

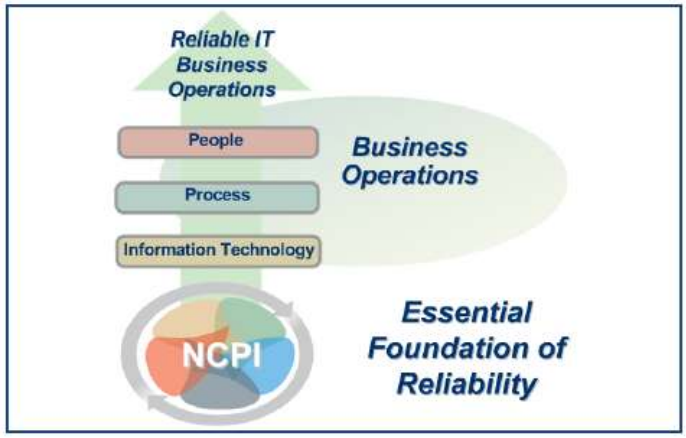
1) SME Datacenters

In today.s technology driven world, SMEs depend on stable IT platforms, this is especially true of HGSMEs or SMEs with 10 or more employees. A modern business cannot function without IT, but crucially, this does not mean simply laptops and desktop computers but the network critical physical infrastructure (NCPI), which are the foundation upon which IT and telecom networks reside as depicted in the graphic below:



As the graphic shows, NCPI comprises of power, cooling, racks, security, fire protection, cabling, management and services. If any one of these elements fails (and they often do) the whole business is under threat, and yet it is often the last thing to be considered during the start-up or even the early expansion phases of a business.

NCPI is the essential foundation for reliable IT Business Operations, and once in place, the other three building blocks of Information Technology (IT), processes and people with the right level of skill and training to support the operation of these systems can be added to ensure reliable IT business operations are maintained.



Unfortunately, putting this vital infrastructure in place is usually cost prohibitive during the start-up and expansion phases as there are so many demands being made on very limited cash flow and working capital. The practical solution is not for SMEs to invest in more IT equipment that will require processes and skilled people to maintain, but rather to create specialist managed service datacenters designed specifically for SMEs, where the full NCPI, IT, software as a service (SaaS), processes and people are available on demand and at an affordable price.

The pricing models for these datacenters and (internet) cloud based SaaS should reflect the extreme demands on cash flow and working capital for start-up and expanding SMEs and the author believes that part of the EU and government enterprise funding allocated to supporting SMEs should be directed towards subsidising this service.

2) Sustainable Business Process Management

Whatever an organisation‟s size, standardised processes must be at its heart if it is to prosper. They are an essential management tool to optimise efficiency, improve customer relations, lower operating costs and substantially increase working capital and cash flow – the life blood of any organisation.

Despite this, standardized processes are virtually non-existent in the early phases of most SMEs lives, and they are run haphazardly, with tasks being carried out as and when they need to be completed with little regard for process. Regretfully the majority of SMEs never get past the initial stage of “Heroics” depicted in the Process Maturity Journey graphic below and this is a major contributory factor to the very high SME failure rates during the first four years:

In order to create these processes, information must be collected and proactively managed, and consistent ways of working need to be defined, deployed and maintained. Finally, when these basic elements are in place then processes can be measured and improved, turning them into one of an SMEs most valuable management tools.

This is where Business Process Management (BPM) is essential. BPM is a structured method of monitoring, analysing and improving end-to-end business processes and relevant resources using current software and technology. This methodology is used to great effect by large organisations, but many SME operators are not aware of the benefits of BPM and so remain attached to older functional ways of thinking and managing, to the detriment of their long term survival.

The solution is to encourage early adoption of BPM by SMEs. This can only be achieved through making them aware of its necessity and benefits, and by working closely with the best BPM solution providers, adapting their applications to focus on and meet the specific needs of SMEs from start-up to maturity.

There are three steps to this end;

- Developing and delivering a content rich short course on the principles and benefits of BPM to higher education students and SMEs, via the e-learning platform described above.
- Developing and offering an SME adapted version of a leading BPM application.
- Providing SMEs with a subsidised hosted managed bureau service that can offer on-demand advice, consultancy and technical support.

4. CONCLUSION

Great progress has been made, both in the Serbian academic community and government administration, to put in place a comprehensive support framework for the development of SMEs.

SMEs have the capacity to lead the way in growing the emerging Serbian economy and in the drive for market share of what is an increasingly competitive and hostile global market. As shown in section 1 of this paper they are the real giants of the Serbian economy but it is clear that they need solid, practical support and they need it now.

In this paper the author has presented solutions for assisting the MoERD and academic community in implementing the excellent Strategy for Development of Competitive and Innovative Small and Medium-sized Enterprises by delivering quickly, efficiently and cost-effectively the competencies, skills, technologies and tools that are urgently needed by SMEs.

To that end he has approached and is contracting with three leading international service providers to deliver the solutions set out in this paper. Each partner company has responded with enthusiasm and optimism and are willing to put both their funding and substantial development resources behind the project against committed volumes.

These large, experienced and well established international service providers will bring their knowledge and expertise to the process of developing and delivering each of the disciplines discussed in this paper namely:

- Ready made e-learning platforms delivering entrepreneurial education for students and SME skills training courses in business basics, financial awareness and PRINCE2 project management methodology
- Business Process Management training, consultancy, applications and software tools adapted to meet the specific needs of Serbian SMEs and delivered via cloud technologies
- The design and build of SME specific datacenter managed services to provide the Network Critical Physical Infrastructure, Information Technology, cloud-based SaaS software applications, processes and people that are so vital to SMEs for reliable IT business operations.

The author is creating a Serbian company called Inteleksija. Inteleksija is based on social enterprise principles and is partnering with these leading international service providers. It is dedicated to delivering the urgently required supplementary education and training for entrepreneurship to students and to strengthening the competencies, skills, technological capacity and competitiveness of SMEs in Serbia.

There is much still to be done, but the essential ingredients are already in place. With the support of the Serbian academic community and the Serbian Ministry of Economic and Regional Development this vision can quickly be brought to life.

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CAN Based Embedded Systems for Vehicle Applications

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Abstract: **The implementation of various electronic subsystems in different kind of on-road and off-road vehicles is constantly expanding. Accordingly the new vehicles, instead of being mechanical systems, become advanced mechatronics systems which development and testing call for a new approach. Possibility of using data available on vehicles network seems to be extremely powerful tool on it.**

The paper deal with new approach for service load data measurement and acquisition as a helpful tool in development and testing of different mechatronics vehicles' systems. Based on complexity of the system and different communication protocols on the vehicles' networks it was found as extremely practical solution to make approach which will be based on standards which are widely accepted by the industry. The new approach is based on the hardware and software platform oriented to the main vehicle controllers with the task to acquire data which exist on the network and which are relevant to the transmission service load. The said hardware as well as software utilities have to enable computer based monitoring of the vehicle systems behaviour and in that way to be the tool for new vehicles development.

The new system was tested in real service. It was found that system can enable significantly less time of vehicle instrumentation before testing and accurate data acquisition.

1. INTRODUCTION

The one of the most important factor which impacts the new product development, including it's testing is duration of development activities. It is of great importance to reduce the time from the initial technical specification of the new product till the moment of lunching its' serial production. That task is mainly oriented to the development engineers which are under great pressure to satisfy market driven dements for fast and reliable new product design.

Many new designed vehicles' have to be in application with already installed advanced mechatronics systems. Simply speaking, if an existing vehicle would be placed in the service conditions which can be expected for the new vehicle then it can be used for service load measurement and acquisition which would be reference input for the new vehicle under development. It is of great importance to analyse possibility for controllers which are the parts of vehicle's mechatronics systems. Simply speaking, collecting the service load based on standard electronic enables faster and more reliable new product development and validation.

The system which was developed for service load data acquisition on vehicles fitted with CAN bus is presented in the following text.

2. CAN BASED SYSTEM FOR SERVICE LOAD DATA ACQUISITION

The concept of the system is based on common situation on nowadays vehicles already fitted with electronic networks which are in use for data interchanging among different vehicle's controllers and their instruments (Fig. 1 - top). In spite of the fact that there are a few protocols which are in use on vehicles' networks it is of importance to be noted that all of them are based, mainly, on the same physical layer which is, nowadays widely accepted by all producers. That is physical layer defined through ISO 11898 or frequently named as CAN 2.0B. As it is given in Fig. 1 - bottom, all data which has to be transferred through this layer have to be organized in frames which start with SOF (Start of Frame) character, followed by 29 bits CAN identifier, RTR character, Control Field, 0 to 8 byte Data Field, CRC Field, Acknowledge Field and EOF (End Of Frame) bits.

From the message format is clear that data of interest for service load would be placed in Data Field. But, to be in position to use those data a few problems have to be solved. Those problems are mainly related to the CAN identifier (ID).

As it is defined by ISO 11898 CAN ID has to be 29 bits long. But, different protocols use that identifier in different ways. For transmission load investigation it is of importance to be oriented to the protocols which are dominant for engine and transmission controllers. As per situation in the market those controllers are mainly based on SAE J 1939 protocol. SAE J 1939 is a protocol with all 7 layers, but for the first two layers (lower two layers) it takes definition from ISO 11898 i.e. CAN 2.0B bus. Before establishing data acquisition from CAN bus it has to be analysed in which way SAE J 1939 uses CAN's identifier (Fig. 2b). In brief, in J 1939 the first 3 bits of ISO 11898 Identifier (ID) are in use for priority (000 for the highest priority and 1111 for the lowest priority). The next 18 bits are in use for PGN or Parameter Group Number.

The PGN is the key element for understanding possibilities for service data acquisition from the existing vehicle's network. Actually, all data which have to be sent to the CAN bus are organized in the groups. For example, all data relevant for the electrical transmission controller would be placed in the data message (according to the SAE J 1939 terminology: PDU i.e. Protocol Data Unit) in which PGN would be 61442 and 61445. Data available in messages (i.e. messages Data Fields) with stated PGN(s) would be: transmission selected gear, transmission actual gear ratio, percent of clutch slip, transmission input shaft speed, etc. It is clear that lot of data significant for transmission service load are already available on the vehicle bus in the messages with appropriate PGN's.

Out of data messages with PGN(s) related to the transmission controllers, there are other messages of the interest. Those are mainly the messages from engine electronic controller, retarder controller, axle controller, etc.

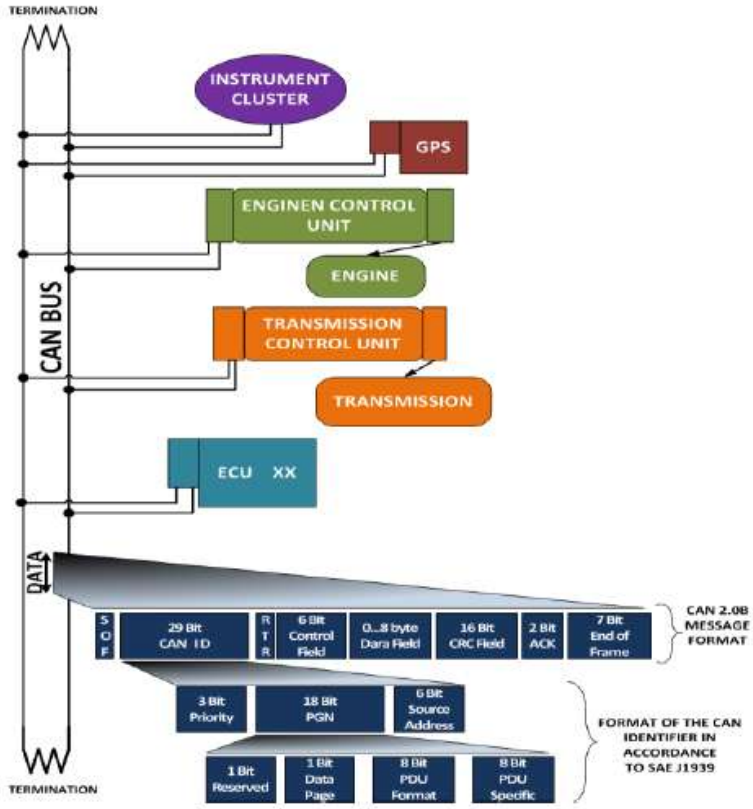

Figure 1: Common configuration of the vehicle's CAN bus (top) and the message format (bottom).

It is clear that for the concept of service load data acquiring is essential to be familiar with the PGN concept. Unfortunately, the concept of PGN and establishing CAN identifier is not as simple as said above. Strictly speaking, PGN has 4 parts: Reserved bit, Data Page bit, PDU Format - 8 bits and PDU Specific - 8 bits. Also, it has to be recognized that PDU Specific can be defined in two different ways based on the value of PDU Format: as the Destination Address (for PDU Format values 0 to 239) or as Group Extension (For PDU Format values 240 to 255). All of this makes approach to the messages on the CAN bus (PDU) very complicated and can cause a lot of problems.

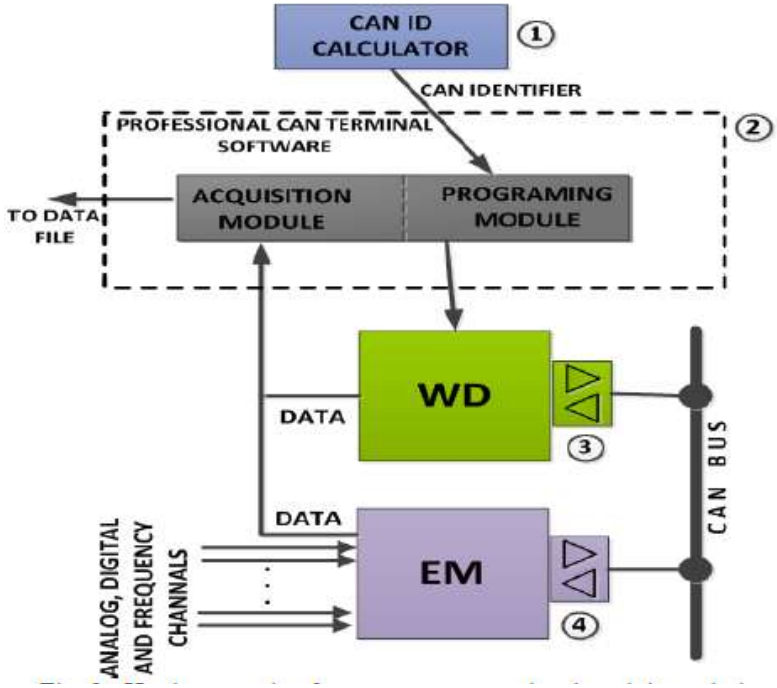

Figure 2: Hardware and software components developed through the project (meaning of numbers and abbreviations are given in the text).

As it was explained, defining the proper PGN is not sufficient for successful data acquisition i.e. acquiring of data of interest from the CAN bus. It is also important to know the position of the value of interest in Data Field. The Data Field is 8 bytes long and encloses different data. Their allocation in Data Field must be known for proper data extraction.

Based on explained concept of data flow through CAN bus it is obvious that first interest in establishing the system for data acquisition has to be oriented to providing of adequate software tools for PGN, CAN Identifier (ID) and Data Field evaluation.

To reduce problems i.e. to enable easier service data acquisition through CAN bus the project which results are given in this paper considered development of a few software and hardware components which are listed below.

1. CAN Identifier (ID) Calculator – software component,
2. Professional CAN Terminal – software component,
3. Watch Dog (WD) – hardware component,
4. Extension Module (EM) – hardware component.

The scheme of functional interdependence of the developed components are given in the Fig. 2 where components are marked with appropriate numbers as given above.

The first of developed components is "CAN identifier (ID) Calculator", with the structure as in the Fig. 3. Through varies data bases it provides support in defining CAN identifier from different standards including SAE J 1939. The user has to approach to the date base trough Excel (Fig. 3, path mark with 1). The data base can be searched in different ways including

searching based on data of interest such as engine torque, engine rpm, etc. In that way user can find out the value which he is interested in to monitor or to acquire from the bus. Once when the value of interest is defined the software defines PGN and other parts of 29 bit identifier (Fig. 3, path mark with 3) in accordance to the previously explained rules. In that way the user is in position to know which message has to be grabbed from the communication on the CAN bus and to be in position to extract appropriate value(s) from the data field in that

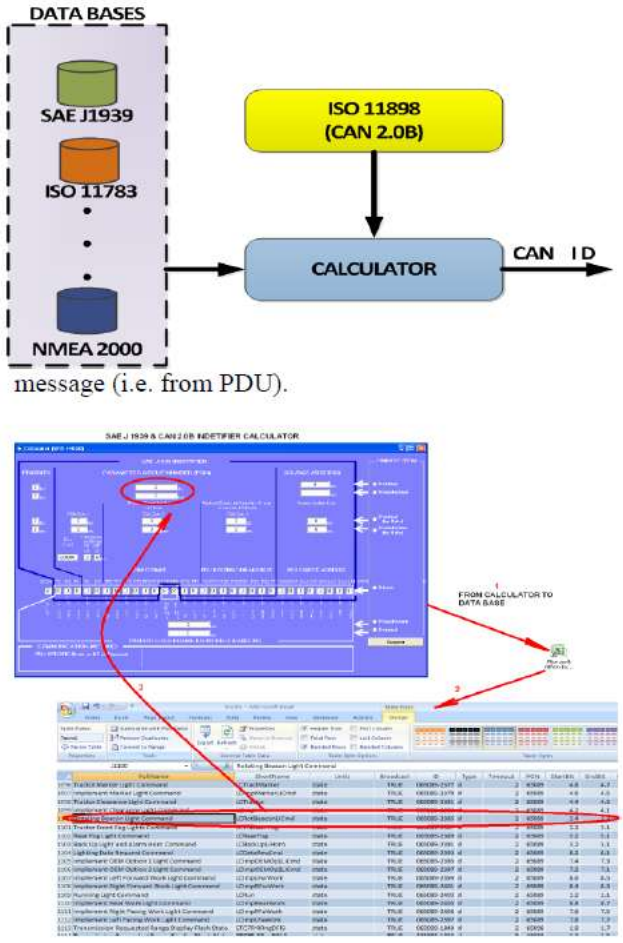

Figure 3: CAN Calculator; top – the software structure; bottom – the monitor page which provide support to the user to calculate CAN ID based on SAE J 1939 protocol.

Since data are organize in 8 bytes Data Field, for successful monitoring, it is essential to be known the position of the data of interest within Data Field. Last two columns in the data base (see Fig. 4, columns marked with ¡§StartBit¡¨ and ¡§EndBit¡¨). In this way the first software component which is developed in this project enable to user the full support related to the messages on the CAN bus even without his deep knowledge of the protocols.

The next part of the data acquisition system developed for the project was dedicated hardware (see Fig. 4 - top), named WD. Actually that is Watch Dog type hardware with the following basic specification:

- Microprocessor based mother board
- 128 dedicated memory slots,
- Two CAN based gates,
- One Ethernet gate,
- Memory block for application programs, etc. (see Fig. 4 - top).

