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Preface

This special volume contains selected papers of the Conference „Modern Enterprise: Management – Engineering – Computing“ in the framework of the TEMPUS Project “Curriculum Development Master Study Mechatronics Management in Kosovo (MSMMK) – JEP-41170-2006” at the University for “Business and Technology – UBT” in Prishtina, Kosovo, November 6 and 7, 2008. This event was organised according to the decisions of the “International Federation of Automatic Control – IFAC“ to cover the whole field of control including all peripheral areas.

The contribution of P. Kopacek (IHRT – TU Vienna) presents the results of a BMVIT study „ Robots in Austria“. It was previously published in Vol. 1/2009 of this Journal.

The paper of A. Pajaziti, Sh. Buza und I. Gojani of the University Prishtina „Cost Oriented Robots for Kosovo“ presented an overview on the state of the art on robotics in this country. By means of two case studies from Small and Medium Sized Enterprises (SME`s) in Kosovo the authors discuss how a successful robot implementation could be realised.

M. Chivarov et.al (BAS, Sofia) describes a low cost robot (Robco Phoenix) developed in cooperation with Vienna University of Technology. This robot is suitable for distinct applications in SME`s.

An insight in industrial oriented robot research and education at UBT gave A. Dermaku und E. Hajrizi. A mechatronic laboratory was installed in the framework of the TEMPUS project mentioned above. There is an increasing interest of the local industry for common projects.

The two last papers deal with peripheral subjects. L. Stapleton (Waterford Institute of Technology – WIT) gave an overview on technology driven innovations in Ireland and suggested some results for Kosovo. Virtual companies imply a security risk for data are was topic of A. Kealy und F. Keliher also from WIT.

P. Kopacek

Cost Oriented Robots for Kosovo

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Received January 7, 2009

Abstract - *The cost of developing and operating control and automation systems is a crucial factor of productivity and competitiveness for a number of applications in manufacturing plants, quality control systems and robotics.*
This paper has been focused on practical use of technologies that provided significant cost reduction in operating automated systems for a variety of industrial applications and buildings/facilities operations in Kosovo.
Topics that have been discussed were as following: key technologies reducing cost of automation systems; industrial applications of variety technologies, such as smart devices, wireless sensors and control systems, field robots, etc.; cost reducing engineering strategies as well as simulation of manufacturing systems and processes form cost estimation.

Key words: *Robots at SMEs, Manufacturing Automation, Cost Oriented Automation*

1 Introduction

The importance of automation in the process industries has increased dramatically in recent years. In the highly industrialized countries, process automation serves to enhance product quality, master the whole range of products, improve process safety and plant availability, utilizes efficiently resources and lower emissions.

The greatest demand for process automation, in general is in the chemical industry, power generating industry, and petrochemical industry; the fastest growing demand for hardware, standard software and services of process automation is in the pharmaceutical industry.

The starting points in assessing the future needs for automation are, on the one hand, global development and economic trends, and, on the other, the way in which they are reflected in the development of society and the economy (Sirkka-Liisa, Jämsä-Jounela., 2007).

Cost Oriented Automation promotes cost effective reference architectures and development approaches for production and transportation that properly integrates human skill and technical solutions, includes shop floor production support and decentralized process control strategies, addresses automation integrated with information processing as well as automation of non-sophisticated and easily handled operations for productive maintenance.

Cost Oriented Automation opposes the rising cost of sophisticated automation and propagates the use of innovative and intelligent solutions at affordable cost. The concept can be regarded as a collection of methodologies aiming at exploiting tolerance for imprecision or uncertainties to achieve tractability, robustness and in the end Cost Oriented solutions.

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Cost Oriented Automation does not mean basic or poor performance control. The design of automation systems considers its life cycle with respect to cost: cost oriented automation. Batch processing in manufacturing with decreasing lots, but increasing part complexity as well as mixed parts to be manufactured, demands for intelligent automation integrated with human capabilities of experience and knowledge regarding shop floor control and maintenance to save cost: cost effective automation (Erbe, H.-H.2003).

Soloman (Soloman, S., 1996) points to shortening product life cycles that need more intelligent, faster and adaptable assembly and manufacturing processes with reduced set-up, reconfiguration and maintenance time. Machine vision, despite partly of costly components, properly applied can reduce manufacturing cost (Lange, F. and Hirzinger, G., 2002). In order to survive in a competitive market it is essential that manufactures have the capability to deploy rapidly affordable automation with minimum downtime. This capability to adapt to a changing manufacturing environment results in cost saving and increased production. The concept of Cost Oriented automation or affordable automation is the provision of the human mind (Soloman, S., 1996).

Within the last years so called shop floor (micro workshop) oriented technologies got developed (Erbe, H.-H., 1996) and achieved success at least but not only in Small and Medium sized Enterprises (SMEs). They are focused to agile manufacturing that means to use an intelligent automation combined with human skills and experiences at the shop floor.