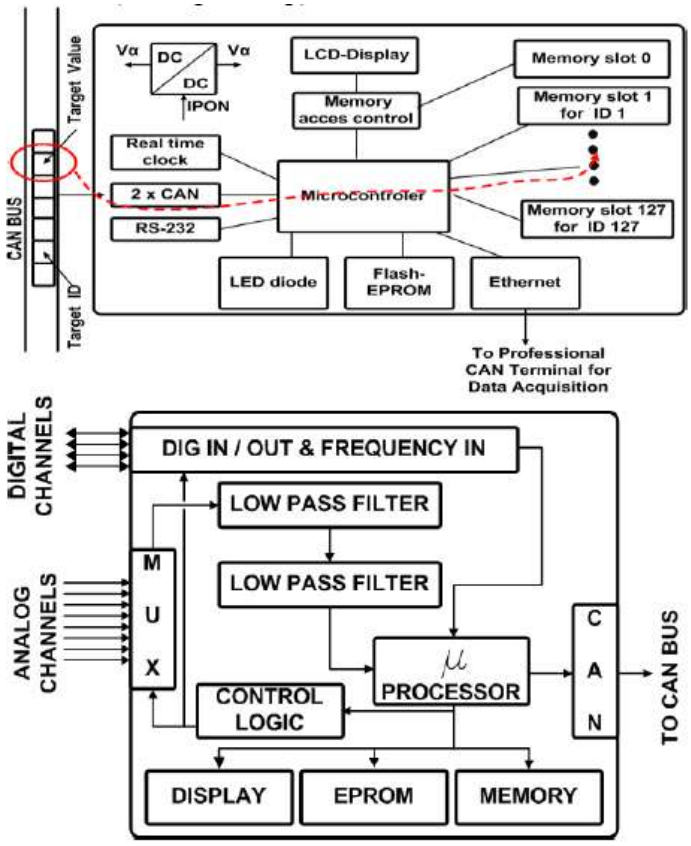

Figure 4: Configuration of the hardware components: top – WD (Watch Dog); bottom- EM (Extension Module).

The WD hardware was initially programmed with parameter free software developed in this project. The software drives WD to continuously listen the traffic on the CAN bus. Once when WD starts it work it asks for the values for parameters. Those values have to enable WD to know CAN identifier(s) of interest, part of the data field which has to be extracted from the message with defined identifiers as well as to enable to WD to know in which memory slot the extracted value has to be downloaded. This process is visualized with red lines in Fig. 4 (top)

and explained with more details and trough example related to the transmission related data, later in the text (see Fig. 7 and text in the chapter 3).

Once when user defines all parameters WD performs operation of grabbing data of interest from the CAN bus and places values of interest in the memory slots. The on line monitoring and data acquisition of the values are available through the Ethernet gate.

The third part of the developed system is software which enables WD programming, on line data flow monitoring and data storage for post acquisition evaluation. That software product, named ¡§Professional CAN Terminal¡¨ (main user page of the software given in Fig. 5) has specification as follows:

- Automatic allocation of WD within local network,
- Definition of parameters which defines data of interest from CAN bus,
- Monitoring of ongoing communication in real time and data storage,
- Possibility for sending messages to the CAN bus.

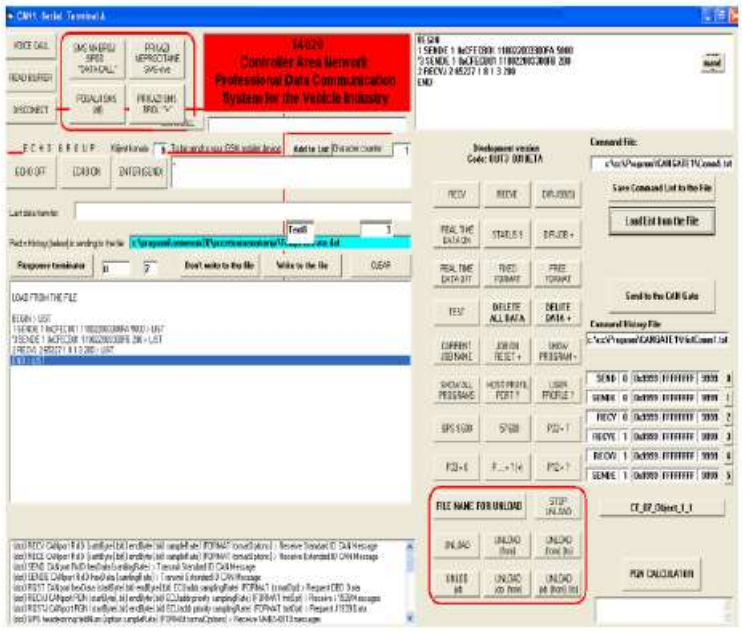

Figure 5: “Professional CAN Terminal” software – the main monitor page.

The second hardware component which was developed in this project was “Extension Module” or EM (the configuration given in Fig. 4 – bottom). The EM, among others, performs two essential services:

- Analog to digital conversion of the analog values and
- Broadcasting CAN based messages with converted values.

The necessity for development of the module comes from the circumstance that not all values of interest were available on the CAN bus. It is common situation that there are some

values of interest for acquisition which are broadcasting by no one electronic control unit connected to the vehicle's bus. In such cases there are two possibilities for acquiring data of interest: (i) to use separate (additional) data acquisition system or (ii) to provide the system which will measure the value(s) of interest and make up the PDU(s) with Data Field in which data of interest (measured values) would be incorporated. The second noted way has some advantage. It enables utilization of the already existing data acquisition system which is oriented to the CAN bus, for acquisition of all needed data and makes needless any additional measurement and acquisition unit.

In this project the second of two stated approaches was used.

3. CAN BASED SYSTEM APPLICATION

As it is noted in the introduction, one of the important advantage of data acquisition through CAN bus is to provide accurate service load data for the system which has to be developed, by using data from already existing systems. This chapter deals with that kind of the new data acquisition system application i.e. its application in designing a tractor transmission.

For the purpose of designing the new agricultural tractor transmission it was necessary to make in detail investigation of gear box input power (actual input rpm and torque) as well as front and rear axle input toque and rpm. All those data was needed as the input for precise design calculation of the new tractor transmission.

Figure 6: System for service load data acquisition trough CAN bus: top – configuration of the system, bottom left – EM built in the tractor; bottom middle – GPRS modem built in the tractor, bottom left – installation of the WD unit.

It was found that tractor with close the same specification as the new tractor which had to be developed existed on the market. Based that the existing tractor was "CAN based" it was found as cost and time effective to provide transmission service load data by utilization of CAN based data acquisition system on existing tractor. Consequently, it was brought out as possible to avoid making of the prototype of the new tractor for the purpose of service data investigation.

The existing tractor was instrumented in the way that WD was installed on its CAN bus (see Fig. 6). For real time data monitoring WD's Ethernet port was connected to Ethernet port of GPRS modem i.e. it was establish data channel from CAN bus to GPRS network. Monitoring station was fitted on the local computer with Professional CAN Terminal software and with another GPRS modem (receiver).

For acquiring data which were of interest for this investigation and which were found as missing in CAN bus traffic (broadcasted by no one ECU on the network) the Extension Module (ED) was connected to the bus.

Since the front axle input torque was not-broadcasted value of interest the additional front axle torque measurement line was established on tractor's propeller shaft and the analog signal from the toque conditioning unit was directed to the EM.

Before data acquisition, it was necessary to find out appropriate PGN(s) part of Data Field in PDU(s) and ID for the values of interest. That was done with previously developed CAN Calculator software. The following text gives in detail explanation of that process. Given explanation is of general importance since it provides guidance for other researcher and facilitates their work on data acquisition htrough CAN bus.

For the engine speed which is (when the vehicle's clutch is engaged i.e. while the transmission is loaded) equal to the transmission input speed, the relevant PGN is 61444 and 2 bytes long data of engine rpm starts in 4th byte in Data Field. It was found that engine control unit on the tractor had address 0. Based on SAE J 1939 i.e. with help of CAN Calculator software it was found that corresponding CAN identifier which of interest as ID = $00DE0400_{hex}$. The whole process can be visualized as it was given in Fig. 7 and represented in symbolic way as follows:

Engine speed:

Priority Level: 3 >>> ID = 011xxxxxxxxxxxxxxxxxxxxxxxxxx$_{bin}$

PGN: 61444_{dec} 00F004 $_{hex}$= xxx00111100000000100xxxxxxx$_{bin}$

Source: 0_{dec} = 0 $_{hex}$= xxxxxxxxxxxxxxxxxxxxx00000000$_{bin}$

Result ID = 217056256_{dec} = $00DE0400_{hex}$

Start position in Data Field: 4th byte

Length: 2 byte

Note: "x" replaces 0 or 1 i.e. bit can be set or reset.

The next value of interest is engine torque or transmission input torque which is broadcasted by the engine electronic controller, with the same PGN. The calculated output torque of the engine is transmitted as indicated torque in percentage of reference engine torque. Consequently, from CAN calculator software it was found that the ID of the message which contents data relevant for torque was 217056256_{dec} or given in-deal:

Engine torque

Priority Level: 3 >>> ID = 011xxxxxxxxxxxxxxxxxxxxxxxxxx$_{bin}$

PGN: 61444_{dec} 00F004 $_{hex}$ = xxx00111100000000100xxxxxxx$_{bin}$

Source: 0_{dec} = 0 $_{hex}$= xxxxxxxxxxxxxxxxxxxxx00000000$_{bin}$

Result ID = 217056256_{dec} = $00DE0400_{hex}$

Start position in Data Field: 2nd byte

Length: 1 byte

Even the torque level is transmitted in percentage of reference engine torque one can easily find out the actual torque. That is possible based on the engine characteristic which is always defined in ECU memory as rpm/torque matrix. The matrix can be given in one of three modes. Mode 1 provides a complete curve of speed and torque points while modes 2 and 3 provide a partial curve of speed and torque points and a separate end speed governor characteristic. Data from the matrix loaded in ECU can be asked by sending the request with PGN 65251.

Here, we have to recall the part in which the Professional CAN Terminal software was described. As one can recognize in given specification of that software it's main purpose is to help in WD programming, to enable monitoring of the traffic on the CAN bus and to support data acquisition. But, as it was given in the software specification, it also has capability to send messages to the CAN bus. Here it is clear the purpose of that (sending request with PGN 65251).

Before starting data acquisition it is essential to send request with PGN 65251 to CAN bus. That request would be served by engine control unit. The ECU will replay with message with multi-data field (total length 39 bytes) which will be matrix data. Only in that way one will be in position to find out torque value (in Nm). The actual torque level would be find based on torque value in percentage which would be transmitted with ID 00DE0400hex as explained above and from the data which would be enabled trough request with PGN 65251.

The next values of interest were actual or engaged gear ratio and actual transmission range. Taking together, those two values give information of overall transmission ratio. Both are defend in data field of the messages with the PGN 61445, as follows:

Transmission actual gear ratio:

Priority Level: 6 >>> ID = $110xxxxxxxxxxxxxxxxxxxxxxxxxx_{bin}$

PGN: 61445_{dec} $00F005_{hex}$= $xxx00111100000000101xxxxxxx_{bin}$

Source: 2_{dec} = 2_{hex}= $xxxxxxxxxxxxxxxxxxxx00000010_{bin}$

Result ID = 418383106_{dec} = $18F00502_{hex}$

Start position in Data Field: 2^{th} byte

Length: 2 byte

Transmission current range:

Priority Level: 6 >>> ID = $110xxxxxxxxxxxxxxxxxxxxxxxxx_{bin}$

PGN: 61445_{dec} $00F005_{hex}$= $xxx00111100000000101xxxxxxx_{bin}$

Source: 2_{dec} =2_{hex}= $xxxxxxxxxxxxxxxxxxxx00000010_{bin}$

Result ID= 418383106_{dec} = $18F00502_{hex}$

Result ID= 418383106_{dec} = $18F00502_{hex}$

Start position in Data Field: 7^{th} byte

Length: 2 byte

In, addition, it was needful to provide data for real tractor speed. That is extremely important since there is no other way to find out wheel slip (and to give input do design time for development of differential locks) out of measuring the real vehicle speed and each wheel rpm.

Real vehicle speed value, in nowadays tractors, is provided based on GPS based Doppler transducer which broadcast measured value to CAN bus with PGN 65256 in according to concept as given bellow. The priority and position of the data in data field are:

Navigation-Based Vehicle Speed (real tractor speed):

Priority Level: 6

ID=110xxxxxxxxxxxxxxxxxxxxxxxxxx$_{bin}$

PGN:65256$_{dec}$= 00FEE8$_{hex}$=xxx00111111011101000xxxxxxxx$_{bin}$

Source: 10$_{dec}$ A$_{hex}$= xxxxxxxxxxxxxxxxxxxxx00001010$_{bin}$

Result ID = 419358730 $_{dec}$ = 18FEE80A$_{hex}$

Start position in Data Field: 3rd byte

Length: 2 byte

A few other values of PGN are also taken in consideration during the development but we will not discuss them here.

4. VERIFICATION OF THE SYSTEM

This section deals with verification of the system results of measurement conducted with the previously explained system.

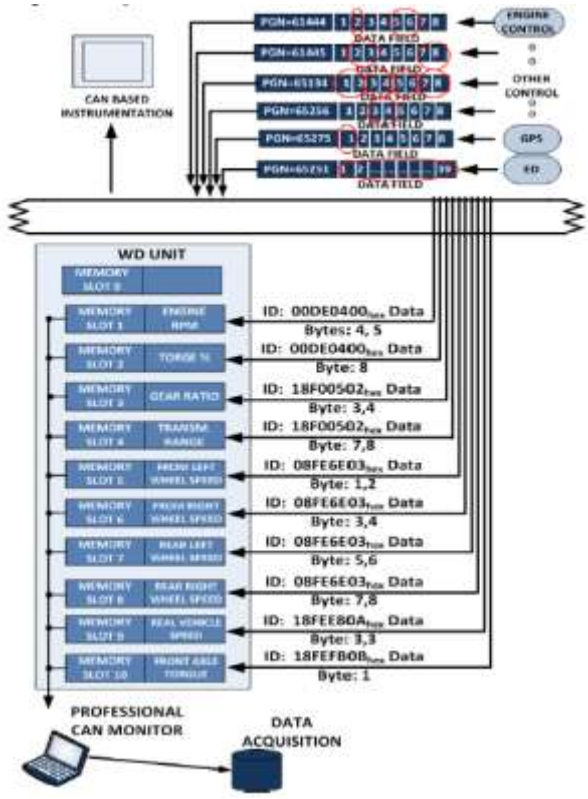

Figure 7: Concept of the measurement

The agricultural tractor with service mass of 2850 kg, mass distribution front : 1250kg, rear: 2600 kg, rated engine power of 66 kW at 2250 rpm with transmission concept 6x2 gear ratio forward, 4 WD and with it's own CAN bus was fitted with Watch Dog (WD) hardware, Extension Module (EM) hardware and GPRS modem as given in the Fig 6. On the "receiving" side it was establish server with installed "Professional CAN Terminal" software and receiving GPRS modem.

The vehicle was submitted to the two types of tests:

- Regular service application (haulage, in field operation, etc.) as per predefined scenario and
- Non regular service application i.e. special tests created for in detail investigation of CAN based acquisition system's capability.

To enable verification of the new data acquisition system the conventional measurement (taken as a reference) of gearbox input torque and rpm was conducted simultaneously with measurement done with the new system. The reference measurement was done by implementation of full bridge strain gauge arrangement for toque measurement (at the output gearbox shaft and propeller shaft for front axle) and inductive transducers for rpm measurement (at the input gearbox shaft) as well as multichannel signals conditioning unit (HBM's Quantum). The position of the transducers installation was selected based on available space for their installation.

The testing according to the first service condition (regular service application) was conducted with the purpose of defining the transmission input torque service load distribution. Actually, it was necessary to provide to design team information related to the percentage of particular torque level in total service life of the transmission.

It was found that the system is capable to enable accurate measurement with close to no preparation of the tractor. Thanks to GPRS connection it was possible to make no limitation on area where the tractor will operate as long as GPRS network is available.

It was found that suggested concept is extremely powerful. Without implementation of suggested concept (software and hardware developed in this project) the preparation time of the tractor was 2 weeks (because of complexity of torque measurement in the gearbox). In addition, disassembling of equipment and assembling transmission after measurement regularly took one week. With implementation of CAN based hardware and software for data acquisition the preparation time was a few hours, only.

5. CONCLUSION

The CAN based approach in monitoring of the vehicles' mechatronics systems can significantly reduce time for vehicle instrumentation and enable to development engineer to make whole testing in the already existing vehicle before making the prototype of the new vehicle or system under development.

The concept is accomplished by building up dedicated hardware and software. Totally two hardware and two software components were developed. The results of initial testing of all developed components indicate their good performances.

Trough initial testing of the development platform it was accomplished accurate monitoring.

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Supply Chain Management as a Key Factor for Improving Macedonian SMEs' Competitiveness

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Abstract: **In recent years, effective logistics and supply chain management have been recognized as key opportunities for improving the profitability and the competitive performance of the companies. Also in the last few years, a significant progress in the field of small and medium enterprise development in Macedonia has been seen. The supply chain management is seen as a catalyst for unleashing economic growth in Macedonia and throughout the region of Southeastern Europe. Supply chain performance will be a key indicator of overall corporate success in the upcoming period and core advantage when entering foreign markets and compete with low cost countries. Small and medium enterprises (SMEs) with efficient logistics and SCM will be able to maximize their profitability and improve their competitiveness. That is why this paper elaborates the supply chain management as a key factor for improving the competitiveness of the Macedonian SMEs.**

1. INTRODUCTION

The reason for the existence of the supply chains is that there are very few companies that can produce end products for end-customers from raw materials on their own, without the assistance of other organizations. The company that produces the raw material is often not the same company that sells the end products to the endcustomer. In order to provide end products to the endcustomers, a network of actors is involved in activities (as purchasing, transforming and distribution) to produce products and/or services. All of these actors add value to the end product. The series of companies that interact to produce end products, and to contribute to the value of end products, is actually the supply chain. [1]

Consequently, the competition is no longer between companies but between supply chains. The goals of the entire supply chain become the common objective of each company. Cost and service improvements that were not achievable by individual companies will now be attained by cooperating companies. [2]

The large companies in Macedonia, although they exist in small number, have developed logistics and SCM system. This is especially the case with the companies that were privatized during the transition period and where a foreign investor is a dominant shareholder. Usually in these companies the main advantage is that they use the experience, the know-how and the benefits from the already well established logistics and SCM system in the parent company, located in some foreign country.

The successes achieved by organizations that implement the strategic supply chain management approach will certainly have a positive impact on the popularity of the approach and a trend towards implementing the supply chain management approach by increasingly more organizations is to be expected. This trend will undoubtedly influence small and medium-sized businesses (SMEs). Many SMEs are already supplying materials, products and services

to large organizations. Hence, the adoption of the strategic supply chain management approach by large organizations in supply chains will have a definite impact on them (SMEs). [3]

It is obvious that the position of the SMEs regarding the SCM is not as favorable as for the large companies. If we have in mind the fact the SMEs dominate in the Macedonian economy, we can say that the development of the Macedonian economy is based on the development of the Macedonian SMEs.

2. DEVELOPMENT OF SMES IN MACEDONIA

According to the data of the State Statistical Office the number of active business entities in the Republic of Macedonia in 2010 was 75497. The sectors with the highest share in the structure of business entities were: Wholesale and retail trade; repair of motor vehicles and motorcycles with 28326 entities or 37.5% and Manufacturing with 8263 entities or 11.0%, whereas the least represented were the sectors Electricity, gas, steam and air conditioning supply with 107 entities or 0.1% and Mining and quarrying with 164 entities or 0.2%.

The data on the structure of active business entities according to the number of persons employed show that the highest share of 78.5% belongs to business entities with 1-9 persons employed, followed by business entities with no persons employed (or the entities did not provide information about persons employed) with 14.2%, and entities with 10-19 persons employed with 3.3%. The share of entities with 20-49 persons employed was 2.1%, those with 50-249 persons employed participated with 1.6%, while entities with 250 or more persons employed had a share of only 0.3%. [4]

Nearly 99% of the companies in Macedonia are registered as small enterprises, employing nearly 55% of the employees in the private sector. According to the main activity registered, the majority of businesses are in the wholesale and retail trade sector (47%), manufacturing sector (13.1%), and the transportation, storage, and communications sectors (approximately 10%). The largest employer is the manufacturing sector, with 35.6% of the total number of employees in the private sector.