Shop floor control, Fig. 1, is the link between the planning and administrative section of an enterprise and the actual manufacturing process at the shop floor and is the information backbone to the entire production process. What at least Small and Medium Sized Enterprises (SMEs) need are Cost Oriented shop floor control devices, not only to avoid more or less complicated and expensive technology, but to effectively use the skill and experience of the workforce. Recent achievements for manufacturing are:

- Cost Oriented numerical controls for machine tools and manufacturing systems (so called job-shop controls).
- Programmable Logic Controller (PLC) shifting from PLC´s to general purpose Personal Computers. PC´s can easily perform many of the functions originally built into a PLC.
- Life Cycle Assessment of manufacturing systems: design, production, implementation, maintenance, qualifying operators (human skill), refitting, recycling/disassembling with respect to costs.
- Information-/Communication-Technology integrated in manufacturing system components to foster an agile automation in networked manufacturing enterprises and their extension to virtual enterprises.

Cost Oriented Automation is also related to:

- Organizational change and implemented information technology in Small and Medium Sized Enterprises for cost effective use of automation/control systems;
- Total Productive Maintenance with Tele-diagnostic via Internet to reduce costs for specialists;
- The internet protocol; it can be used for networking of controls, sensors and actuators;

- Shop floor control and maintenance with decision support based on automatic generated proposals by multi agents.

Robots, as a module of automation processing, can be divided in three classes (Whittaker, W.L.,1993):

1. Programmed robots perform predictable, invariant tasks according to preprogrammed instructions. They are the backbone of manufacturing, mostly preprogrammed off-line with a

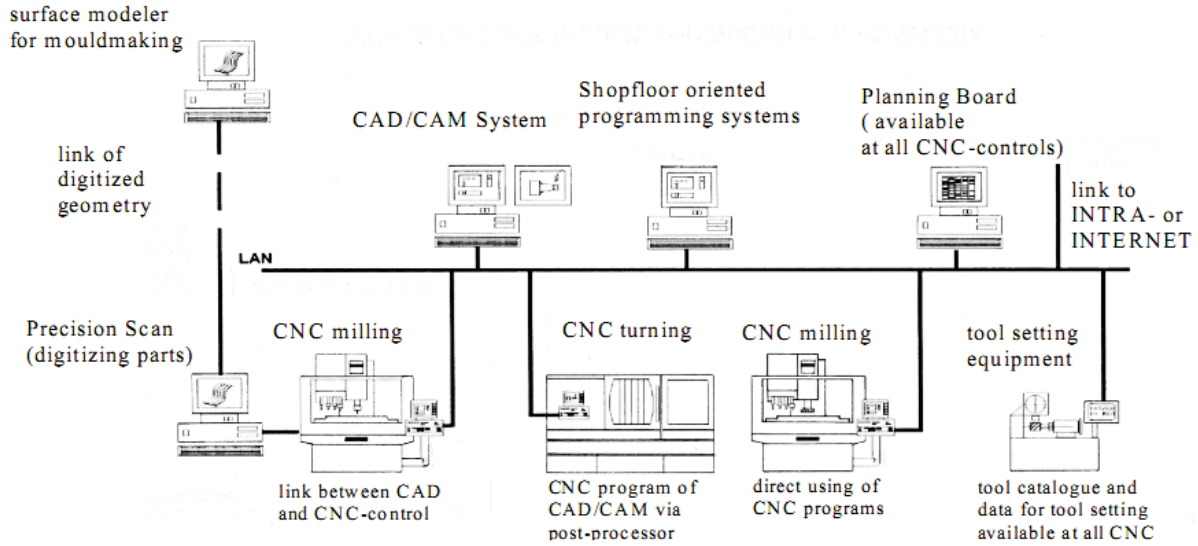

Fig. 1 Modules of a Shop Floor Network (Erbe, H.-H., 1996)

simulation of the programmed tasks before loaded to the robots at the shop floor (for a so called realistic robot simulation).

2. Tele-operated robots include machines where all planning, perception and manipulation is controlled by humans. Also called manipulators, they are served in real-time by operators. Tele-operation over great distances is one of the challenges for these kinds of robots (in minimal invasive surgery and distributed manufacturing).

3. Cognitive robots sense, model, plan and act to achieve goals without intervention by human supervisors. They serve themselves to real-time goals and conditions in the manner of Tele-operators but without human intervention. These are called Field Robots or autonomous robots.

As robot technology is mostly regarded as costly, one can see today an application not only in mass-production (automobile industry) but also in small and medium sized enterprises (SMEs), manufacturing small lots of complex parts. The rising product variety and customer pressure for short delivery times put robots in the focus. Hybrid forms of tele-operated and programmed robots are therefore attractive. The stationary application of such robots are not very useful due to the always changing needs in SMEs and specialists for installing and programming are expensive and hardly to find in SMEs.

An important point respecting the cost of robot technology in SMEs is the role of the human operators. Future tele-operators will combine robotic and manually controlled functions, with the degree of automation depending on the success of artificial intelligence research.

2 Cost oriented robots

Robots have become a normal feature of the industrial landscape.

In the last 30-40 years, large enterprises in high-volume markets have managed to remain competitive and maintain qualified jobs by increasing their productivity, through, among others, the incremental adoption and use of advanced ICT and robotics technologies. In the 70s, robots have been introduced for the automation of a wide spectrum of tasks such as: assembly of cars, white goods, electronic devices, machining of metal and plastic parts, and handling of work pieces and objects of all kinds. Robotics has thus soon become a synonym for competitive manufacturing and a key contributing technology for strengthening the economic base of Europe.