The Macedonian Government puts a high priority on the development of the SME sector, focusing on measures and activities to support the development and competitiveness of SMEs, and to improve the business environment in general.

The strategic framework for support of SME development is defined by the following documents: the Small Business Development Strategy, Program on measures and activities for the promotion of entrepreneurship and creation of competitiveness of the SMEs in the Republic of Macedonia, the European Charter for Small Enterprises, the Law on Realization of Handicraft Activities, and the Law on the Agency for Promotion of Entrepreneurship of the Republic of Macedonia (APERM).

In order to achieve a higher degree of coordination among the relevant factors, the National Council for Competitiveness and Entrepreneurship was established as an advisory body to the Government, linking the private and public sector to improve the climate for entrepreneurship development.

The Agency for Promotion of Entrepreneurship of the Republic of Macedonia is the major player on the national level for the implementation and coordination of national and international support to the small businesses. The Agency works in cooperation with various

foundations, development centers, centers for technology transfer, Euro Info centers, as well as private consultants. [5]

From the aspect of its size and flexibility the SMEs represent the most dynamic but in the same time and the most vulnerable segment in the global economic structure of the country. That's why, the policy makers responsible for SME development, necessarily need a reliable mechanism for systematic follow up and assessment of the condition of the sector. It will further on, help them to select and carry out adequate measures providing the desired level of SMEs development. [6]

Already in 2002 the Ministry of Economy has published an SME Strategy paper covering a ten year period (2002 to 2013), together with an action plan for implementation of the strategy for the period 2003 to 2006. The overall approach to the development and support for the SME sector that has been outlined in this Strategy paper remains valid. However, a number of developments have made it necessary to revise the SME Strategy and Programme:

- A new Government was elected in July 2006 with an election manifesto and programme which places strong emphasis on increasing the competitiveness of the economy, and on promoting domestic and foreign investment; the Government moreover recognises the important role that the SME sector must play in achieving these objectives.
- With attaining Candidate Country status for accession to the European Union (EU) in late 2005, the harmonization of the National legislation and regulatory framework with EU norms and standards has become a priority. This pertains in particular to numerous laws and regulations affecting the SME sector. Candidate Country status also requires that the Government implement the EU Charter for Small Enterprises, and pursues the goals of the Lisbon Agenda.
- New EU initiatives such as the EU Commission's Instruments for PreAccession Assistance (IPA) and the Competitiveness and Innovation Framework Programme (CIP) present new challenges, in particular in relation to Science, Technology and Innovation (STI) and Information and Communications Technology (ICT) as a means of enhancing the competitiveness of SMEs. The Government must respond proactively to these challenges, in order to create a business environment in which SMEs not just survive, but thrive and are enabled to compete within the EU markets.

Therefore, the SME Department undertook a major revision of the existing strategy paper in the course of 2006, leading to the revised SME Strategy 2007 - 2013. This document has identified the following key areas for policy improvements in relation to the SME sector:

- The legal, regulatory and institutional environment;
- The business climate;
- Support to small businesses;
- Access to finance;
- Taxation for SMEs. [7]

3. ADVANTAGES OF SUPPLY CHAIN MANAGEMENT STRATEGIES FOR SMES

Chapman, Lawrence and Helms believe that SMEs can take advantage of the supply chain management strategy for various reasons: [8]

- SMEs are critical links in many supply chains.
- SMEs are very flexible. Many SMEs are still young and developing and it is therefore easier for them to reengineer existing business processes and adopt a supply chain management approach than for large organisations with a long-standing organisational structure and culture. The integrated approach is inherently part and parcel of SMEs.
- SMEs follow an integrated approach by nature. Various business functions are usually performed by one or a few persons working together.
- Computer software programmes are more SME friendly. IBM, for example, started the service Smart Start, which allows SMEs to use IBM's expertise with information systems along with their own business expertise to find and implement ERP system solutions that work for their business.
- SMEs can also benefit from global competition. Supply chain management provides a method of addressing the competitive challenges facing business today.

Small businesses are therefore already vital links in the supply chains in which they participate. By virtue of their size, flexibility and expertise they possess advantages that they can use to benefit their supply chain and strengthen their own businesses.

Technology is increasingly affordable and available to help SMEs take advantage of supply chain strategies. Because of the competitive pressures facing small businesses it is critical for them to use supply chain perspectives and associated strategies to create synergies with supply chain partners in order to succeed in the global competitive environment [7]. Despite the optimism of Chapman, Lawrence and Helms there is reason to doubt the general implementation of the supply chain management approach and willingness and ability to implement the approach by small businesses. [3]

4. SURVEY'S RESULTS

Supply chain performance will definitely be a key indicator of overall corporate success in the upcoming period and core advantage when entering foreign markets and compete with low cost countries. Small and medium enterprises (SMEs) with efficient logistics and SCM will be able to maximize their profitability and improve their competitiveness. That is why a survey has been accomplished in order to see how Macedonian SMEs are managing their supply chains and what should be done in order to make SCM a critical factor for increasing their competitiveness. The research about SCM in Macedonian SMEs was made through a web based questionnaire, which was sent to 68 managers of small and medium enterprises from various industries in the Republic of Macedonia. The questionnaire was answered by 55 managers and only those answers are included in the analysis.

Out of the 55 interviewed managers, 28% are form SMEs from the manufacturing sector, 44% from the service sector, and 28% are offering both products and services.

It is disappointing that only 37% of the SMEs have a separate logistics department and 63% do not have. From the companies that do not have a separate logistics department, 77% plan to establish one in near future, 13% do not know if they will and 10% do not plan at all. Of course this is an encouraging fact. 54% of the interviewed managers think that there is a need for organizational change for SCM adoption in the company, 33% think that there is no need for organizational change and 13% do not have opinion about this issue.

Regarding the current public policy towards SCM, 34% of the interviewed managers are not satisfied, 27% are satisfied and 19% are very satisfied.

On the question How do you manage your supply chain?, we got the following answers: 34% have close partnership with suppliers, 39% have close partnership with customers, 25% use outsourcing, 23% are holding safety stock, 21% use subcontracting, 14% use Supply Chain Benchmarking, and 12% use Vertical integration. These are the most popular methods among the Macedonian SMEs, while we got negligible percentage (i.e. almost no one) for using other sophisticated methods, such as: Electronic Data Interchange (EDI), eprocurement, Just-in-Time (JIT) supply, Third Party Logistics Providers (3PL), Fourth-party logistics provider (4PL) and similar.

13% of the interviewed managers think that their company is not successful at all in managing its supply chain in general, 34% think that they are just not successful, 28% think they are somewhat successful, 17% think they are successful and only 8% think that they are very successful. These figures are disappointing, but the managers are aware of the fact that there is a need of implementing different systems in the companies for supporting the Supply Chain Management. More of the half of the interviewed managers believe that the Supply Chain Management in the company will be supported strategically by the implementation of the following systems: Material Requirements Planning (MRP), Manufacturing Resources Planning (MRPII), Enterprise Resource Planning (ERP), Warehouse Management System (WMS), Customer Relationships Management (CRM), Supplier Relationships Management (SRM), Ecommerce, Radio Frequency Identification (RFID), Bar coding and Electronic Data Interchange (EDI). Nearly three-fourths of the interviewed managers strongly believe that the companies will achieve great benefits with the implementation of those systems, such as: better quality and quantity of information, reduced lead-time in production, reduced inventory level, better operational efficiency, increased coordination with suppliers and customers and flexibility. But, they are of course aware that the implementation of these systems is very expensive and a long-run project, probably as SMEs they will not be able to implement most of these sophisticated systems, so as a solution for overcoming the unfavourable level of logistics and SCM development in the SMEs, they are planning to implement the following future measures for supporting the company effort in logistics and SCM by raising the awareness of the importance of these topics: More funding and financial support (73%), More formal education (65%), Easier access to vocational training (62%), Better infrastructure (61%), Increased regional cooperation between institutions (59%), Closer cooperation between companies and governments (57%) and Improved information provision (54%).

5. CONCLUSION

Success in integrating global supply chains starts with the ability of companies to move goods across borders rapidly, reliably and cheaply. In order to connect the Macedonian economy to the world trends and processes and connect the Macedonian market to the

European and the world market, the highest priority should be given to the development of logistics and supply chain management in Macedonia. It is obvious that for the large companies it is easier to reap up the benefits of the well established logistics and SCM division. The position of the Macedonian SMEs regarding the SCM is not as favorable as for the large companies. If we have in mind the fact the SMEs dominate in the Macedonian economy, we can say that the development of the Macedonian economy is based on the development of the Macedonian SMEs. That is why this paper is focused on research about the level of development of logistics and SCM in the Macedonian SMEs. Macedonian SMEs must fully understand the supply chain management approach and their role. Large organizations, however must realize that, despite their size, SME suppliers are important partners who can contribute substantially to savings in the supply chain. Only in this way they can increase their profitability and competitiveness and become integral parts of the global supply chains.

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Contactless payments based on Near Field Communication Technology

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Abstract **- Contactless payment systems is expected to bring following benefits: speed and convenience at the point of sale, greater level of consumer protection compared to cash, reduction in cash usage and its associated costs, greater choice for customers in making payments. Contactless payments represent cashless payments that do not require physical contact between the consumer mobile phone and POS terminals by the merchant. The largest payment institutions support these types of payments. Implementation of contactless payment systems are based on same infrastructure that exists for the payment cards with magnetic strips and does not require additional investments by the firm and financial institutions, other than upgrading the existing POS terminals. This paper describes the advantages of introducing contactless payments by mobile phone based on NFC technology through pilot projects conducted by VISA, MasterCard and American Express Company in order to confirm in practice the applicability of this technology.**

1. INTRODUCTION

Definition that describes RFID, NFC, contactless and smart cards are used interchangeably, resulting in confusion between the differences. Confusion is especially strong between contactless smart cards and RFID. Both contactless smart cards and RFID use radio frequencies for communicating between the card and reader. RFID is mainly meant for applications within the supply chain, for track and trace. Contactless smart cards on the other hand are mainly meant for payments, banking, mass transit, government and ID, and access control. This paper aims at clearing the confusion between the two technology definitions and presents the way of using contactless cards with the business benefits of these technologies. NFC is designed as a short-range standardized technology for providing contactless communications for mobile devices [1]. NFC is intended to be an intuitive method of establishing ad-hoc connections, simply requiring that two NFC-enabled devices are brought in close physical proximity to each other. NFC also allows for devices to interact with existing contactless/RFID systems. In 'passive' communication mode NFC allows devices to emulate passive contactless smart cards, while 'active' mode allows for devices to act as contactless smart card readers or to communicate with each other. The use of NFC-enabled devices in contactless systems has received much publicity.

2. TECHNOLOGY

RFID is a wireless automatic identification and data capture (AIDC) technology. It includes tags, Antenna or coil Electronics programmed with unique information, reader and software. The Integrated circuits group comprises of IC designers, antenna and IC manufacturers. These

ICs are used in the development of RFID hardware equipments which comprises of tags (that can be active or passive), in addition to readers and printers.

The software and middleware in the equipment is integrated with the back-end systems by the system integrators who also act as the distributors and value added resellers. In addition, several companies provide training and consulting services. Some companies focus on one key aspect while others provide services across the value chain. The Table 1 lists the various RF technology features.

TABLE 1 - RF TECHNOLOGY FEATURES

Frequency Range	Low frequency RF	High frequency RF ISO/IEC 15693	High frequency RF ISO/IEC 14443	Ultra High frequency RF
	125/135 KHz	13,56 MHz	13,56 MHz	902 – 928 MHz
Technology name	RFID	RF enabled contactless smart card	RF enabled contactless smart card	RFID
Standard (for communications link)	Proprietary for access control. ISO/IEC 11784 and ISO/IEC 11785	ISO/IEC 15693	ISO/IEC 14443 and ISO/IEC 7816, parts 4 & above for application/security standards	ISO 18000-6 for inventory control tags
Operational Range	Medium: < 20 - 60 cm	Medium: < 70 cm	Short: < 10 cm	Long: 3,5 - 10 m
Data transfer rates	< 10 Kbps	26 Kbps	106 – 848 Kbps	20 – 100 Kbps
Chip types supported	Memory only	Memory, Fixed Logic	Memory, Fixed Logic, Microcontroller, Crypto processors	Memory only
Memory capacity range	Hundreds to low kilobytes	256 bytes and 2K bytes	64 Kbytes and more	Hundreds of bits today
Read/write ability	Read/write	Read/write	Read/write	Read/write
Factory affecting security	Longer range, Fixed logic chip, Limited flexibility in communications protocols	Longer range, Fixed logic chip, Limited flexibility in communications protocols	Short range, Programmable microcontroller, Counterfeiting and tamper resistance features, More Flexibility in communications protocols	Longer range, Fixed logic chip, Limited flexibility in communications protocols
Available form factors	Tags, Plastic card, Key fob, Watch	Tags, Plastic card, Key fob, Watch	Plastic card, Key fob, Watch, Mobile phone	Tags, Plastic card
Applications	Security, Access control, Asset tracking, Animal tracking, Automobile immobilizer	Inventory tracking, Physical access control systems	Secure ID cards and documents (ePassport), Credit and debit card payment, Transit payment, Physical access control systems	Transportation vehicle Inventory tracking, Supply chain

NFC technology allows for the integration of contactless technology into active devices, such as mobile phones. A NFC enabled device can act as both a “contactless card” and a “contactless reader”.

NFC devices, as specified in ISO-18092/ECMA-340 [1] and ISO-21481/ ECMA-352 [2], are compatible with existing contactless systems adhering to ISO 14443 [3], ISO 15693 [4] and FeliCa [5]. The NFC standards also define a communication mode for peer-to-peer (P2P) or 'active' communication, with the purpose of facilitating communication between two NFC-enabled devices.

At first sight, NFC is not an RFID system, but a wireless data interface between devices is similar to Infrared or the well-known Bluetooth. However, NFC has several characteristics that are of interest in relation to RFID systems. Data transmission between two NFC interfaces uses high-frequency magnetic alternating fields in the frequency range of 13.56 MHz. The maximum communication range typical for NFC data transmission is 20 cm because the respective communication counterpart is located in the near-field of the transmitter antenna; therefore the communication is called near-field communication.

The NFC interface that is the target is also able to establish, in addition to other NFC interfaces, the communication to compatible passive transponders (e.g. according to ISO/IEC 14443) that the NFC target supplies with power and that, via load modulation, can transmit data to the NFC interface. This option enables electronic devices equipped with NFC interfaces, such as NFC mobile phones, to read and write on different transponders such as smart labels or e-tickets. As the NFC interface in this case behaves similar to an RFID reader, this option is also called 'reader mode' or 'reader-emulation mode'.

If an NFC interface is located close to a compatible RFID reader (e.g. according to ISO/IEC 14443), the NFC reader is also able to communicate with a reader. Here, the NFC interface adopts the roll of an NFC target and can transmit data to the reader using load modulation. This option enables RFID readers to exchange data with an electronic device with NFC interface, such as NFC mobile phones. From the reader's perspective, the electronic device behaves like a contactless smart card; this option is also called 'card mode' or 'card-emulation mode [6].

3. THE BUSINESS BENEFITS OF NFC TECHNOLOGY

NFC provides a technology that makes it possible simply to add a very flexible RFID interface to electronic devices. In addition, NFC is compatible with MIFARE, a common NXP contactless smart card technology, and with FELICIA, Sony's contactless smart card system [8] as well as with all ISO/IEC 14443-A-specified transponders and readers. NFC application can be divided into different categories [9]:

- Touch and Go: in this category we find applications such as access control systems, logistics reporting systems or security technology as well as ticketing systems. Here the NFC device behaves like a contactless smart card that contains an access code or ticket and has only to move quickly past the reader.
- Touch and Confirm: applications such as mobile payment where the user has to confirm the interaction by pressing a button or entering a PIN into the NFC device.
- Touch and Capture: here, the NFC device is located close to the transponder (smart label) which for instance can be attached to a smart poster. The NFC device can read out transponders for information such as phone numbers or a URL for further information.
- Touch and Link: applications that require an online connection of the NFC device. Data read by the NFC interface are forwarded via an online connection (GPRS,

UMTS) to a server. The server can process these data and send back information to the NFC device where it is shown on the display.

- Touch and Connect: a connection of two NFC devices for transmitting images, MP3 files or simply for matching phone directories of two NFC-enabled mobile phones.
- Touch and Explore: it is possible to randomly combine the above categories. Touch and Explore allows the user to intuitively 'find and explore' new applications.

Figure 1. NFC provides three different operating modes with a variety of applications [6]

There are clear signs that in the future the mobile phone will be the personal NFC device. As most people carry their mobile phones on them all the time there is a valuable additional benefit if everyday services can be provided through an NFC-enabled mobile phone. NFC devices are most easily used in applications that already dispense with of a reader infrastructure. Therefore, contactless smart cards of a public transportation ticket application can be easily replaced by NFC-enabled mobile phones. The phone's NFC interface takes on the function of the contactless smart card, with the ticket data sets being safely stored in a secure element. However, the special advantage of mobile phones is that, via the GSM interface, new additional functions and services can be offered that may lead to novel business models. OTA services (OTA = over the air) can administer data in the secure element of an NFC-enabled phone. OTA services make use of the mobile's option to transmit data via GPRS or UMTS. Using OTA services ensures secrecy of personalization data due to strong encryption and authentification [10]. This way it is possible for public transportation businesses to use OTA services to automatically send customers an electronic monthly season ticket at the beginning of the month which the customer can save in his or her NFC phone. Even a single ticket that was ordered with the Internet browser of a modern mobile phone could be directly transmitted to the secure element of the mobile after processing the order with OTA services; and it will be immediately available to the user.

4. NFC APPLICATIONS FOR CONSUMERS

The use of the mobile handset for contactless payments (and specifically the 'user interface' provided) gives rise to a number of additional elements of functionality, including:

- user-configurable security protection, subject to minimum standards
- ability to offer expenditure tracking, aiding budgeting and control
- additional issuer-configurable risk parameters

In addition to these benefits, it is believed that with the enhanced functionality on their phones, users will take more care of their handsets. In concept proving trials, users have said they are less likely to carry wallets or purses as well as payment enabled mobile phones, and so the potential loss from any theft might be reduced.

The world's first RFID mobile telephone with NFC capability was announced by Nokia in February 2005 as an enhanced version (model 3220) of an existing model. It is based on the ISO 14 443-A standard and is intended to support all functions supported by smart cards, such as payment transactions, ticketing, etc. With an NFC mobile phone, the user can initiate a transaction at a point of sale or entrance to a sports facility by touching the phone to a marking that indicates the location of an RFID tag or antenna. The credit card data and ticket information are stored securely in the smart card chip. The advantage of a telephone is that it can transmit as well as receive via the NFC link. Peer-to-peer communication is also supported, which for example means that two mobile phones can exchange data with each other directly.