So far, the automotive and electronics industries and their supply chains are the main users of robot systems and are accounting for more than 60% of the total annual robot sales. Robotic technologies have thus mainly been driven by the needs of these high-volume market industries. In these global key markets where relatively few robot manufacturers can compete, European robot manufacturers face today a fierce competition.

To remain competitive in the global arena, future manufacturing scenarios throughout all industrial branches will have to combine highest productivity and flexibility with minimal lifecycle- cost of manufacturing equipment. This is particularly valid for today's small and medium sized productions as these are particularly prone to relocation due to high labor costs. In order to face these challenges and respond to ever changing customer demands, paradigms of knowledgebase manufacturing have been formulated during the Lisbon Summit in the year 2000 by concentrating on high-added value products, skilled work force and superior manufacturing technology.

2.1 A design case of a robot cell

Due to their flexibility and programmability, industrial robots play a central role in manufacturing, tightly integrated with its surrounding equipment to accomplish the needed productivity. The evolution of industrial devices like PLC's, cameras, intelligent sensors, etc., with their special programming environments/languages/features for configurability and reuse of those devices, forms a bottleneck for system integration. Therefore, programming a manufacturing cell usually requires specific knowledge about different devices making it a work for trained specialists or multi-disciplinary teams.

An example of a robotic cell (Veiga G., Pires JN, Nilsson K., 2007) is given in Fig. 2, composed of an ABB IRB 140 robot, equipped with the new IRC5 controller, a conveyor controlled by a PLC (Siemens S7-200) and a web camera. Basically, the conveyor transports sample pieces over the machine vision system, which calculates the number and position of the pieces. The results are sent to the robot controller to command the robot to pick them from the conveyor and place them into a box. A detailed description of this setup is available at (Pires, J. N., Godinho T. and Araújo R., 2006), where the author used an alternative solution based on a general client-server application developed using TCP/IP socket based communications. Since only the robot has built-in support for sockets communications, the several PC based applications were to distribute services over the network. They also developed two different clients to operate the cell: PC based GHMI (Graphical Human Machine Interface), and a PDA interface operates the cell: PC based GHMI (Graphical Human Machine Interface), and a PDA interface.

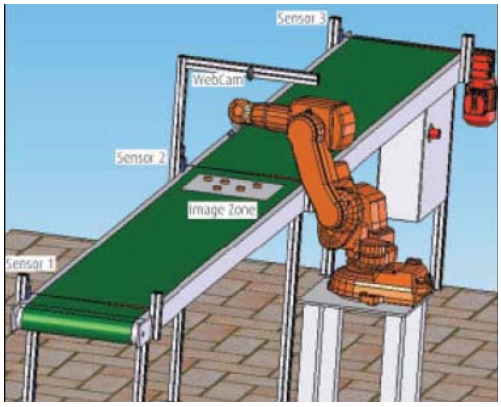

Fig. 2 General view of a robot cell (European Robotics Network, 2005)

2.2 Current and Future Trends in Industrial Robot Technology

There are numerous new fields of applications in which robot technology is not widespread today due to its lack of flexibility and high costs involved when dealing with varying lot sizes and variable product geometries. New robotic applications will soon emerge from new industries and from SMEs, which cannot use today's inflexible robot technology or which still require a lot of manual operations under strenuous, unhealthy and hazardous conditions.

Relieving people from bad working conditions (e.g., operation of hazardous machines, handling poisonous or heavy material, working in dangerous or unpleasant environments) leads to many new opportunities for applying robotics technology. Examples of bad working conditions can be found in foundries or the metal working industry.

If sensor information can be reliably used for robot control and if robot instruction schemes may be intuitive (e.g., by using more intuitive interaction mechanisms, built-in process knowledge and automatic motion generation), many other applications where present robot technology has failed can be envisioned (European Robotics Network, 2005):
Assembly and disassembly (vehicles, airplanes, refrigerators, washing machines, consumer goods). Obviously challenges address cost-effective robot systems which are able to cope with a wide range of processes, tasks and objects. In many cases fully automatic task execution by robots is impossible. Cooperative robots should support the worker in terms of force augmentation, parallelization or sharing of tasks. Cost-effectiveness can only be reached by drastically reducing the health hazards for the worker or increasing the productivity of the manual workplace by typically 50 – 100 %.
Aerospace industry currently uses customized NC machines for machining, drilling, assembly, quality testing operations on structural parts. In assembly and quality testing, the automation level is still low due to the variability of configurations and insufficient precision of available robots. Identified requirements for future robots call for higher accuracy, adaptivity towards work-piece tolerances, flexibility to cover different product ranges, and safe cooperation with operators.
SME manufacturing: Cutting, fettling, deflashing, drilling, deburring, milling, grinding and polishing of products made of metal, glass, ceramics, plastics, rubber and wood.
Food and consumer good industries: Processing, assembly, filling, handling and packaging of food and consumer goods.

Construction: Cutting, drilling, grinding and welding of large beams and other construction elements for buildings, bridges, ships, trains, power stations, wind mills etc. In most of these applications robots would have to cope with products having big variations in geometry and material properties and often produced in small batches.

Generally new types of robot systems which will have to deal with the range of applications described above will have to fulfill one or more of the following requirements:
Portable or mobile, to be used with minimum installation, calibration and programming effort.
-Allowing safe interaction (human augmentation)
-High forces, payloads when needed without any safety risk
-Interactive instruction and problem handling instead of programming
-Cost Oriented (1/2 of today's robot price)
-Force control in processes (machining, assembly) and 3D vision to adapt to variability in part geometry
-Stand severe environment.

3 SMEs in Kosovo

In market economies, small and medium enterprises (SME) are a dynamic and active sector where much capital is invested. As a result, they contribute to employment growth and productivity improvement. Now days, the SME sector is the main source of new job generation and income growth. Therefore, the private sector is a major force for growth and transformation in all market economies, including the countries in the region.

In Kosovo, SMEs employ the largest overall number of workers having a significant impact on the aggregate increase of domestic products, services and budget income etc. SMEs are the drivers of a market economy, which presented by the fact that make up over 99% of the total number of enterprises.

In 2004 at 39,257 SMEs were employed about 93,260 employees, mainly at trade sector 36%; at production sector about 15.57%; sector of energy suppliers 9.97%; transportation 8.78%; hotels and tourism 7.85%; construction 7.54% etc ((Observatory of SMEs, 2006).

Historically Kosovo's economy was concentrated in extractive industry, production of non-final materials, semi-final agricultural products. There are 43 metal working SOEs under an ongoing process of privatization (Potential Analyses in line with Metalworking Sector in Kosovo, 2007). As by December 2006, the portfolio of Kosovo Chamber of Commerce consists of 87 metalworking businesses.

In a today's highly competitive market, Kosovo metalworking manufacturers face the challenge of reducing manufacturing cycle time, delivery lead-time, stable supply of raw materials and inventory reduction. However, every organization (company) has its own objectives and its own way of decision-making processes. Due to the conflictions among the objectives of each organization and non-integrated decision making processes, there might be difficult organizing a supply chain management among these companies and finding out a mechanism which help to resolve those conflictions and to integrate processes.

The majority of SMEs have started to formulate and implement structured development plans covering periods of between 3-5 years taking into consideration circumstances and developments in Kosovo, also are highly dependent upon external funding, especially loans from Diaspora or international financial markets.

There is still a significant negative difference between imports and exports and extremely heavy reliance on imported raw material and final products. The problems/barriers identified that SME's face during their activities/production/manufacture include centralized management, poor-quality materials, unfavorable loan terms, no information of market trends, no quality insurance, inability to meet export market, lack of product diversification, high cost of imported materials, etc.

4. Case studies

SMEs are considered as a key component in the rebuilding and future economic development of Kosovo.

In order to have clear picture about the current situation of the possible implementation of robot into automation manufacturing, two companies in Kosovo who have expressed interest to be involved in case studies.

First the visit of SME called "Rugova" in Peja which is bolting the source water took place. Technology equipment for bottling was from Italy consists as following:

1. Uniblock 12/12/1 – model Oceanic-G with 12 valves with capacity of 1.500 – 2.500 plastic bottles/hour for different shapes of bottles of 200 until 2.000 ml,
2. Automation labeling line model M3000,
3. Semi-automation rotation Uniblock model CP-1. The base of the pallets is 1.000 x 1.200 mm, while in one pallet can be placed:

- 2.980 plastic of 500 ml
- 1.183 plastic bottles of 1500 ml

Height of the pallet is 2.350 mm for both types of bottles.

4.1 Production capacities

One package of filled bottles along with labels contains 6 pieces of 1500 ml plastic bottles or 12 pieces of 500 ml plastic bottles. The palletizing is done manually into the pallet of 800 x 1200 mm.
Thee workers are in charge with palletizing process, while one worker is in charge to feed the Uniblock 12/12/1 for filling with water (see the below pictures).

We have been informed in details about the overall producing process from the technical staff, who explained us about the technology in use, production problems they are dealing with as well as they have shown the interest to automation some of the operation where they considered the bottleneck of the production.

Fig. 3 Two possible working places needed to be automated at “Rugova” in Peja

The second factory we visited was “Gorenje - Elektromotori” in Gjakova. This factory is out of production for more than ten years, due to the difficulties with identifying the owner of the factory. GE produced various types of engineered motors designed specifically for products of identified customers, assorted in three production programs.
According to the company’s mission and objectives, it is with significant importance starting reengineering production program with new types of motors dedicated for household appliances, focusing on those for washing machines. Having in consideration that motors for washing machines are inconsumable products and designed specifically for identified customers, the company’s approach for analyzing market needs was making direct contacts with these identified customers/manufacturers of washing machines from previously served market niches in Italy and Slovenia.