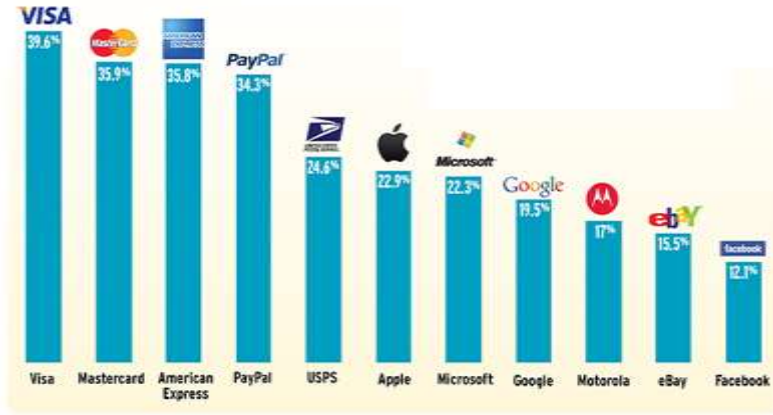

Figure 2. Most trusted brands in mobile payments (precent of respondents expressing trust), source: MobilemarketingWatch

Immediately after the announcement of the first NFC mobile telephone, Visa and MasterCard stated that they welcomed it as complement to their credit cards. NFC telephones are already being used successfully in the public transportation system of Hanau near Frankfurt, Germany. Besides ticketing, there are numerous other potential applications for NFC in the consumer and industrial sectors, for example when repair technicians need to identify individual parts and access more information about these parts in the transponder memory or central databases

In April 2006, Royal Philips Electronics and Visa International published the results of a study on NFC technology for contactless payment, with the title 'How Would You Like to Pay for That? Cash, Card or Phone?'. According to the study, consumers rate the convenience, ease of use and 'coolness' of NFC mobile telephones very highly [10]. The study participants used NFC mobile telephones to make purchases in coffee shops, download films in DVD shops and buy concert tickets via smart posters, among other things. Further expansion of NFC technology is thus very probable.

4.1. Application scenarios for NFC mobile telephones

A smart poster has an RFID tag with a suitable marking. If an NFC telephone is held close to the tag, it can read the data stored in the tag. It can then call the ticket centre of a concert promoter or similar organization to reserve tickets immediately and pay for them. When the concertgoer arrives at the event location, he or she holds a mobile telephone next to the check-in terminal at the entrance and is immediately allowed to enter. For the concertgoer, standing in line to pick up a ticket is a thing of the past. It could hardly be faster or easier.

NFC-enabled mobile phones could even be used to implement applications that are problematic regarding the installation and networking of the readers (e.g. in vehicles) or that are too expensive (if the target is nationwide coverage, for instance). Project Touch and Travel introduced in 2005 by Deutsche Bahn AG is example where NFC-enabled mobile phones used as tickets for long distance travel [6]. Railway stations that are part of the Touch and Travel network only need to be equipped with passive transponders (ISO/IEC 14443) that are located in eye-catching 'touchpoints'. To buy a valid ticket, the previously registered customer starts a specific application – the Touch and Travel applet – on an NFC-enabled mobile phone immediately prior to the journey and moves the phone into the reading range of the touchpoint transponder. The Touch and Travel applet now builds an online connection via mobile phone to a data centre, transmits the data read out of the transponder to a server and writes some of the data received by the server into the mobile phone's secure element. This way the customer is booked into the system and the railway station where the touchpoint was read is entered as departure station of the forthcoming journey. The booking data set entered into the secure element now constitutes a valid ticket and can be easily verified by the conductor with a portable reader. At the end of the journey, the customer simply goes to the nearest touchpoint and repeats the reading procedure. This way, the customer checks out of the system, the journey is registered as ended and the corresponding price is calculated.

Figure 3. An NFC-enabled mobile phone with the corresponding payment application simulates a contactless credit or debit card (source:MasterCard PayPass)

Even for payment transactions, the use of NFC phones opens up completely new opportunities. An NFC mobile phone that is used for payment simulates contactless credit or debit cards (card emulation mode). The POS terminal cannot distinguish whether the card holder uses a contactless card or an NFC phone with the corresponding payment application. The advantage is obvious: If the POS terminal includes a contactless reader NFC technology can be accepted for payment without any additional efforts. This does not affect the processing

of the payment with NFC phones as the existing infrastructure can be used. Even if the battery is empty, NFC phones can still be used for paying as the POS terminal contactlessly provides the necessary power to the NFC chip.

Differences become obvious when the 'credit card in the phone' supports additional functions that traditional cards do not have. An NFC-enabled phone is, strictly speaking, a highly complex IT system and can store several card data sets in the secure element, i.e. also several credit and debit cards of different payment systems. During the payment process, the 'card holder' (i.e. the phone user) only has to select a preferred card or has the option to previously make this selection with a special menu entry in the NFC phone. Other possible functions include the temporary inactivation of the card; for instance, if owner lend the phone to somebody else who is not supposed to use the stored credit cards. OTA services can be used to personalize the secure element with personal credit card data and extend an existing expired card. If the owner of an NFC-enabled phone registers the phone as lost and wants to remotely inactivate the card functions he or she can easily use OTA services to do so.

Some pilot projects and scenarios [10]:

- Philips Arena, Atlanta, USA. Sports fans can use NFC here to buy products or download mobile contents – such as ring tones, screen savers or video clips – by holding their mobile telephone next to a smart poster.
- City of Caen, France. During a six-month trial project, 200 residents of the city used Samsung NFC mobile telephones to make payments in shops and car parks and download video clips, bus schedules and information about interesting sites.
- Taiwan Proximity Mobile Service, Taiwan. Prototype BenQ NFC mobile telephones were used to test secure payment transactions for public transport in Taiwan.
- Ordering a taxi at a hotel. An out-of-town hotel guest needs to order a taxi. In the future, the guest can simply touch his or her mobile telephone to the tag of a taxi poster in order to be connected to the taxi dispatch centre. The dispatcher knows the customer's location right away without asking and thus knows where to send the taxi.
- Arriving in Paris by train. A traveller is looking for the schedule of trains returning to the airport. The traveller touches the tag on the schedule and enters the desired departure time, and suitable connections are downloaded to his or her mobile telephone.
- Paying parking fees and bus fares. To pay for a parking ticket in a controlled parking zone, you can hold your mobile telephone next to a parking ticket dispenser. You can pay for a bus fare by swiping a mobile telephone past a check-in unit.
- Access to ski areas. Smart cards are already widely used in large ski areas for contactless access to the slopes. In the future, you can use your mobile telephone and avoid queuing at the lift station for a smart card. This also puts an end to arriving back home and discovering that you forgot to return the smart card and collect your deposit.
- Calling a service hotline. If you have a malfunction with a home appliance or trouble using the appliance and you want to sort this out by calling a service hotline, you usually do not know the telephone number. In the future, you could simply hold your mobile telephone next to the nameplate of the appliance and the call would be placed for you automatically.

4.2. Industrial Uses of NFC

NFC mobile telephones also offer new possibilities for industrial uses, since they are an order of magnitude less expensive than current RFID readers. They are thus a logical choice to

replace RFID readers. This naturally assumes that employees who use the RFID readers already have mobile telephones. The 13.56 MHz NFC frequency is also widely used for RFID tags on individual objects (items), so the ROI in RFID methods can be accelerated considerably in trade and industrial applications. For example, Nokia offers a service product for security and maintenance organizations that require full-coverage communication with their technicians or contractual partners [10]. NFC mobile telephones can be used to manage and monitor the tasks of technicians and security personnel. For example, if the check points of a security round are fitted with RFID tags, the security guard only has to hold his or her mobile telephone next to the tags to document proper performance of the round in terms of locations and times. The same holds true for maintenance technicians if the equipment to be maintained is fitted with RFID tags. In this way, the necessary documentation of the work or the rounds can be generated automatically and concurrently with the activities.

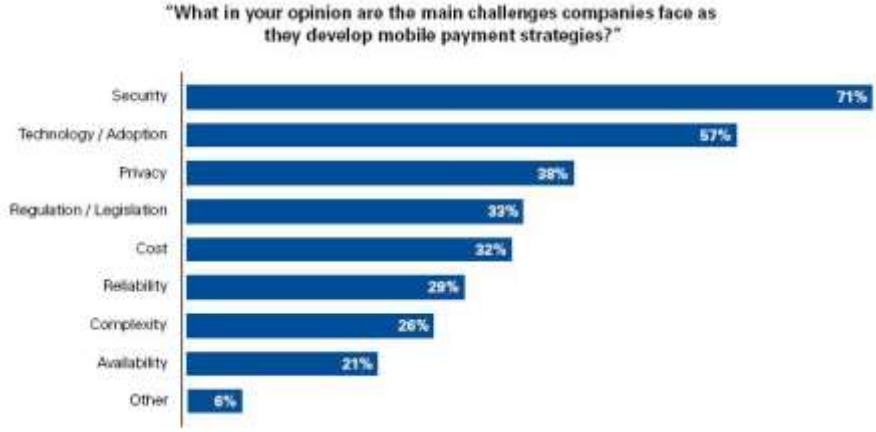

Figure 4. Chart represent most important concern in mobile contactless payments based on 446 companies, multiple answer accepted, source KPMG 2011 Mobile payments global survey

5. CONCLUSION

Financial corporations worldwide are placing a high priority on implementing new technologies that improve the security and convenience of identity verification and payment transactions. The use of NFC Technology not only creates a great method for mobile payments and data communications but it also allows these experiences to be extended and create vision of future - technological ubiquity, one in which computing through dedicated devices will slowly disappear, while information processing capabilities will emerge throughout our surrounding environment. With the benefit of integrated information processing capacity, industrial products will take on smart capabilities. They may also take on electronic identities that can be queried remotely, or be equipped with sensors for detecting physical changes around them. Such developments will make the merely static objects of today dynamic ones - embedding intelligence in our environment and new business opportunities. Contactless chip technology enables strong security features along with convenience, durability, flexibility and reliability. It provides the features and performance needed to meet the different business requirements that drive a diverse set of applications. There will be rapid growth in sales of next

ten years with contactless smart cards, tickets and RFID enabled phones. Consumers prefer the fast transactions and reliability that come with contactless approaches. One of the most important challenges is convincing users to adopt emerging technologies like NFC. Concerns over privacy and data protection are widespread, particularly as sensors and smart tags can track a user's movements, habits and preferences. But whatever the concern, one thing remains clear: scientific and technological advances in these fields continue to move ahead at breakneck speed.

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Bricolage approach for the software development in SMEs - Case study of simulator manufacture

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Abstract: **Bricolage approach, based on the idea that new product should be result of innovative assembly and adaptation of available technologies and tools in order to make them work in practice, may effectively be applied in software design in SMEs.**

This paper presents a longitudinal case study of using bricolage approach in a SME producing flight simulators. The focus is on parts of the software for simulation of airplane flight, including development, testing and validation. The software is built from few commercially available tools, some free components, and in house developed specialized and integrating modules.

1. INTRODUCTION

Modern ICT has enabled the Small and Medium Enterprises' (SMEs) to become more integrated, more effective across longer distances, and to operate with more efficiency.

However, SMEs can experience difficulties in adopting Information Systems (IS) and aligning them with their strategic development [1]. Introducing standard IS and Enterprise Resource Planning may impose a rigid structure on a company, requiring that a SME behaves like a large company with long-term strategic planning and lots of in-house experts for IS . two requirements that are typically not fulfilled for a SME [2].

SMEs possess abilities to innovate fast, to respond rapidly to changing environments and to satisfy customer's emerging and evolving requirements that can give them a competitive edge over larger organisations. However, these attributes are rarely exploited when SMEs implement IS.

A useful concept is bricolage, as it deals with the need for SMEs to learn about the possibilities of IS in situ, simultaneously exploiting the can-do approach that is usually found in SMEs [1,2]. The bricolage is based on the assembly and integration of various existing technologies and devices in order to make them work in a novel product. In addition, IS may be implemented piece by piece, stretching IS to support administrative and other functions that were outside of the application.s intended scope.

This paper presents the results of several years of development IT solutions in one SME - French flight simulator manufacturer [3]. Starting at late nineties in the field of hi-tech IT technology, and promoting low cost technology products on market, the enterprise succeed to install their Flight Simulator Training Devices (FSTD) worldwide. One of its FSTD is installed in JAT Flight Academy in Vrsac.

The role of adopted strategy, combining existing commercial and free software components with in-house IS development, was significant factor for the enterprise success. Full control of the customer-tailored parts of the software makes it possible to remain flexible and dynamic, and to conform to the need of the customers at any time.

This experience may be useful for other SMEs, at least those working in the fields of innovative technological solutions.

2. BRICOLAGE APPROACH AT SME

Bricolage (the term is borrowed from French meaning "do it yourself") is used in several disciplines, to refer to the construction or creation of a novel product from a diverse range of things that happen to be available. By strict definition the bricoleurs 'universe of instruments' is closed and he will make use of whatever is at hand [1].

For example, in education bricolage is described as a way to learn and solve problems by trying, testing, and playing around, very much like a constructivist approach to learning [16], contrary to the analytical style of solving problems.

The concept of bricolage has been adopted, among others, by information systems developers [2]. When considering IS bricolage 'materials at hand' are usually considered to be information technology hardware and software artefacts.

There is an increasing race in the IT business environment which requires faster and more efficient software development methodologies. Thus, many alternatives to classical waterfall development process model are suggested [17,18]. For example, rapid application development (RAD) and eXtreme Programming (XP) have in some cases allowed small teams to develop systems quickly in rapidly evolving requirements. In addition, outsourcing software development and combination of bought, in house developed and open sourced software, which often happens in SMEs practice, make scenarios not well addressed by formal software development methodologies.

In fact, improvisation is frequently a chosen business model of SMEs. It enables them for a fast reaction on immediate pressure, as they can adapt and change to suit market conditions with no long term direction or strategic planning. Sometimes this flexibility is giving them a competitive edge over large companies. Bricolage approach formalizes and systematizes this process of IT systems development.

3. IT APPROACH AT SIMULATOR MANUFACTURER

Aeronautical industry is usually related to cutting edge technology products, large systems, large investments, very systematic approach and rigorous standards. The solutions are often exclusive and expensive. Flight simulation industry is not an exception.

In many branches of industry, flexible low-cost products, adaptable to current market demands are produced by SMEs. This might be expected in the flight industry, too, but that seldom happens. Namely, practice, standards, experience and development methodology in aeronautical industry leave little or no room for small firms with limited resources, unless they find their way to produce high-tech low-cost solutions.

Although "high-tech low-cost" seems to be an oxymoron, it may not be the case if a SME succeeds to find a way outside well known schemes and procedures. A conceptual approach of bricolage is not only ideological but just practical framework to find new innovative solutions.

ALSIM [3] is French simulator manufacturer started to build Flight Simulation Training Devices (FSTDs) for pilots. initial training [4] in late 90'ies. Independent firm with 25 to 30 employees including management, finance, sales and marketing, development and production, succeeded to develop its own products and its own methodology. What happened just corresponds to what is meant by the concept of bricolage.

The text to follow will highlight an aspect of the IT development usually considered as hi-tech in simulator technology. Its major components are:

- airplane flight modelling;
- collecting of representative data;
- implementing the flight model on FSTD;
- validation of the flight model;
- qualification of the flight model and FSTD.

It will be explained how the company under study has integrated all these components into a successful marketable product, combining off-the-shelf parts with in-house developed components, thus successfully implementing bricolage development process in practice.

4. SOFTWARE CONCEPT FOR FLIGHT MODEL DEVELOPMENT

The development concept in the company under study in this paper is centered around real time (RT) simulation software implemented on the training devices.

4.1. Real time IT support

Only few commercially available tools are used on PC Windows platform:

- Visual C++ 6.0 for real time programming;
- PC anywhere, for access of distant computer
- Adobe Illustrator, Corel Draw, 3D Studio Max for graphical content (assets) of synthetic instruments and indicators in the cockpit and visual system creating computer generated imagery of outside world;
- Microsoft Word and Excel for documentation.

This completes RT informatics support. A distributed system architecture shown in Fig. 1 (autonomous processes interact with each other by message passing) is adopted for RT software on FSTD.

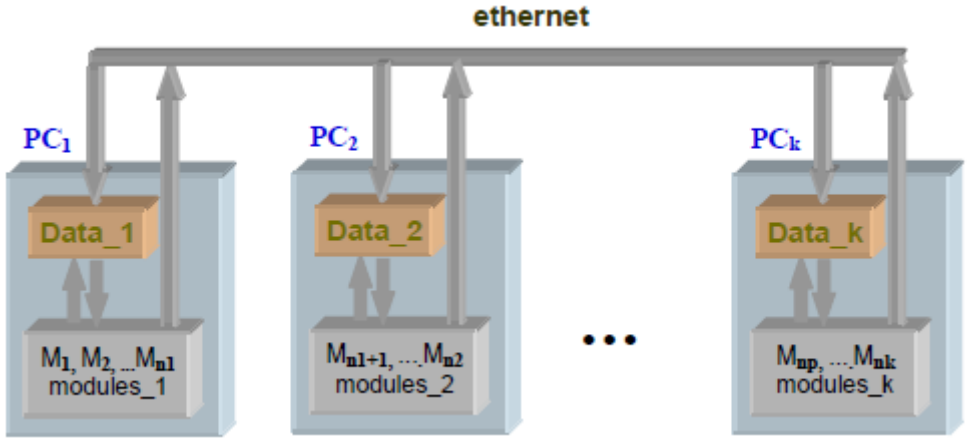

Figure 1: Distributed computing architecture

The processes are running either on the same physical computer or different computers.

Peer-to-peer architecture is exploited where there is no special machine or machines that provide a service or manage the network resources. Instead all responsibilities are uniformly divided among all machines, known as peers. Peers can serve both as clients and servers. This is in fact application of the concepts of DIS (Distributed Interactive Simulation) i HLA (High Level Architecture) [5,6,7] which offer high level of modularity and flexibility.

Thus, FSTD are built primarily from low-cost massive production components and common basic software tools are used.

4.2. Non-real time IT support

Software for Flight Model Development (SFMD – running in non-real time) is composed from in house developed modules or third party products. The latter is either free software (e.g. Octave – Matlab clone, or GCC compiler), or bought for a fee of the book with the software attached (e.g. Sidpac [8], Stdaer [9] etc.). Each of these modules has been tested and validated prior to its integration in the SFMD package.

The integration of third party software was not simple due to variety of programming languages, input-output formats, and a mixture of source and executive code. Generaly, none of these modules has been compatible with others.

The principle of distributed computing is exploited, because data-centric architecture enables computing without any form of direct inter-process communication.

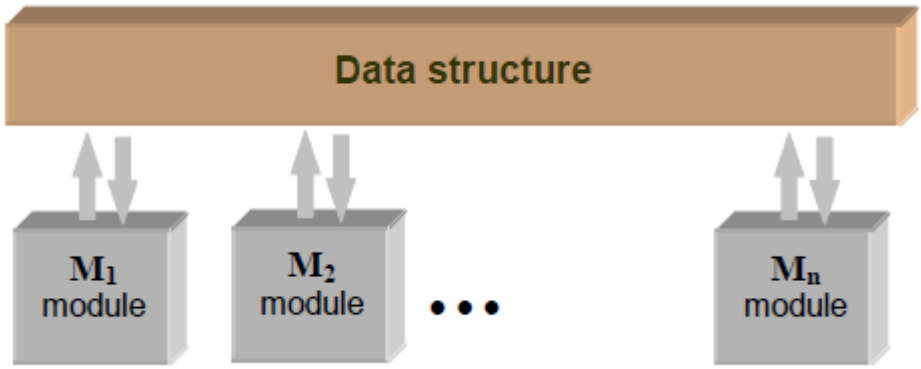

Figure 2: Data centric Architecture

Again, the ideas from HLA are exploited. All modules of SFMD are independent but it is asumed that communicate with rest of the system trhough comunication interface (which corresponds to midleware in HLA terminology).

In howse developed modules are already built compatible, and third party modules are wrapped by an auxiliary software layer to obtain FSMD compatibility (see Fig 3).

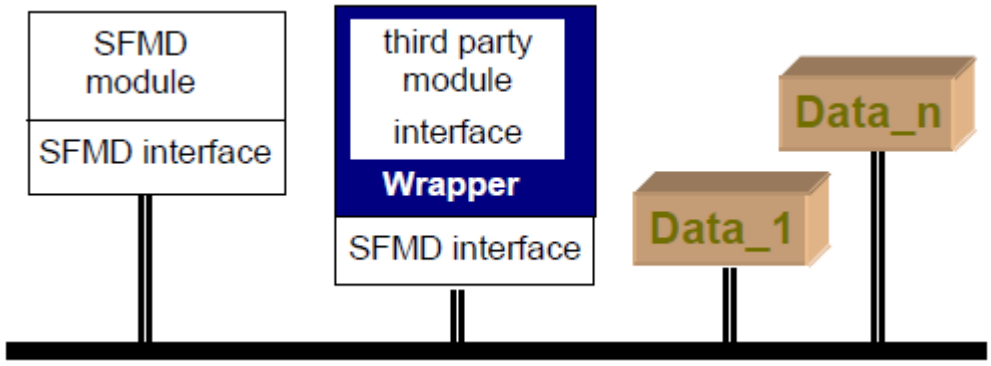

Figure 3: Integrating third party modules into SFMD

The following sections give more details on particular tasks, methods and modules in SFMD.

5. FLIGHT MODELLING AND SIMULATION MODULE

Flight model or mathematical model of airplane motion is commonly adopted system of differential equations representing rigid body with six degrees of freedom in quasistationary aerodynamic flow field [10-12]. Solution of this system may be represented in the form:

$$Ch = f(p) \quad (1)$$

where Ch is set of airplane characteristics (fixed values as airplane maximal speed, ceiling, or functions like motion time histories e.g. flight altitude versus time), p is set of airplane parameters (fixed values as weight, wing area or functions like engine thrust vs. airspeed and height) and f is function .

Parameters p are input data to the flight simulation model while characteristics Ch are output data, i.e. results from the simulation model due to eq. (1).

The set of parameters p (known as data package) is sold by airplane manufacturer, since these data are normally predicted as a part of the airplane design. For some simulated airplanes there is no data package to buy, so simulator manufacturer has to build it. The practice at ALSIM was to build its own data for simulated airplanes.

Thus, the task to be solved by use of SFMD is: a) Build the set of representative parameters p for a simulated airplane, b) Obtain the set of airplane characteristics Ch, both of them validated and conform to the standards [4].

5.1. Data collection

Primary sources for the airplane flight model definition are: certification data sheet, Airplane Flight Manual and Airplane Operating Manual as officially approved documents. Additional data may often be found in some of textbooks [8-14], and in various technical reports.

The next level of data collection concerns the similar airplanes (i.e. those having similar or same purpose, certification category, propulsion, weight and size). Using principle of aerodynamic similarity and model equations [8-14], this data may be used to predict parameters of the target airplane.

5.2. Data consistency check and flight model parameter prediction

Data collected from various sources may be more or less reliable and should be checked for consistency.

For data consistency checking, the following simple statistic principle is often exploited. The values of the same parameter coming from various sources are compared. If some value is outside the pre-set level (which may be defined in terms of standard deviation σ), its source may be eliminated from further considerations, or taken into account with the confidence level depending on deviation of parameter mean value.

Flight model parameters are predicted using standard techniques for airplane design, available in the textbooks [8-14] and technical reports. Often the books are accompanied by software ready to use.

The principal software packages exploited in the airplane flight modelling are the following:

- DATCOM. The U.S. Air Force Digital Datcom is a computer program that uses flight conditions and aircraft geometry to estimate the aerodynamic stability and control characteristics of aircraft. Digital Datcom follows the methods in the U.S. Air Force Stability and Control Datcom [13]

- Smetana codes is a software accompanying the book [9], permitting to estimate aerodynamic parameters of a light airplane – just corresponding to the class of airplanes used in the initial pilot training and simulated on the low-cost FSTD.
- Lowry codes [14] represent Excel sheet implementing simple techniques for predicting light airplane performances. It is used in inverse fashion: parameters are tuned until predicted performances fit the real airplane performances.

6. FLIGHT MEASUREMENT MODULE

Demonstration of the simulator fidelity, i.e. that simulated airplane behaviour is sufficiently close to real airplane behaviour require flight measurement records done at specified test conditions by standards [4]. Flight records may be bought from airplane manufacturer (if available) or done in house. The latter is the option adopted by ALSIM. The equipment developed in house, dedicated to the flight measurement for the airplane model development is based on the following principal low-cost components [15]:

- Laptop computer (Sony Vaio PCG-141C notebook)
- PCMCIA data acquisition card (National Instruments DAQ Card AI-16E-4) collecting up to eight analog input signals and eight digital IO signals.
- Attitude and Heading Reference System (Crossbow AHRS400CA-100)
- Video and voice recording camera
- Accessories, position and force sensors completes the system hardware.

The software is written in C++ (hardware communication routines) and Matlab.

7. FLIGHT MODEL VALIDATION AND TESTING MODULE

At a first stage the flight model is validated in non-real time context. It consists of validation of model equations which are common to all airplanes in a simulated class and validation of model parameters, specific to simulated airplane.

Model equations are implemented in software modules and they are validated prior to use in SFMD as well as during each flight model development. Namely, they may be considered as source of the of model parameters and data consistency check described in last section also attributes the confidence level to the module.

The simplified principle of the consistency check may be stated as: "If the results of two different modules are identical or sufficiently close, then both of them are correct. In opposite case they are both considered not correct and further validation is necessary".

In Fig 4. a simulation results are compared with flight records. Although match is relatively good, the deviations may be noted.

One may not a priory state that neither simulation results are correct (comprising equations, parameters and simulation algorithm) nor the flight records are correct (since they suffer from measurement and data processing errors).

Flight model parameters and equations are considered validated after achieving acceptable confidence levels.

By model based testing approach, a real time simulation model is validated using standard unit and integration test techniques and driver-stub arrangement.

Finally a series of automated tests is executed on the simulator and compared with the data collected during model development. The test results together validation data are delivered with device.

Each of FSTD in use is subject to periodic evaluation (called FSTD qualification according to standards [4]) by flight and technical inspectors which run the tests and compare with validation data.

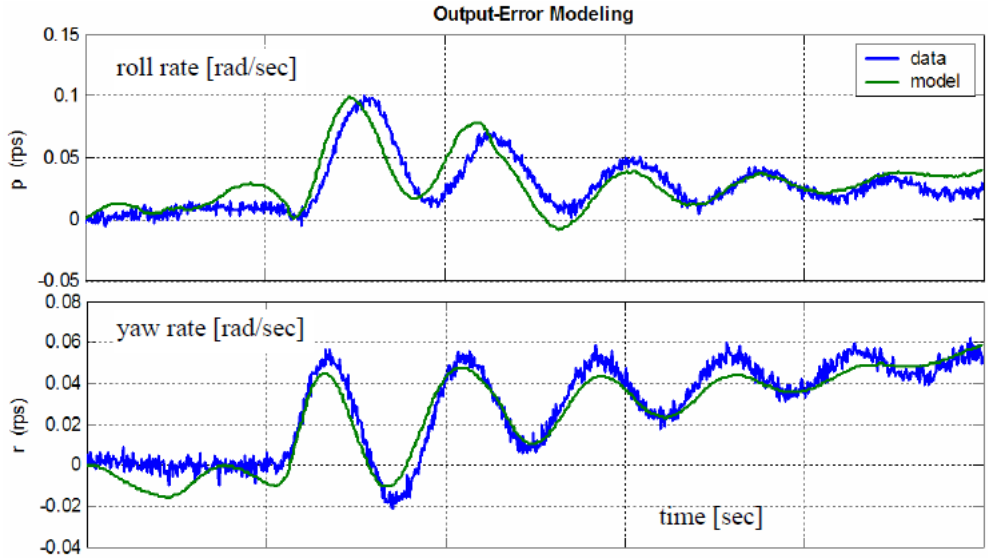

Figure 4: Comparison of simulation results with flight records

8. CONCLUSION

The standard IS development approach tailored primarily for policy and operation of large companies might not be olways the best solution for SMEs which usually operate with limited resources, but are typically more flexible and adaptable.

Introducing IS piece by piece from already available products, combined with in house development, may result in IS better adapted to SME company needs. This approach is formally called bricolage. Experience and IS solution described in this paper indicate that bicolage approach of combining technologies at hand may result in successful products

developed by SMEs, although those products are usually considered to be hi-tech and exclusive for large companies.

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Stigmergy processes in the function of Web information system management and their importance in the development of small and medium-sized enterprises

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Abstract: **Stigmergy processes are a key factor in the development of information systems for small and medium size enterprises, they represent an efficient, applicable, costeffective and reliable solution, their future implementation will be crucial in the progress and survival of the Web based enterprises. Development of the company which offers software supports to their clients, use this type of software for autonomous development, systems based community support, grouping and dedicated to the development of such type of products, plays a crucial part in products development. Enthusiasm of the community oriented members has a crucial part in the open source software processes, where members take active take part in the development, improvement of functionality, mechanisms of coordination, stability, efficiency, and the software security. Stigmergy is a term taken from biology, presents a mechanism for controlling and coordinating the work of individual and the environment, members and the environment as an enclosed system, for the benefit of community and all their individuals. Many processes on the Internet are stigmergy oriented and based, and its understanding is crucial for the future processes of Internet development.**

1. INTRODUCTION

Stigmergy processes are a key factor in the development of information systems for small and medium size enterprises, they represent an efficient, applicable, costeffective and reliable solution, their future implementation will be crucial in the progress and survival of the Web based enterprises. Development of the company which offers software supports to their clients, use this type of software for autonomous development, systems based community support, grouping and dedicated to the development of such type of products, plays a crucial part in products development. Enthusiasm of the community oriented members has a crucial part in the open source software processes, where members take active take part in the development, improvement of functionality, mechanisms of coordination, stability, efficiency, and the software security. Stigmergy is a term taken from biology, presents a mechanism for controlling and coordinating the work of individual and the environment, cooperation of members and the environment as an enclosed system, for the benefit of community and all their individuals. Many processes on the Internet are stigmergy oriented and based, and its understanding is crucial for the future processes of Internet development.

Complex software applications, web sites, magazines, encyclopedias, social sites are result of stigmergy processes, where members without fees of restrictions, use complete software code or part of it, modify it, commercial monopoly is excluded and is not constrain factor in continuous software developing. Stigmergy process paradigm, with "work in progress" as the slogan, represents an essential factor, where the modification of the environment serves as external systems memory, encompasses work groups or individuals into a continuous chain of upgrades and improvements.

In this study of stigmergy processes, special attention will be focused to the Drupal development, the CMS open source software, as a practical application realized on than one million Web sites and applications, its development is supported by hundreds thousands of active users, who in their own and benefit and goodness of community, working in active modules development, the software implementation which its strength exceeds all community together, and whose adaptability and creativity, system resources, wide theoretic and practice area, economic feasibility, presents a challenge for all competing products. Applicability of the Drupal CMS system in the following areas: electronic commerce, web information systems of small and medium enterprises, on-line magazines, travel agencies, media web sites, systems of education, scientific research projects, etc. In the practical part of the paper we show Drupal system and its implementation in the distance learning system, as a real-time effective solution for on-line education system.

2. SYSTEM, INFORMATION SYSTEM, WEB INFORMATION SYSTEM

In the analysis of information systems in modern interpretation has far greater significance, we start from the system that is commonly defined as a set of entities, at least two, organized to perform a particular function, while interaction of parts creates a whole. That is a set of interrelated dependent parts which together form a whole so that this set has a specific purpose, goal and changes in any part leads to changes in another part to. [1]

Information system is an integrated system of human activities and technologies that support the operations, management and decision making. Today's information system show is multidimensional, presented three axes with its elements in the way of data integration, of network standardization and distributed applications.

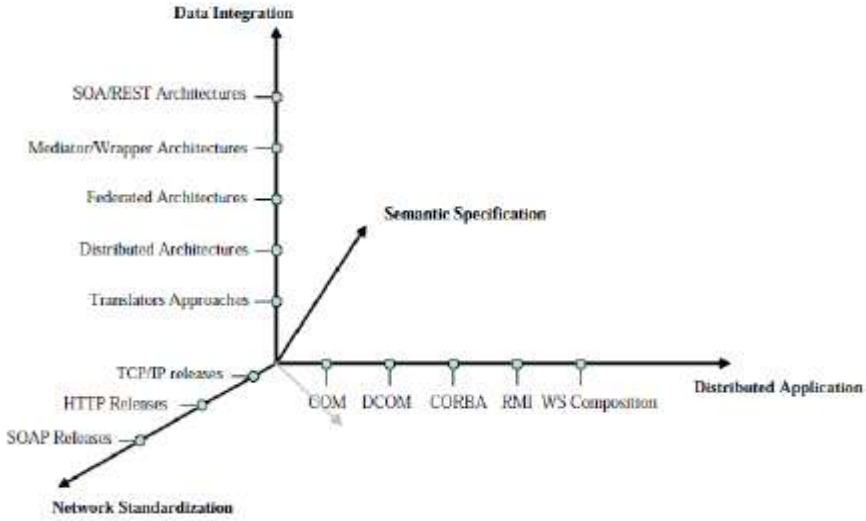


Figure 1: [2]

3. OPEN SOURCE SOFTWARE AND STIGMERGIC PROCESSES IMPORTANCE

The open source processes are almost identical to the termites colony building, process known as stigmergy. There is no centralized leader; no hierarchical project layout designs termite colonies. Stigmergy is simultaneous process between the communesassociations and its members, the work coordinating process for the systems impruvments, in the benifit of the individuals and community development.

Basic stigmergic processes features are:

- individuals do not respond to centralized instructions
- each individual does in his own way
- mode of communication is via the environment (site, forum, blog, comercial support)
- system feedback, benifit of an individual from the community and the community of individual
- errors are discovered by accident but they prevail abundance of the commune and its willingness to help
- stability and persistence of components depends on the environment and each individual
- all structures lead to the improvement, simplification, the applicability of the product around which the community operates and works
- stable states of the system are mulitple.

Stigmergy processes are based on the belief that hierarchy is extremely inefficient, where all personal is rely on the head person who manages all aspects of the activity, creativity and intuitiveness, inventiveness are completely ignore.

Open source software is those whose source code is publicly and available for elementary rules of usage, the code can be changed, adapted and improve. Such products are: Firefox, Joomla, Drupal, LINUX, MediaViki, Wikipedia etc.

The GNU General Public License (GNU GPL or simply GPL) is the most widely used free software license, originally written by Richard Stallman for the GNU project. The GPL is the first copyleft license for general use, which means that derived works can only be distributed under the same license terms. Under this philosophy, the GPL grants the recipients of a computer program the rights of the free software definition and uses copyleft to ensure the freedoms are preserved, even when the work is changed or added to. This is in distinction to permissive free software licenses, of which the BSD licenses are the standard examples. [3]

The classical economics model holds that people are intrinsically selfish, and will not do anything to help others—such as providing information products—without remuneration. Traditional economics is based on the assumption that private property rights are needed as an incentive for production. Only when you have full control over your production can you ask remuneration for it to the people who would like to use it. Moreover, the free market model assumes that competition is needed to optimize production: if people do not buy your products because they prefer the one of your competitors, you will be forced to improve your products

or lower their price. When the major producers all cooperate, as in a cartel, competition is eroded and prices can increase freely without corresponding increase in quality. [4]

If small and medium enterprises are often showed as organizations including the qualities of flexibility and resistance, the auto-organization seems, on the other hand, very rarely held in reticular organizations. It is here that swarm intelligence, which include the phenomena of auto-organization of social insects, brings us elements of reflection in the light of the four main mechanisms that constitute the auto-organization phenomena:

- The existence of multiple interactions,
- Development by the positive feedback,
- End by Negative feedback,
- The amplification of fluctuations. [5]

Using models of social insects allowed us, at first, to consider otherwise the mechanisms of coordination and control in a peculiar reticular organization, a grouping of small and medium-sized firms working on shared projects. [6]

4. DRUPAL APPLICATIONS LAYERS

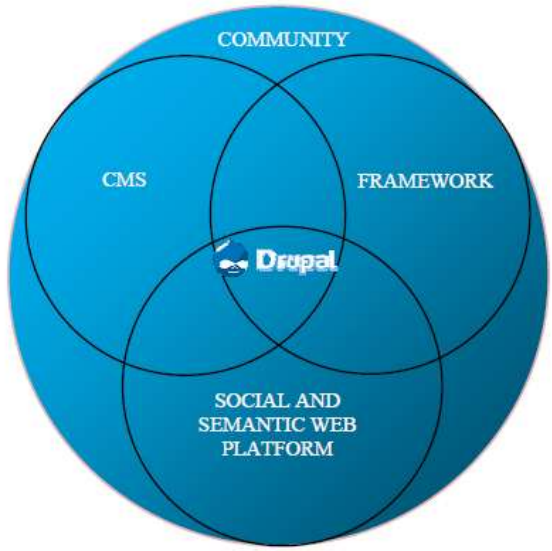
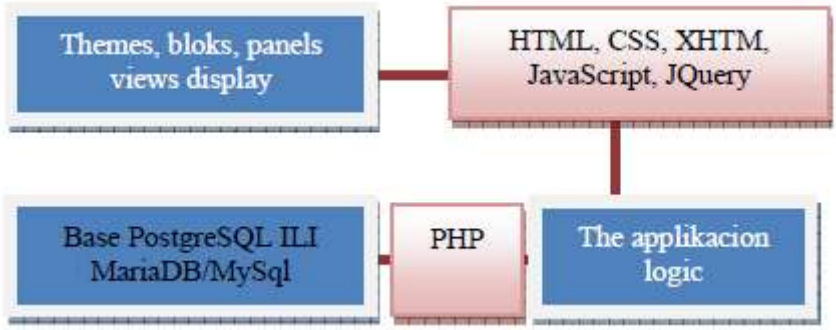


Figure 2: [7]

Drupal is written in the PHP programming language, Java Script and Query libraries represent the standard programming tools, while the database is based on PostgreSQL or MariaDB/MySQL. Application layers of which was built Drupal application are:



With the slogan Come for the software, stay for the community, 656,444 people in 228 countries speaking 181 languages power Drupal. Drupal is an inevitable force of progress and continuous improvement. At the main Drupal Web sites: http://drupal.org/ you can find information for the beginners and advanced user, conference theatres information, security patches, information about new modules and themes details installation instructions, diverse community, software and hardware system requirements. The Drupal is supported by community oriented individuals, diverse groups which are paid for the modules and specific code developments. On the various Web sites you can find books and video instructions, tutorials for the specific system functions. [8]

Drupal is highly modular, open source, Web CMS (Content Management System), its strength is based on great support and cooperation hundreds of thousands of passionate people and teams, working on powering improvement and upgrade of the system. As expandable, encompassed with advanced administrative interface, supported by teams of highly qualified programmers, the code are continually updated and improved, the security system is based on multiple Drupal layers.