Fig. 4 Machines to be served by manipulation robot at “Gorenje Elektromotori” in Gjakova

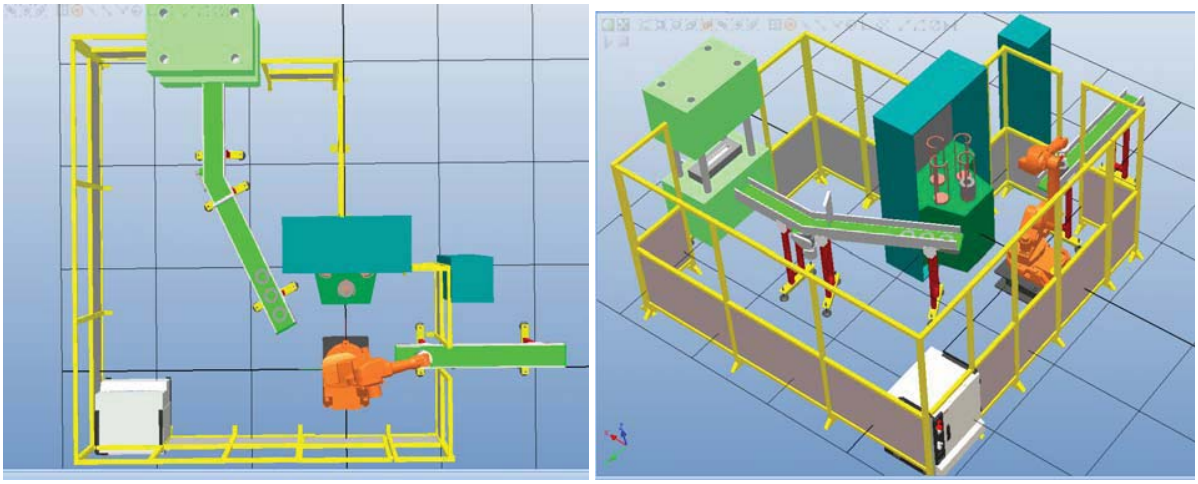

Fig. 5 Layouts of robotized working cell at “Gorenje Elektromotori” in Gjakova

In the Laboratory of Robotics of the Faculty of Mechanical Engineering (FEM), the University of Prishtina is being finalized the pick-and-place industrial robot. The robot has three axes about which motion ca occur: rotation in a clockwise direction on the unit on its base, arm extension or contraction and arm up or down; also the gripper can open or close. These movements are actuated by the use of pneumatic cylinders by solenoid controlled valves. The gripper can be opened or closed by the piston in a linear cylinder extending or retracting, showing a basic mechanism that could be used. PLC has been used to control the solenoid valves and hence the movements of the robot unit.

The first tests have been performed showing the advantages in technology and cost aspects of robots that would be designed, developed and constructed by FEM Staff in connection with partners from industry.

This robot cell is expected to be employed in new SMEs who will express interest to have production lines with automation processes.

Fig. 6 Pick-and-place industrial robot

Robotics research in Kosovo is also done at UBT in Prishtina (Dermaku,A. and E. Hajrizi, 2009)

5 Conclusions

In a today's highly competitive market, Kosovo companies in general face the challenge of reducing manufacturing cycle time, delivery lead-time, stable supply of raw materials and inventory reduction.
The majority of SMEs have started to formulate and implement structured development plans covering periods of between 3-5 years taking into consideration circumstances and developments in Kosovo, also are highly dependent upon external funding, especially loans from Diaspora or international financial markets.
SMEs are considered as a key component in the rebuilding and future economic development of Kosovo therefore applying process automation needs to be main motivation.

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7 Aknowledgement

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Mechatronics Educational Robots Robko *PHOENIX*

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Abstract
Important facts for interaction between Robots and Humans are presented. Educational robots as a good tool for learning about robotics are discussed. Statistics and Market analysis of robotics is introduced. ROBKO 01 is reminded. A developed articulated robot and its technical parameters are presented. Hardware and software systems of our articulated robot are described. Importance of educational robots is concluded.

Keywords: *Articulated robots, Educational robot, Service robot, Entertainment robot, ROBKO 01, ROBKO Phoenix.*

1 Introduction

In the beginning of the robotics, most robot applications were related to industries and manufacturing and these robots were called Industrial robots. With development of a new, more versatile robots new sensors and sensory systems, visual systems, microcontrollers, batteries etc. today robots start working in almost all fields of services too. Their application areas are from service robots for professional use to service robot for personal use including also educational, entertainment and leisure robots.
We can expect that the field of robotics will be changed dramatically in the 21st century. The number of service robot applications will grow much faster than that of the industrial robots. All this is expected because of the penetration of service robots in all spheres of human life and activities.
People perceive robots in a different way than other machines because they are performing tasks like humans who are programming them. Robots are entering more and more human homes today and are realizing often a real interaction with them (*Chivarov, N., Shivarov, N. and Kopacek, P., 2008).*
Based of those features educational robots are the best tool for learning about robotics and interaction between robots and humans.
Robotics is multidisciplinary scientific field which includes mechanics, electronic hardware, software, artificial intelligences, sensor and sensory systems etc. and is a good test-bed for educating students, young specialist and researchers (*Kopacek, P., 2007*).