The possibility of separation and the system maintenance organization is integrated into the very essence of the system architecture, hereby the presentation part is fully separated from the system code and maintenance parts, and is enforced by the system authorization and modularization. Drupal is constantly being improved by drupal.org associations through the

permanent forums, blogs and conferences. “73 Sessions and 87 BoFs later it's all over and we can emerge from the DrupalCon bubble. DrupalCon London has been an amazing success with a final attendance of 1751. We're delighted to announce that as well as being the biggest European DrupalCon in terms of attendees, DrupalCon London was also a profitable event - investing over £38,000 back into the Drupal Community.” [9]

Many profitable organizations, small and medium size enterprises, contracts Drupal teams in the code improving and the module developments for the business requirements specifications. Drupal is used as a web portal, on-line journals, electronic commerce systems, photo galleries and systems of distance learning. Drupal is fully modular, new designee styles added via modules and themes, that are integrated in the Drupal core or added as contributed themes or modules.

5. PRACTICAL DRUPAL SYSTEM IMPLEMENTATION

Drupal is practical web application used for everything from personal blogs to enterprise applications. Used for the different web sites, blogs, academic journals and conferences, electronic commerce systems, tourism organizations advertisements, the system of the distance learning, Drupal is used for the biggest Web sites.

5.1. Scientific conferences

Web site EDASOL scintific conference.

Basic site information: Drupal versions 6.22, defined content types with CCK , View models used to present the various content types, theme Orange, administration theme Garland, languages: bilingual (serbina and english), 65 built in modules, search engine optimization is done with Drupal SEO modules. [10]

Web site scintific conference ICASUS.

Basic site information: Drupal versions 6.22, defined content types with CCK , View models used to present various content types, theme BlueMaster, administration theme Garland, site is bilingual (serbina and english), 75 built in modules, search engine optimization is done with Drupal SEO modules, Gmap optimization.[11]

5.2. Scientific journals

Basic site Emc-review and Gfpn scientific journals.

Sites inforamtion: Drupal versions 7.7, defined content types with CCK , View models used to present various content types, theme Ellington7 and Desk02, adminstration theme Garland, 40 built in modules, search engine optimization is done with Drupal SEO modules.

Figure 3: [12]

Figure 4: [13]

5.3. Tourisam advertising sites

Basic site inforamtion: Drupal versions 7.7, defined content types with CCK , View models used to present various content types, theme Marinelli, 65 built in modules, languages

(English, Croatia, Italian), built in content managment system, search engine optimization is done with Drupal SEO modules. [14]

5.4. Eelectronic commerce

Demo Drupal pages with sa E-commerce soultions and merchandise details.

Figure 5: [15]

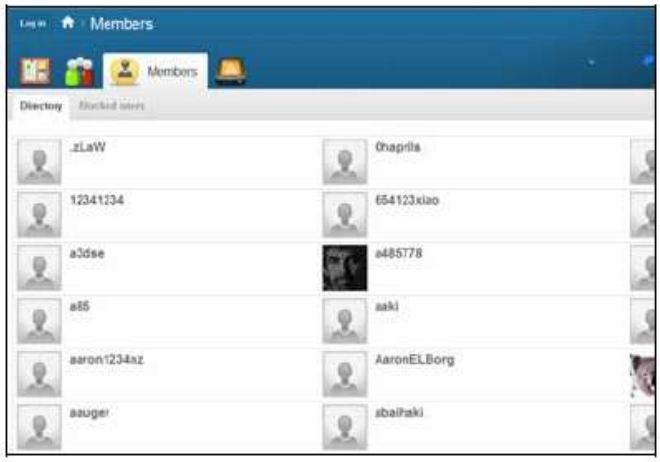
„Messenger bag“ is added and shoping chart as it is followed. Site is built with E-commerce Drupal moules.

Figure 6: [16]

5.5. Social networks

Figure 7: [17]

Organic group: enables usere to operate and maintane specific social group. Every group is organized their own memebers and social groups. Each group can have subscribers, and maintains a group home page where subscribers communicate amongst themselves. Groups may be selective or not. Selective groups require approval in order to become a member, or even invitation –only groups. There are lots of preferences to configure groups as you need. [18]

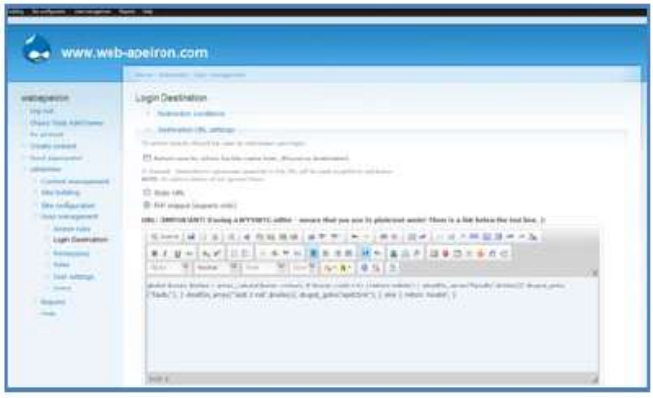


6. THE DISTANCE LEARNING SYSTEM *DRUPAL CMS*

6.1. Logging destination [19]

Login sessions implemented through PHP code:

```
global $user;
$roles = array_values($user->roles);
if ($user->uid==1) { return 'admin'; }
elseif(in_array("faculty",$roles)){ drupal_goto("faulty");
elseif(in_array("ispit 2 rok",$roles)){
drupal_goto("ispit2rok");
else { return 'node9'; }
```



Sessions redirects users to the specific site pages according to the previously defined roles of the system administrator conceptual design. It is possible to specify certain conditions like referring pages or user roles and make the destination depend upon them.

6.2. List of users, rights and filtering users by groups

Access rights are enabled through the checkmark of the individual fields and users groups of within the system permissions. The users are divided into precisely defined groups according to incoming subject or the exams period. Upon completion of the pre-preparation obligations users are moved to the examination group, finishing the testing duties most of the rights are blocked, except checking the result of the examination, polls overviews. Users are required to fulfill different polls “POLL” and leaves comments on the blog so that the whole process is improved are modified.

6.3. CCK – content construkcion kit [20]

CCK and View modules are the crucial part of Drupal system, due to its powers and extended functionality, special attention is focused on their practical value. CCK modules allows user to define content in accordance their own needs, content can be grouped to fulfilled conceptual and technical Web system designee. The key factor is to create the middle level of presentations as connection between raw database contents and node implementations. Hundreds of add-on are available for download for this modules to extends to create the most complex content system

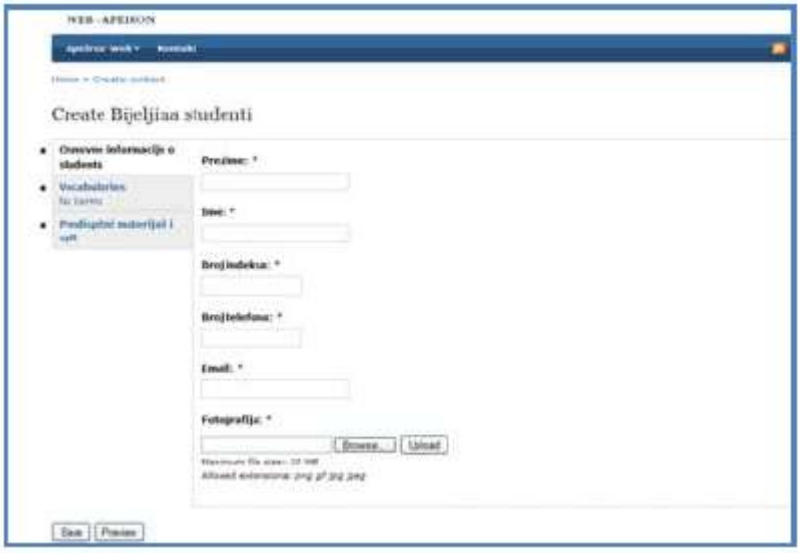
Defined content types for the content Bijeljina students as basic category information about student are: name, surname, telephone number, E-mail, etc.

Bijeljina student content system organizations: The basic information are grouped into category as followed: student's information, preparation's materials, exercises, exams, while adapting modular system implementation is powered by Drupal API system.

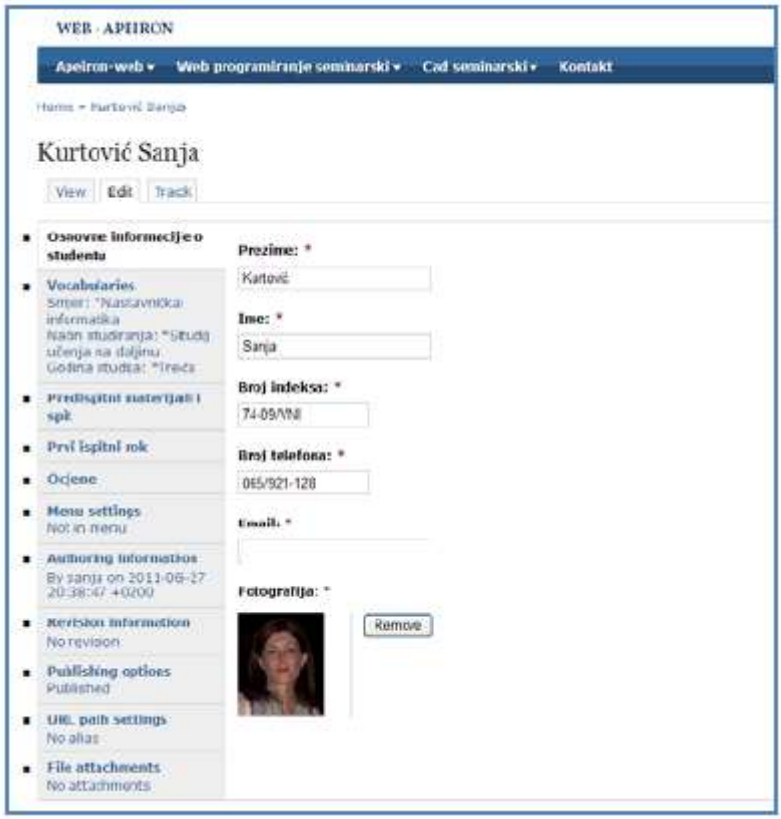
Individual content presentation is student content type that has exactly the fields I need in accordance with the system requirements and presentation practical goals. Photos preparing for the presenting format: Defining "Preset - pre-defined elements" using the "Image cache" module to adapt the photo in a format requested, rendered through the Image cache actions. We previously defined the pictures formats (.jpg, .png, .gif) precisely defined size (100 x 100 px) and frame of 2px, frame color, using the "Define the canvas" presets. The implementation is shown in the CCK, photograph is presented on the rendered Web page.

6.4. CCK menu implementation

Student creates content in order to log onto the system, collect pre-exam materials and gain information which for exams preparations. Student uploads pre-exam solved homework and questionnaires. Information are available for students to edit or delete.



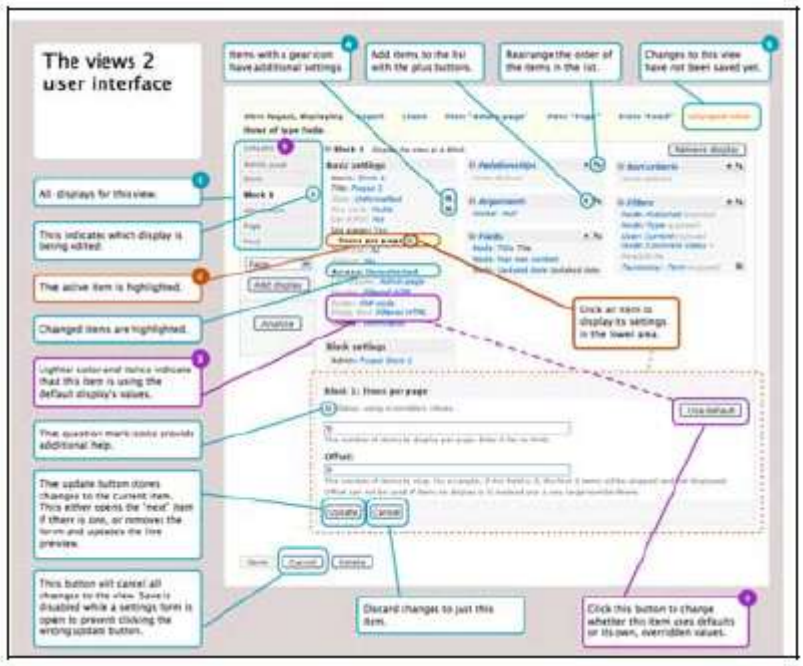
Information available for administrator or professor for defined subjects:



Field editing methods in construction phase:

6.5. Content presentation using view module

Drupal is a stable platform based on relational databases (MySQL usually also have other types supported) while View modules is used to filter information out of the box and preset them on site pages. Drupal Help advance modules is integrated into View modules, shows how administrator can configures and present the above information in accordance with parsing and the system modularity.



Views interface interpretation (basic concepts):

- All displays in view: Every view has a number of displays which represent where output will be placed (Number 1)
- The active items is highlighted: When you click on the link for an item, a form will open up (Number 2)
- Lighter color and italic indicate that this item is using the default display's values. (Number 3)
- Items with a gear icon have additional settings - Some items, particularly styles, have additional settings. (Number 4)
- Changes to this view have not been saved yet - You can safely leave a view page to go and do other things. If you come back, the view will still be there, stored in a cache. (Number 5)

Views interface basic displays

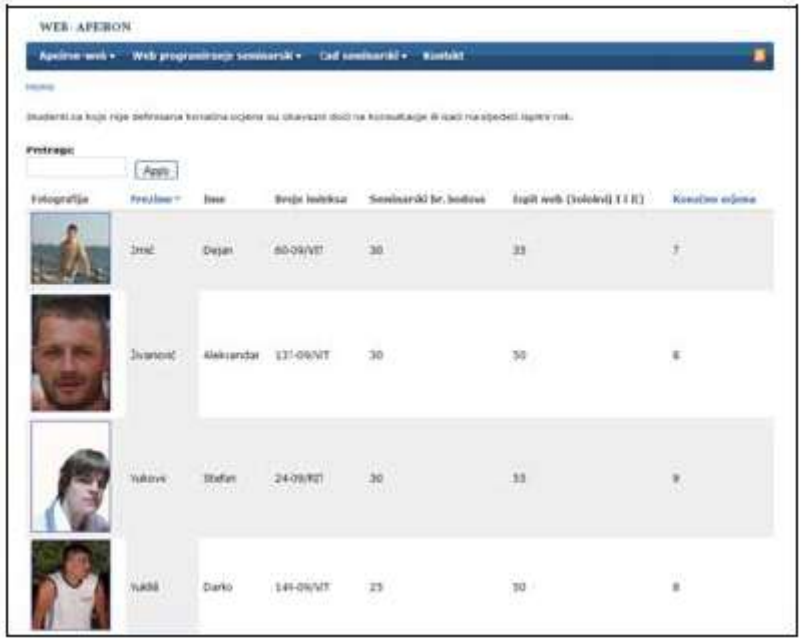
- Fields are the individual pieces of data being displayed.
- Relationships allow you to expand the query to include objects other than the base query. This is actually made more difficult to understand by the fact that Views actually includes a few relationships by default, and doesn't tell you they're there.
- Arguments are input. While they often come from the URL, they don't always so please don't be shocked when they don't
- Filters are used to reduce the data set that Views provides. That is to say, without any filters applied, Views will return all of your content. You don't want that, so at least some filters must be used.
- Displays tell Views where the output should go. By adding a display to a View, you can have your view appear as a page, or as a block, or even as an attachment to a different display on the view.

- Sort criteria determine what order the records are retrieved from the database and displayed in.

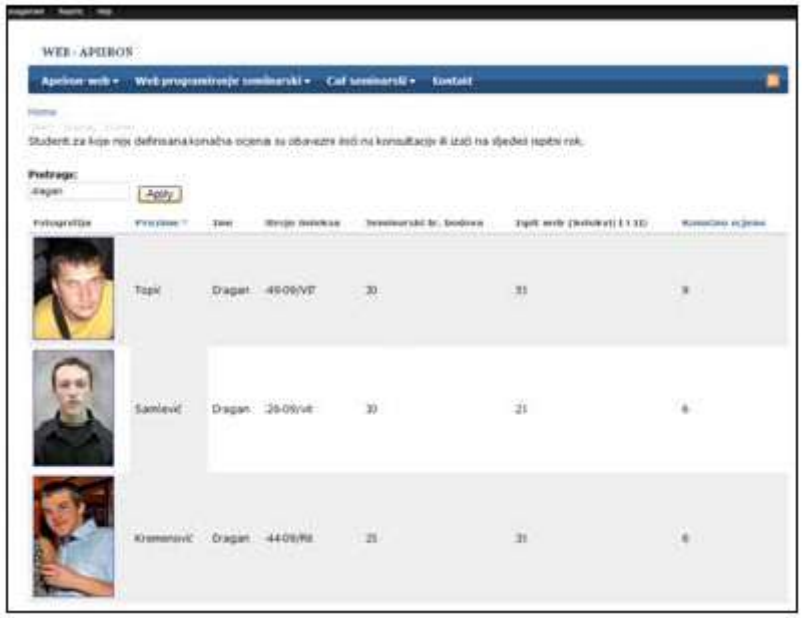
During Drupal View installations process, other models are required to be installed to enable View integral tool modules fully functions. It is mandatory to install CTool as additional module to implement .inc files, AJAX responder, object caching, models dialogs.

6.6. Views in www.web-aperion.com system [21]

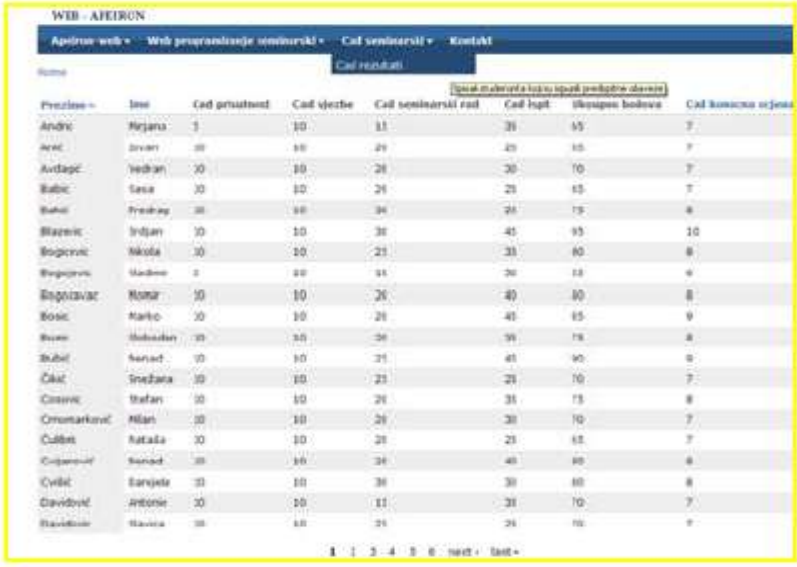
Web programing exams results are filtred from raw database, definded by CCK with special desigen of every data as construction field, View modules with database query represents results, and API does page finally rendereing.



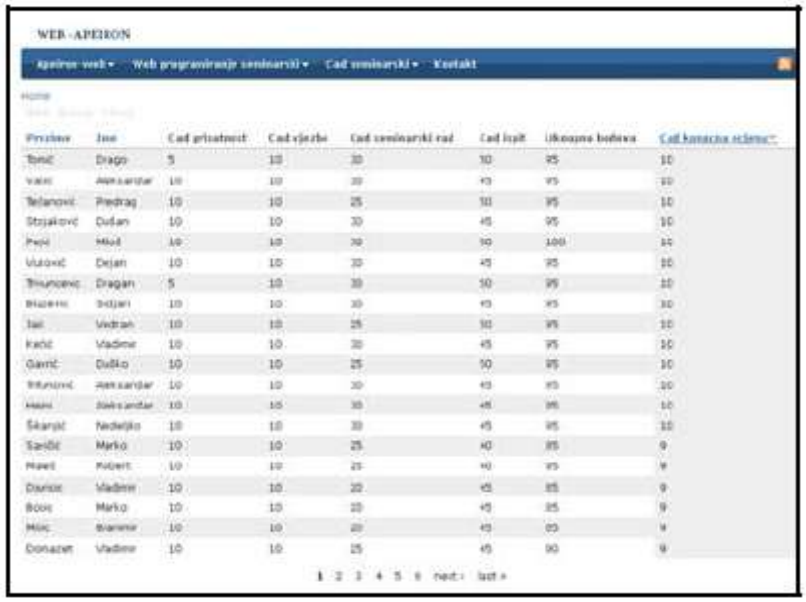
Search result of Dragan as a name, results are presented in the in the below specified web pages. Photograph selections enables student to edit profile details, and leave comments inside specific Drupal nodes.