2 Statistics and Market Analysis

A study made by the experts of the United Nations together with the International Federation of Robotics (IFR) is covering the statistics, market analysis, case studies and profitability of Robot investment (*IFR, 2006*).
According to these studies, Total worldwide stock of Service robots for professional use: 39,900 units installed up to the end of 2006.
Service robots for personal and private use: about 2.44 million units for domestic use and about 1.1million units for entertainment and leisure sold up to end 2006.
So far, service robots for personal and domestic use are mainly in the areas of domestic (household) robots, which include vacuum cleaning, and lawn-mowing robots, and entertainment and leisure robots, including toy robots, hobby systems and education and training robots. Projections for the period 2007-2010: 35,500 new service robots for professional use to be installed. Projections for the period 2007-2010: about 3.6 million units of service robots for personal use to be sold.
The market for entertainment and leisure robots, which includes toy robots, is forecast at about 2.2 million units, most of which, of course, are very low cost.

3 ROBKO 01

In the late 80's educational robot ROBCO 01 was developed (*Shivarov, N., 1987*). It's mechanical system was simple and strings driven using stepping motors. ROBKO 01 is six degree of freedom articulated minirobot consisting of base, three links and a gripper driven with stepper motors, gears and rollers (see fig.1). Control of the robot was realized with TTL integral schemes, transistors and diodes. Special driver language ROBASIC was created for programming ROBKO'01.

Fig. 1 Articulated Educational Robot – ROBKO 01

It was produced in a large series for domestic use and export in all former socialist countries and some west ones (small series for Argentina, France etc.). They have been produced over 18000 pieces. This robot had a great impact on introducing robotics to the young generation of that time.

4 ROBKO *Phoenix*

Having as a base ROBKO 01, developed in late 80's, we decided to redesign it and to design it's mechanical system with new links produced from aluminum and it's drives with new DC gear-motors, to apply a new hardware-control modules, new software, new graphic-user interface and new sensor system giving feedback to the control system about the exact position of the joints. As a result now we have a new modern multipurpose articulated minirobot (see fig. 2).

Fig. 2 Articulated Minirobot – ROBKO *Phoenix*

Technical parameters of the Articulated Educational Robot – ROBKO *Phoenix* are shown below (table 1).

Parameters	Link 1	Link 2	Link3	Link 4
Working range [deg]	300	110	95	185
Type of the reduction gear	WORM	WORM	WORM	WORM
Reduction rations	i=33	i=33	i=33	i=48
Actuation	Micromotos HL 149 12 V; i=10	Micromotors HL149 12 V; i=10	Micromotors HL149 12 V; i=10	Micromotors HL 149 12 V; i=10
Weight [kg]	0,500	0,250	0,250	0,250

Table 1 Technical parameters

4.1 Modular Hardware and Software systems of the articulated robot arm

The key concept of this robot will be its easy reconfigurability and intuitive user interaction. Having those requirements in mind, the design of the robot is based on modules. Different modules are chosen depending on tasks that must be performed and goals to be achieved. The electronic control blocks and software are configured accordingly.

- ***Architecture of Robot Arm controlling system***

All commands to the Robot Arm, as well as data from its sensors to the operator are passed and processed by the control module *Robot Controller*. The distribution of different queries and commands to different modules, self-test and detection of system's configuration, as well

as the whole robot intelligence at high level is performed by the embedded software of the controller using the system bus Robot System Bus. The immediate control of different mechanism types (motors, electromagnets), is implemented by separate intelligent electronic modules. Those modules care on one hand for communication with the Robot Controller using specially designed communications protocol, and on the other hand for the immediate physical control of different end mechanisms and devices. On figure 3 is shown Control System of our Educational Articulated Robot ROBKO *Phoenix*. The position of actuator mechanism can be monitored, controlled by the motor and on query – transmitted to the Robot Controller. Modules also implement basic functions for electrical overload protection and other low-level functions.

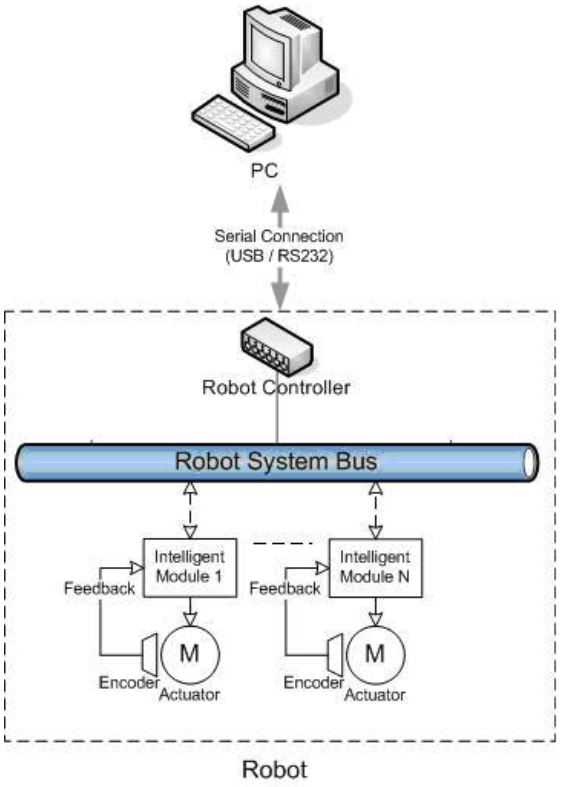

Fig. 3 Control System of the Educational Articulated Robot ROBKO *Phoenix*

- ***Intelligent modules***

The intelligent modules implement direct control of the actuators. They are built using a simple 8-bit microcontroller ATTiny26L (*Atmel, 2003*) and driver ICs that provide the necessary levels of electrical control signals for the proper actuator operation. They also have the ability to collect information from each actuator's encoder.