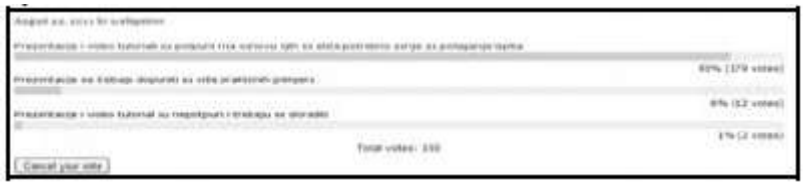
Exam results CAD-CAM-CIM presented in tabular View:



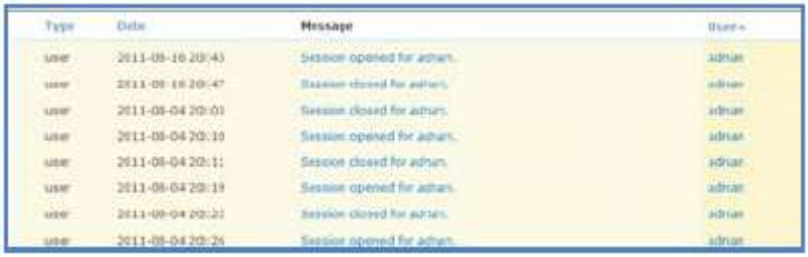
Sorting criteria is a final exams score:



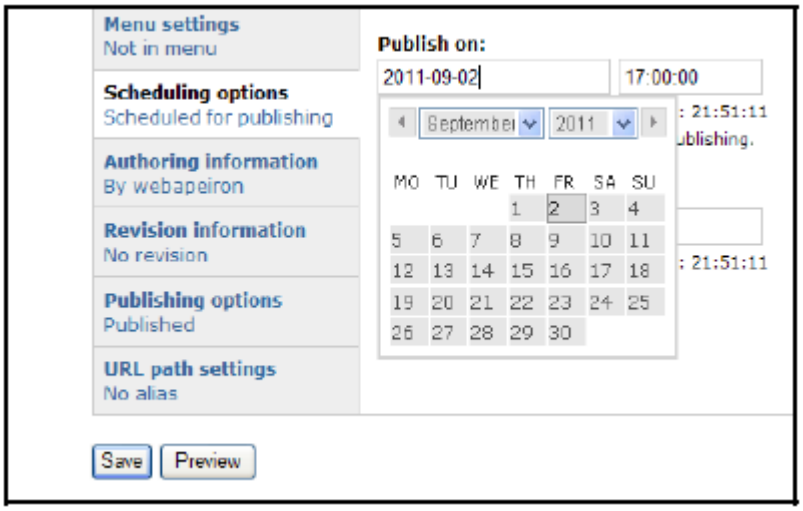
During the work process user permissions are control by system administrator, total time spent on systems, time spent exploring certain content and video presentation, different system's session, filling the questionnaires, are recorded accurately, illustrating the student's system or subject activity. Polls filled by students are the feedback system.



Session and login time are controlled for every system user:



Test time trigger in a time interval X using Scheduler modules:

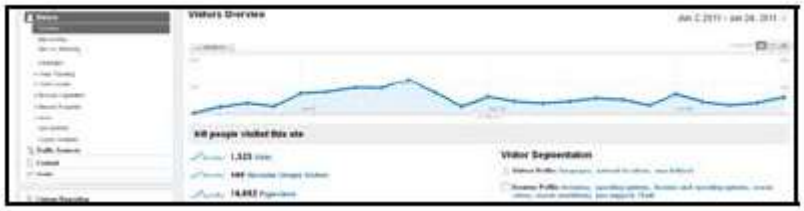


Closing the session in a given time interval Y:

Modules used for this session are “Data”, “Scheduler” and C-Tool modules. [22]

6.7. Google analitic

Google analytic module as final system feedback [23]



7. CONCLUSION

Open source web based system with community support, integration of members to build stronger associations, will be one of the key factor to enter into new stage, choosing highly modulated web solutions for small and medium sized enterprises. Adaptability, code adjustment, numerous modular solution will be competitive factor that will emphasize integrity and adaptability with huge knowledge bank and alternative module options (Drupal system has 8458 modular solutions, August 2011.). Commercial support, the ability of management to notice importance of stuff education, to create the software in the fast and efective way, cost effectiveness and implementation simplicity, IT teams preparation to applying those systems and adopt to our needs is continuous and endless competitive factor and it should be our long term strategy. Based on our innovation desire, response to the constantly changing environment, our flexibility, analitic system understanding in the space of continous upgrading and changes, stigmergic processes with open source software solutions in the incoming decades will be the key factor in the web information systems development.

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[14] http://www.lazagara-vlasic.net/
[15] http://demo.commerceguys.com/dc/catalog/
[16] http://www.drupalcommerce.org/
[17] http://www.popsugar.com/community/groups
[18] http://drupal.org/project/og
[19] www.web-apeiron.com/****
[20] http://drupal.org/project/cck
[21] http://www.web- apeiron.com/admin/build/
[22] http://drupal.org/project/ctools\
[23] https://www.google.com/analytics/

Diffusion of innovation and adoption of workflow management system in small enterprises

Metka Zemljič
Maribor, Slovenia

Abstract: **Projects are evaluated from different perspectives, usually time, financial and quality perspective. There are many tools that project manager can use to help with the overview of tasks, communication process, progress of project etc.**

Based on a case study we describe how diffusion of innovation – introduction of workflow management system happens in small enterprise, which brings more control in different areas, as it brings some disadvantages. We define specialties of adoption process and what consequences does innovation bring. In described case was innovation decision authority driven. New workflow management system was designed by extreme programming, which means progressive design of workflow management system based on needs of workers and project managers. As we analyze the whole process, we also suggest ideas for further improvements.

1. INNOVATION AND DIFFUSION PROCESS

Innovation is idea, practice or object that an individual or a group recognizes as new.

Rogers [1] describes innovation as process of introduction of activities, which vary from one firm to another. Innovation is application of new ideas to products, processes or any other aspect of firm.

Process, in which an innovation is communicated through certain channels over time among the members of social system, is called diffusion. [1] Messages in communication are about new idea. Diffusion could mean planned and/or spontaneous spread of new ideas.

Rogers [1] defines four main elements in the diffusion of innovations:

- Innovation (idea, practice or object recognized as new by individual or other unit of adoption)
- Communication channels (means, which transfers messages between individuals)
- Time (length of time required to pass through the innovation-decision process, rate of adoption or relative speed with which an innovation is adopted)
- Social system (set of interrelated units that are engaged in joint problem solving to accomplish a common goal).

Individuals go through innovation-decision process, which means individual goes through different stages before adopts or refuses innovation. Five main steps are knowledge of an innovation, persuasion (the formation of an attitude toward the innovation), decision to adopt or reject implementation and use of the new idea and confirmation of this decision. [1]

1.1. Technology innovation

Diffusion of innovation is often understood as technology innovation, since societies were and are able to benefit from evolutionary development through the process of technology transfer. [2]

We can see the interaction between innovation and diffusion in various stages of technological development.

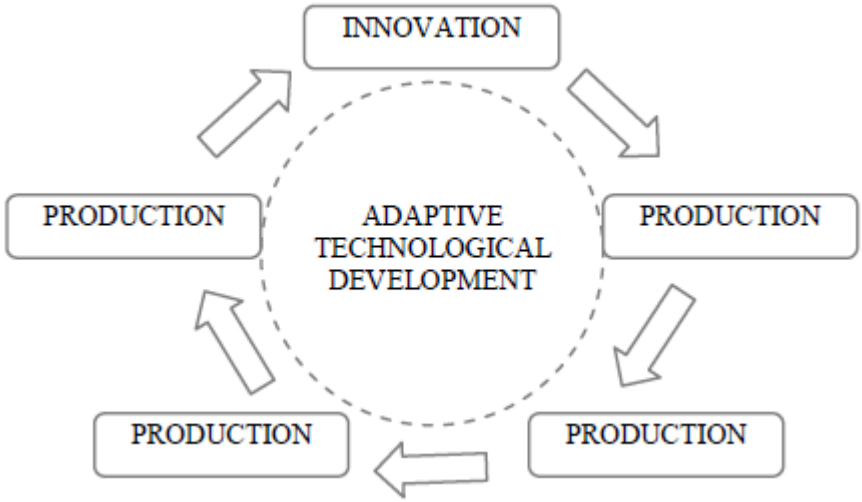

Figure 1: Various stages of technological development: interaction between innovation and diffusion [2]

1.2. Innovation in organizations

In organizations there usually prevails one of two types of innovation decision: collective or authority innovation-decisions. Collective decision is made by all individuals in group, authority decision on the other hand is usually made by few individuals who have the power or position to influence.

Implementation does not always directly follow the organizational decision to adopt innovation. [1]

Organizational innovation process consists from five main stages, similar to the process of innovation-decision by individuals:

- Agenda-setting,
- matching,
- redefining or restructuring,
- clarifying,
- routinizing.

However, innovation process is much more complex then innovation-decision process by individuals. Implementation typically involves a number of individuals who play a role in innovation-decision. [1]

2. CASE STUDY: DESIGN AND ADOPTION OF WORKFLOW MANAGEMENT TOOL IN SMALL ENTERPRISE

Interpretative case study, unstructured interview with management and analysis of process were used for the survey. Our main objective was to identify the diffusion of innovation process with use of agile methods for software design.

Case study analyzes process of innovation diffusion in small enterprise from Slovenia, BuyITC d.o.o. Firm's core business is design of software and internet solutions, like web portals, intranet, and other business applications. It has 12 employees, who work on physically same location; however there was a need for better workflow management recognized. Project manager organizes work and communication between customers, application designers, programmers, graphic designers and coordinates timeline with leadership. Projects are evaluated from different perspectives, usually time, financial and quality perspective.

There were many existing tools for task and workflow management identified, which did not meet all the managements' needs: compatibility with existing time attendance application, adequate task management system for specific tasks, effective control over workflow and reporting.

Diffusion of innovation was recognized on two levels. First is the level, where decision about innovation was made by firms' management. On second level, design of new software for workflow management was interlaced with diffusion of innovation process among individuals (employees). Due to lack of adequate software and needs of employees, decision to adopt the innovation was made.

2.1. Organizational innovation process

Innovation process was driven by authority innovation decision, although also some employees, especially projects managers, recognized the need for a tool for better workflow management. Management went through stages of innovation process [3]:

- agenda-setting,
- matching,
- redefining/restructuring,
- clarifying, and
- routinizing.

The process was interlaced with design and use of new software.

2.1. Innovation-decision among individuals

Life cycle of extreme programming [4], method used for design of the new software, consists from five stages:

- Exploration phase,
- Planning phase,
- Iterations to release phase,
- Productionizing phase,

- Maintenance phase,
- Death phase.

The "iterations to release phase" constitutes of many repetitions and testing of the system. In this phase all the employees actively participated. Although innovation-decision was authority driven, decision for use of the software in this phase was optional. Therefore, diffusion of innovation process occurred. We could classify all the employees in four of five Rogers's adopter categories. [1] Innovators and early adopters were the most active and also contributed the most in the process. Late adopters were last to use the application. Some employees also rejected the use of application in their decision process, but were invited to actively suggest necessary improvements. This raised the level of motivation among all employees, which contributed with many innovative changes.

In this phase most modifications to firs version of application were made, especially to uphold the needs of certain jobs. Compared to previous project, the result was better final product at the end of design phase.

3. CONCLUSION AND FUTURE WORK

Through case study we introduce a different perspective of innovation diffusion. The design of new software is interlaced with diffusion of innovation on different levels. New software was demand-induced for the needs of better workflow management. Extreme programming as an approach of software design was proved as efficient approach, whereas it brings quality software, better user experience with final version of product, with reasonable costs.

Through innovation diffusion among employees (future users of the software) many improvements of first version of the product were made. Opportunity for participation also motivated late adopters and those who were firstly not willing to use the software.

We conclude that similar process would happen with clients, if firm would participate with such approach in "Iterations to release" phase. In order to maintain similar results, this would require clients to provide their own testing groups. The approach would also require definition of protocols and efficient communication to achieve satisfactory level of efficiency.

The approach needs further study, especially analysis of case studies where firm cooperates with clients in "Iterations to release" phase.

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Communications in Distributed Software Project Management

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Abstract: **Software engineering and project management today are using advantages of modern communication technologies, with processes in distributed working environment. This paper addresses research and practical issues in the domain of distributed software development and management and particularly in communications area. We propose an integrated and layered model of all relevant aspects of distributed software project management communications, suitable for performance measurement and teaching alignment purpose.**

1. INTRODUCTION

We are facing the fact that today software is developed by teams that are, for large projects, usually physically dislocated. Terms that are used for this type of software development organization are global software development, distributed software development, teamwork software development etc. Distributed software engineering and project management are facing many issues, categorized as general project management issues, specific to software development and particularly addressed to teamwork and distributed development.

Many years of practical work, issues, solutions and research resulted in sublimation in the form of standards as general accepted approaches to certain working areas. Project management (PM) standard framework include PMBOK guidelines [1], while more precise it is defined in worldwide accepted PRINCE2 body of knowledge. At the other hand, software engineering body of knowledge gives directions in SWEBOK [3].

Some of software project management best practices include [4]: accurate project metrics and measurements, accurate time/cost estimation, project management and software development methodology, project status reporting, automated tool usage, good communication with client, user involvement, adequate understanding of customer problems and requirements, team leadership, participation in decision making, good communication among project staff, morale boosting rewards and performance appraisals.

This paper aims to present most important issues regarding communication in multi-site development working environment. It will present layered model of all structures needed for communication and specially it will present data flow structures regarding PRINCE2 document templates that could be used as basis for standard data format in information exchange during software project management.

2. RELATED WORK

Research in the field of distributed project management and distributed software engineering (i.e. global software development [5]) is recently very productive with general

research trends and directions [6] and presenting experiences from diversity of global projects [7]. Results are related to measurement and monitoring performance [8], comparing performances with face-to-face communication [9] and improving performance of distributed teamwork.

Distributed teamwork software project engineering and management are facing issues such as: technical problems of communication [10], coordination [11], communication speed [12, 13], knowledge sharing [14, 15], group awareness [16] and adjustment of heterogeneous teams [17], creativity and quality [18]. Special issues are examined regarding communication practices in different software development methodologies, such as Extreme Programming [19].

As one of solutions to these issues, specialized software ("groupware") is developed to be used for organizing, communication and integration of teams and their work in distributed working environments. They support acitivities such as meetings [20], organizational learning [21], self and peer assessment [22], integration of process and project management [23] for collaborative multi-site development [24].

3. RESULTS

3.1. Layered communication model for distributed software project management

As one of results of this paper, we present layered communication model, that integrates different aspects of communications in distributed software development and project management.

This model consist of several layers that enable communications, form a communication structure and enable functionality of communications. It is based on general structure of information system (hardware, software, lifeware and orgware).

TABLE 1 – Layered communication model for distributed software project management

Layer	Sub-Layers
Orgware	Communication protocols and standards
	Business rules
	Project management methodology
	Development frameworks
Lifeware	Roles
	Responsibilities
	Constraints
Software	Communication software
	Groupware
	Project management software
	Development environment
Hardware	Telecommunication equipment
	LAN equipment
	Workstation hardware equipment

In this model, hardware presents technical equipment needed for personal and teamwork software development and communication between teams, software enable development, project management and communications, lifeware present set of working roles of individuals within teamwork and project (like developer, project manager, team leader etc.) and orgware present procedures and methodology for project management.

Proposed model presents a basis for teaching process in this field, with systematic presentation of knowledge areas. It also presents a framework for performance evaluation of relevant aspects of communications in distributed software development process and software project management.

3.2. Orgware and Lifeware

Regarding data that are used in project management, more precise prescription regarding document templates and procedures gives PRINCE 2 methodology. Based on this methodology and document templates, business process model (BPM) has been presented (Fig. 1).

This BPM presents workflow, data flow, data stores and basic work roles (lifeware) of the model that are responsible for each activity, data flow and data store. These work roles are: User, Client, Portfolio Manager, Team Leader, Project Manager and Team Member.

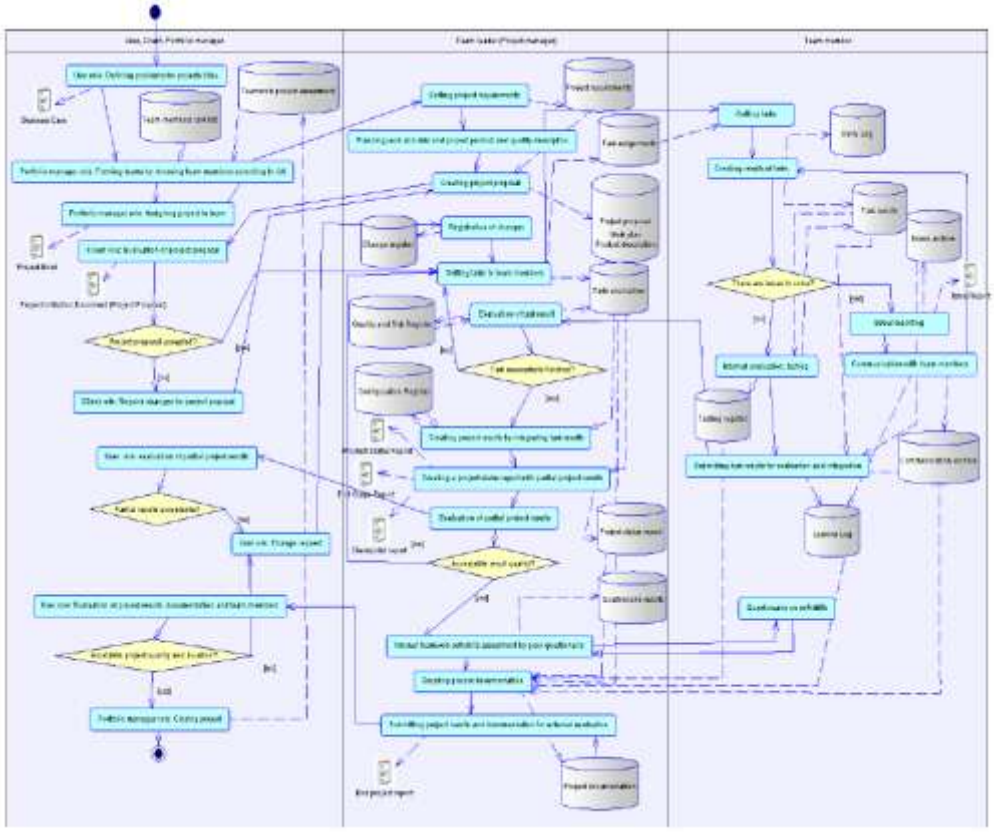

Figure 1: BPM according to PRINCE 2 methodology [25]

3.3. Software

Software support consist of basic communication software (network system software, applicative software such as e-mail, messangers etc.), project management software, groupware tools and software development environment.

Basic knowledge areas in project management as well as basic PM activities should be covered by project management software support. Knowledge areas define important data structures and group of processes require appropriate software functionality.

TABLE 2 – Project management knowledge areas and processes

Basic knowledge areas [1]	***Additional knowledge areas[26]***
Scope	Resources
Time (duration)	Conflicts
Costs	Changes
Quality	***Groups of processes [27]***
Human resources	*Initiation*
Communications	*Planning*
Risk	*Execution*
Procurement	*Control*
Integration	*Closing*

Groupware software as a tool need to support:

- coordination of activities, meetings and setting/getting assignments
- evaluation of results
- integration of work
- knowledge sharing and organizational learning
- social networking and enhance teamwork cohesion
- quality assurance, self and peer assessment
- enhancing creativity.

Recently improved software development environments (like Microsoft Visual Studio 2010) have enhancements in functionality with modules that enable groupware and project management with distributed teamwork. This way software development environments are integrated with previously developed tools - groupware and project management software.

Some of these integrated systems are using web sites or file servers for sharing code and other artifacts during distributed software development and project management.

3.4. Communication

Figure 1. shows communication between all working roles during project activities, from initiation to finalization in BPM according to PRINCE 2 methodology.

In this model it has been shown that communication between working roles are of several types:

1. Initiation of activity - after completion of one activity, another activity (assigned to another role) can be started.

2. Reading data from data store - data stores are assigned to specific roles and some activities of other roles need to read data from data store that is assigned to another role. Permissions to access data are needed to be defined. Obviously, writing to data stores is restricted only to data store owners and other roles are not allowed to access these data stores for writing new/updating data.

Technology solutions support this communication activities by:

1. Business process management systems - enable orchestration of activities that are processed parallely at distributed locations. Starting one activity depending on another (at some other location) is managed by these systems.

2. XML and web services - Data that are to be exchanged can be in informal, semistructural or structural form. It is obvious that there is no direct access to data stores of other working roles, but only using services (like web services) that enable access to previously prepared and deployed data in XML form.Widely accepted standard format for data exchange is XML. It is recognized from all software development environment vendors and database management system developers, so it is most appropriate to structure and exchange data in this format.

4. CONCLUSION

This paper gives a brief overview of knowledge areas and issues in the field of communication within distributed software project management.

Recent research show most communication experiences, global trends and issuess that are addressed and solutions that improve these aspects. Special software development methodologies bring specific challenges in communication, such as Extreme Programming, where time-to-deliver is crucial and all unnecessary administration and time consuming is avoided.

We presented an integrated communication layered model for different aspects of communications within distributed software project management. These layers are organized generally as a structure of an information system - orgware, lifeware, software and hardware. Particularly, software needs are addressed from functional aspect.

Special concern has been given to business process model based on PRINCE 2 methodology for project management, where data flow present communication between working roles in project management. It has been shown that communication types are initiating of activities and reading data stores. Technology such as business process management systems, XML and web services are described as support to these communication types.

Future work in this field is planned to be in detailed presentation of data structures of data flows and data stores, projecting databases and XML structures, in aim to enable development of specific software that could integrate all software modules for the needs of distributed software development and project management process.

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Transformation of coordinates from local to global coordinate system and visualization of data by using Google Earth

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Abstract: **Detail surveys measured on the local level use local coordinate systems. To make the data obtained from such surveys compatible with Google Earth, a geodetic transformation is required – from local Gauss-Krüger coordinate system to global WGS 84 coordinate system. Goal of this paper is to describe a computer program developed to generate KML document from surveying data, so that it can be visualized with Google Earth.**

1. INTRODUCTION

Google Earth is a free computer program which uses a virtual globe to map the Earth using satellite and aerial imagery. Google Earth is a virtual globe that represents the whole planet and uses global GPS coordinate system WGS 84. On the local level all data obtained from land survey use local (e.g. Gauss-Krüger) coordinate system. It is essential to convert data from local to global coordinate system. Doing so will enable user to view their data in any application which is compatible with KML [1] format. This application will use Google Earth [2] for the visual representation of exported objects.

2. BACKGROUND

2.1. Coordinate Systems

Data can be classified into two broad categories: local referencing data and global referencing data. A local referencing datum is a datum which best approximates the size and shape of a particular part of the Earth's sea-level surface. A global referencing datum best approximates the size and shape of the Earth as a whole. These data is not intended to be used as a good approximation of any particular part of the Earth. Rather, their application lies in mapping projects that are more global in nature (Picture 1).

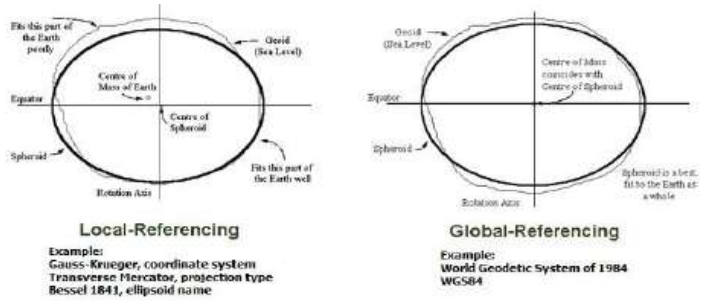

Figure 1: Difference between local and global referencing

In Serbia local coordinate system utilizes Gauss-Krüger projection. Serbia has direction north to south what makes it ideal for this type of projection (Picture 2).

Also known as Transverse Mercator, this projection is similar to the Mercator except that the cylinder is longitudinal along a meridian instead of the equator. The central meridian is placed on the region to be highlighted. This centering minimizes distortion of all properties in that region. This projection is best suited for land masses that stretch north–south. The Gauss-Krüger (GK) coordinate system is based on the Gauss-Krüger projection.

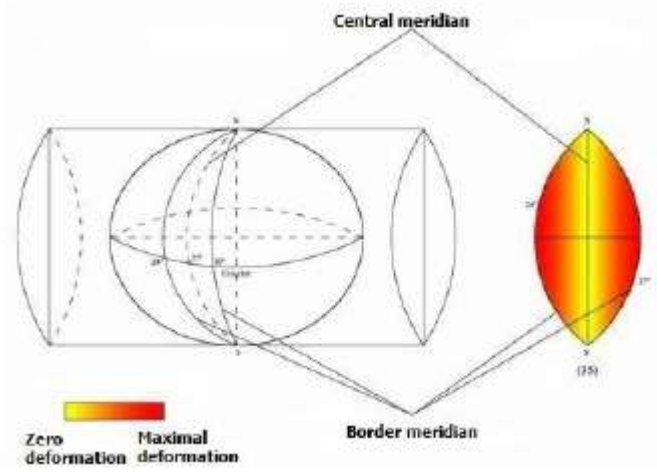

Figure 2: Gauss-Krüger projection

The country is divided in three zones each three degrees wide, roughly from 19 to 23 degrees longitude (Picture 3).

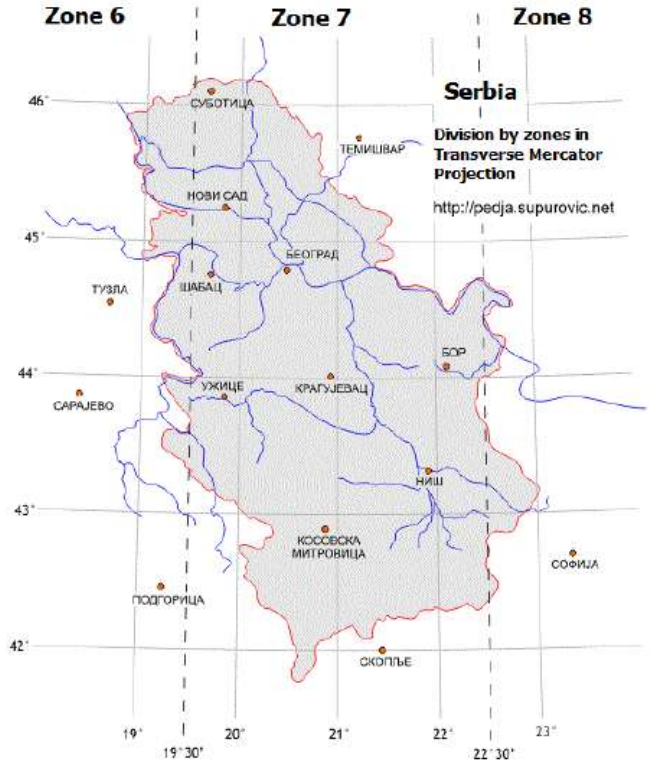

Figure 3: Gauss-Krüger projection for Serbia with zone division

The World Geodetic System datum is the only world referencing system in place today (Picture 4). WGS 84, the latest revision of World Geodetic System, is also the default standard datum for coordinates used in recreational and commercial GPS units. Google Earth uses GPS coordinate system WGS 84 for latitude and longitude and Earth Gravitational Model 1996 (EGM96) for height. WGS 84 is a coordinate system based on the GRS 80 (Geodetic Reference System 1980) ellipsoid, an ellipsoid which approximates the Earth as a whole in the most detail.

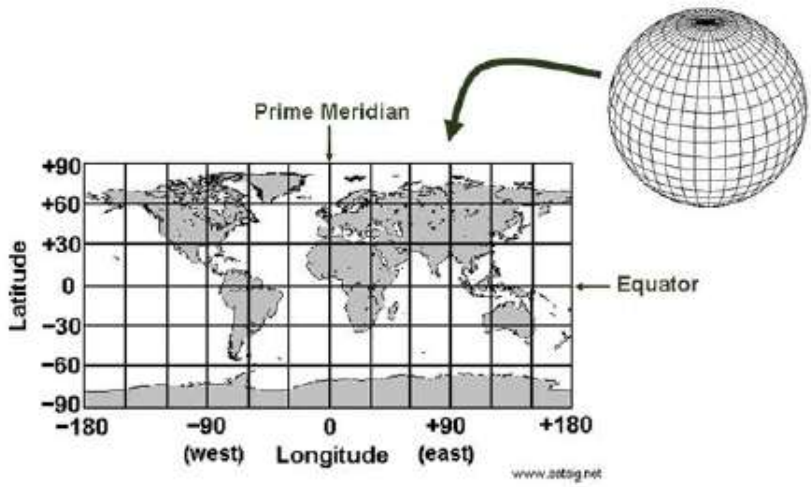

Figure 4: World Geodetic System layout

In order to transform coordinates from regional surveying points to WGS Helmert transformation can be used.

2.2. Transformation algorithm

The Helmert transformation (named after Friedrich Robert Helmert, 1843–1917, also called a seven-parameter transformation) is a transformation method within a three-dimensional space. It is frequently used in geodesy to produce distortion-free transformations from one datum to another using:

$$X_T = C + \mu RX \quad (1)$$

Where:

- X_T is the transformed vector
- X is the initial vector

The parameters are:

- C is translation vector, it contains the three translations along the coordinate axes
- μ is scale factor, which is dimensionless, and as it is usually expressed in ppm, it must be divided by 1,000,000
- R is rotation matrix. It consists of three axes (small rotations around the coordinate axes) rx, ry, rz. The rotation matrix is an orthogonal matrix. The rotation is given in radians

The coordinates of a reference system B are derived from reference system A by the following formula:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^B = \begin{bmatrix} c_x \\ c_y \\ c_z \end{bmatrix} + (1 + s \times 10^{-6}) \cdot \begin{bmatrix} 1 & -r_z & r_y \\ r_z & 1 & -r_x \\ -r_y & r_x & 1 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^A$$

Or for each single parameter of the coordinate:

$$X_B = c_x + (1 + s \times 10^{-6}) \cdot (X_A - r_z \cdot Y_A + r_y \cdot Z_A)$$
$$Y_B = c_y + (1 + s \times 10^{-6}) \cdot (r_z \cdot X_A + Y_A - r_x \cdot Z_A)$$
$$Z_B = c_z + (1 + s \times 10^{-6}) \cdot (-r_y \cdot X_A + r_x \cdot Y_A + Z_A).$$

Projection parameters for Serbia		
Gauss-Krüger projection zone number 7		
Parameter	***Symbol***	***Value***
Semi major axis	a	6377397.155m
Inverse flattening	1/f	299.1528125448
X-axis rotation	R_x	0°00'04.910687''
Y-axis rotation	R_y	0°00'03.003308''
Z-axis rotation	R_z	-0°00'11.094034''
X-axis translation	Δx	-534.787m
Y-axis translation	Δy	-133.682m
Z-axis translation	Δz	-501.482m
Scale factor	R_m	-1.15673966 ppm

3. COMPUTER PROGRAMMING

The computer program was developed using Java, a modern object-oriented programming language. Java is portable, meaning programs developed with the Java programming language can be run on any computer that supports the Java platform. Java is supported by all major PC operating systems, as well as many web browsers, mobile internet devices and mobile [4].

This program was developed using integrated programming environment Oracle JDeveloper 10.1. [5] This environment was chosen for development because it covers full development lifecycle: design, coding, debugging and optimization. For database manipulation programming environment of choice was Oracle SQL[6] Developer. All data that the program is using is stored in Oracle 9i database. Use of development tools and database management system from one software manufacturer ensured compatibility and fast and relatively trouble free development of application.

The computer program has two functions. The first is to generate polygon that represents single cadaster parcel. User chooses cadastral parcel from the list of all parcels for the given

cadastral municipality. When the chosen parcel is marked user clicks the button “Geo-complex export” (Picture 5).

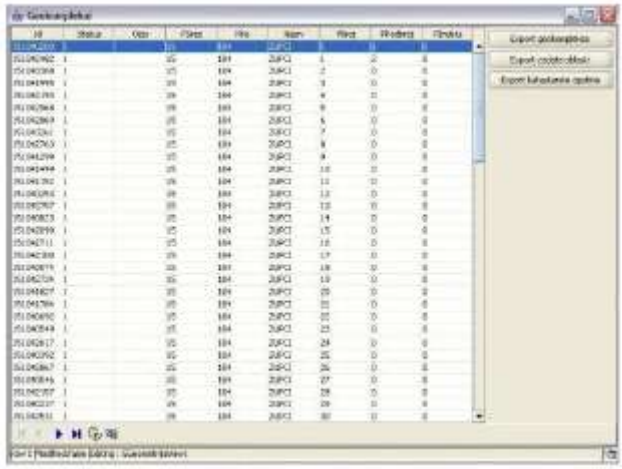

Figure 5: List of geodetic parcel’s for one municipali

Once the action is invoked, the program generates KML file and opens it with Google Earth (Picture 6).

Figure 6: Graphic representation of exported geodetic parcel in Google Earth

The second function is to generate polygon that represents cadastral municipality. This action is invoked by clicking on the “Cadastral municipality export” button, when desired cadastral municipality is selected from the list (Picture 7).

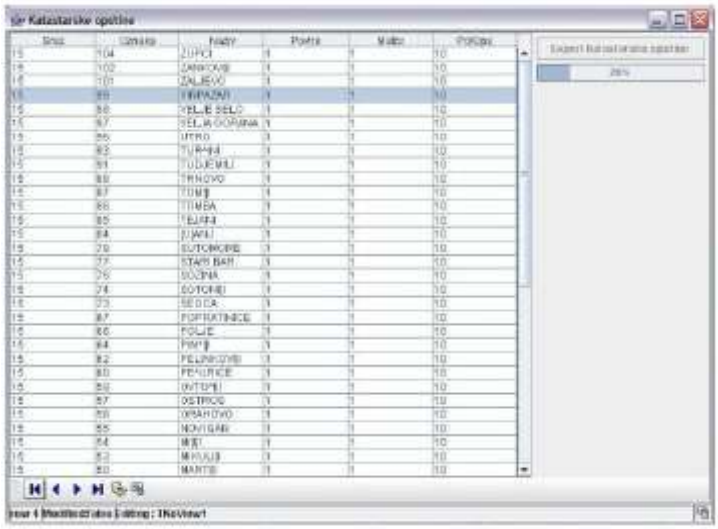

Figure 7: List of cadastral municipalities

Every cadastral municipality is made of a number of parcels that often can number several thousands. This can result in extremely big number of coordinate transformations. Implementing progress bar is absolutely necessary, so user can be informed about process progress.

The result of these actions is a number of single polygons that together represents the whole municipality (Picture 8).

In the tree structure on the Google Earth user interface, user can choose any parcel or simply can click on the graphical representation in the main window of Google Earth users interface.

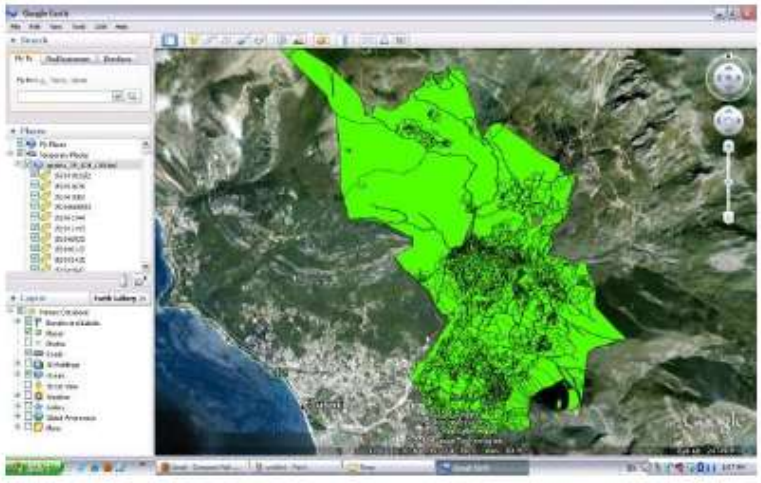

Figure 8: Export of all geodetic parcels for chosen municipality and graphic representation in Google Earth

The result of both actions is creation of a file in the file system of the user's computer.

Both functions use the input data to create a KML file, which includes the new WGS 84 (transformed) coordinates and formatting details. Google Earth uses the KML files to superimpose the data on top of its aerial imagery.

3.1. Java classes of interest used in the application

This class is responsible for the actual coordinate system transformation. Input parameters are coordinates in Gauss-Krüger system. After transformation output parameters are coordinates in WGS 84 system.

Once transformed these values are written in as XML tags using DocumentBuilderFactory class. This class defines a factory API that enables applications to obtain a parser that produces DOM object trees from XML documents. [6]

The COORD class encapsulates all methods related to Earth coordinate transformations. It can transform Earth coordinates between a huge number of Earth data, and it can transform from/to Gauss-Krüger coordinates. [7]

SwingWorker is an abstract class to perform lengthy GUI-interacting tasks in a dedicated thread. [8]

3.2. Future enhancements

There are two areas on which current application can be improved. The first is the interaction with user, the second is data representation.

User interface which would enable configuration of colors for cadastral objects that are generated and displayed could be implemented.

Second, if suitable data can be obtained, KML multi-geometry polygons can be generated. These polygons could represent not only the outline of cadastral parcel; they could represent built objects on it and other major characteristics.

Additional information can be displayed using KML balloon in Google Earth; for example, the size of parcel, name of the owner and other information of interest.

4. CONCLUSION

WGS is a globally accepted coordinate system readily available to wide range of users. On the other hand, Gauss-Krüger coordinate system is used mostly by small number of expert users for specific purposes by specific software. Therefore this software bridges the gap between these two groups.

KML format, which this software uses for generation documents, is used by a number of different GIS software solutions so it can be easily used for data exchange between them.

This program is not intended for precision use. It enables users to quickly see the cadastral objects and relations of them to other objects as well as relation to the terrain in Google Earth or other compatible KML software.

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