- ***Robot controller***

The Controller performs the following tasks:
- Communication with the host computer using a serial connection (RS232);
- Discovery and diagnostics of the system configuration – present intelligent modules;
- Control of actuators and collecting information about their state using the System Bus and a specially designed protocol.

The Robot Controller consists of three main blocks – the Control Unit CU, the Communications Controller CC and Bus Interface module BU, as shown on figure 4.

The Communications Controller implements receiving commands from the operator through a serial connection to the host PC, and sending back data for the robot status. It is implemented using MAX232 integrated circuit.
The Interface Module is responsible for connecting the Robot Controller to the System Bus. It is in fact built into the main CU microcontroller.
The Control Unit is built around an ATMega32 microcontroller from Atmel's AVR microcontroller family (*Atmel, 2002*) and contains the main software implementing the whole high-level intelligence of the Robot.

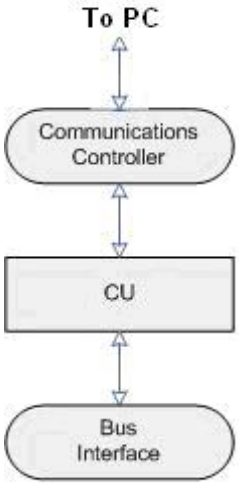

Fig. 4 Robot Controller

- ***Actuators***

The actuator mechanisms are the systems that provide immediate physical functionality and operation of the Robot Arm. All functions related to movement, rotating and catching objects are implemented by some sort of actuator – an electromotor or an electromagnet. All actuators are driven by driver control circuits contained in Intelligent Modules.Actuator's position can be monitored by the means of feedback – encoders that pass information of the Actuator's state back to the Intelligent Module that controls it.

- ***User interface***

The interaction between an operator and the Robot Arm is implemented by software on the host PC (figure 5).

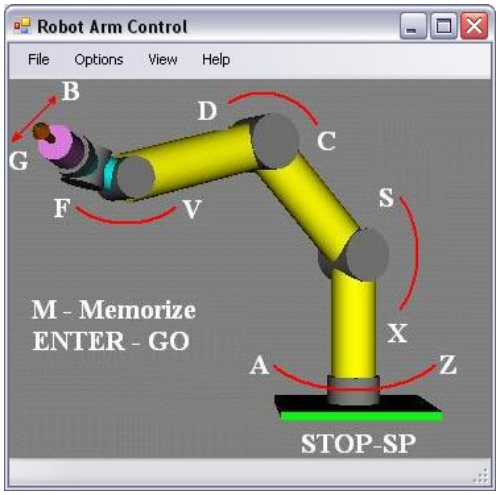

Fig. 5 User interface

The software is developed using Visual Studio Express and provides for the following functions:
- Manual control of individual joints of Robot Arm using a mouse or a key from the keyboard;
- Monitoring the state of all joints and the Robot Arm as a whole;
- Programming series of actions (scripts) that can be executed automatically later

The software has 4 items in the main menu: File, Options, View and Help.
The File option allows for saving and restoring robot positions and scripts.
The Options menu contains items for assigning and changing keys for different actions. The View menu contains options for changing Robot's image appearance in the main program's window.
Help item contains instructions of how to operate with the software.

5 Conclusion

As it was described, in the beginning of robotics development, most of the Robot applications were related to industries and manufacturing and these Robots were called Industrial Robots**.** With development of the new technologies, sensors and microprocessors, today Robots are working in many fields of Service, Starting from Service Robots for professional use to Service Robot for personal use including also educational, entertainment and leisure Robots.
Having our Robot as a good example tool for learning about robotics and interaction between robots and humans we will develop a family of Educational Robots for a variety of applications.
Educational Robotics is very good test bed for education of students, young specialist and researchers and is necessary for all technical schools, colleagues, laboratories and Universities. Our robot was called ROBCO *PHOENICS* as it is emerging from the ash of its predecessors ROBCO 01 which had a glamorous history and impact on the young people.

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ROBOTICS RESEARCH AT UNIVERSITY FOR BUSINESS AND TECHNOLOGY - UBT

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Abstract

It is well known that in general the Robotics, essentially Mechatronics in Kosovo is a new field and in its beginning. The UBT is one of the first Universities in Kosovo that adopt their Curricula and established the Mechatronic as one of the "main focus studies". In this way UBT demonstrated that it is possible to develop higher-education programmes in advanced engineering, which have local economic context in an emerging economy.
The UBT personnel in cooperation with the students of Computer Science Faculty in last year have made a numerous researching-projects at UBT. In this paper some of these projects are described.

1 Introduction

Mechatronics consists of integration of mechanical engineering with electronics, computer systems, and advanced controls to design, construct, and operate products and processes. Mechatronics is one of the newest branches of engineering with far-reaching applications to any sector of society. Generally, a mechatronic system can be seen as a mechanism, which is driven by actuators that are controlled via microelectronics and software using feedback from one or more sensors. Mechatronics is therefore the title given to the sub-discipline of engineering which studies the integration of mechanical and electronic technologies to create 'intelligent' machines, systems and controllers.

2 Robotsoccer

Robot soccer system is working in this way: the digital camera takes the picture and using computer process it in order to be able to make decision on next steps. There is one way direction of communication between computers using radio transmitter to mobile robots that moves on playground. In other term this is called also MAS which means "Multi Agent System".
Hardware of robot soccer system is made up from mobile robots, digital camera, computing centre and transmitting part. Mobile robot include in its self two drivers (motors), two wheels, body, microcontroller, cover with colours that are used for detection of robots and identifying robot ID, robots are carrying a battery with them self and also other parts that are using for robot security on crashing and so.

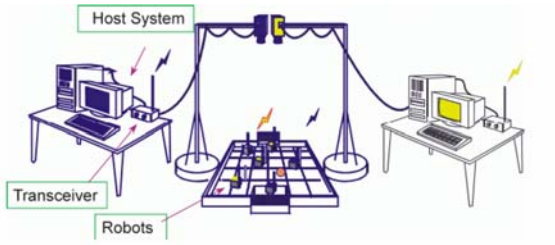

Fig. 2.1 – View of a system

Software structure is made up from three main parts: image processing communication part and the last one is decision make mechanism (system brain). Therefore if there is any problem communicating between any of these parts the system will not work properly in terms of very efficiency system to handle the up from image opposite team.

Image pro cessing, to make system one decision it should have same information from playground, as where are robots and ball (robot and ball position).

Communication unit sends to robots the decision that is taken from Decision make mechanism. The communication is carried through the transmitter, and the transmitter sends the commands using radio waves. Currently we use the frequency of 869.850 MHz

Decision make mechanism, when system takes information from image processing unit, it is analyzing the information and using different functions and its strategy makes decision for specify robot.

3 Robotsoccer at UBT

The Robotsoccer team at UBT consists of 11 mobile Minirobots “Roby Speed” including acceleration sensors, 2 CCD colour cameras, 2 frame-grabber-cards, 2 transmission stations, 12 transmission modules (869 MHz), 1 battery charging station and basic software.

This system will be also used for research in the following subjects: Communication between agents, Intelligent local sensor implementation, Intelligent behaviour of robots.

The system is designed to work using the images acquired by the camera that produces in average 30 frames per second. Those images then are worked out by different algorithms such as pattern recognition, edge detection that are used to detect the robot’s location, orientation and so. The information gathered from the images is sent to the decision unit that decides in which speed, direction and up to which point to go. By the methods of image processing the system detects the location of the ball and tracks it’s movements within the boundaries of the playground. After gathering of all information and making decisions the commands are sent to the specific robot and then that robot will execute the commands that are sent to that robot. The feedbacks that a robot can give is delivered to us be means of lights and also a buzzer. The lights transmit lights in different formats and each of those formats has a meaning for example: if the light are blinking fast then it means that the robot is having difficulties with the transmission because the link to the transmitter is falling and the robot is not receiving each command that is sent to the robot so it may fail to reach it destinations especially when the robot has to do a curve movement. Another format of lights is when the lights on edge it means that the robot is ready. If the robot’s lights are yellow then the robot means that is on standby. This is state to conserve the battery life and it is useful for stages when we have to make some changes in the software part of the system. In other word the system is divided in hardware section and the software section. The interaction between the hardware and software section is carried in two ways, firstly the images are acquired and then the decision is made and then its commands are transmitted to the robots using the transmitter that sends the commands by means of radio waves in different frequencies based on the communication

modules. In this way the system is organized to coop between the hardware and software section.
The complexity on the software implementation occurs in the part of path planning and also the colour detection due to fact that the light coming from different angles can reproduce different scales of colours. What is important for the system to work is the source of light should be white so it means that the only light that is used while the system is working is the light not coming from the light bulbs but from the neon tubes. There might occur also some interferences with radio waves due to the well know issues of radio waves such as wave cancellation for example from microwave oven and different electrical engines and other devices producing Electro-magnetically interference (EMI) and radio frequency interference (RFI). Those can cause the system not to act and eventually the game would be stopped due to the fact that the robots will be not in able to get latest commands and to react based on that command. For this reason the space around not to contain any devices that would interfere into the system.
The implementation of the software section is carried using Visual Studio 2003 and it is programmed in VB and C++ where the GUI is developed using VB and the algorithms for decision making, image processing are done by C++. The robustness of programs made by C++ offers great performance in the operation of the system. In such way the system has coordinated the information flow from the camera to the GUI section that shows how the games is going, robot's location, ball location and also on the GUI we can set different options for the game such as the strategy, standard situation, which robot's to run. There is possible to set the colours and to adjust its scale of colours in different locations of the playground.
The students develop the strategies based on the partitioning of the playground so based on the location of the ball the robots react in way to protect the area in that the robots are designed to be. In such way we would have better protection.
Positions of the attackers have specific position in the game and they can't interfere in each other field, it means that they can't fight for the ball and only one robot can go ahead with the ball.

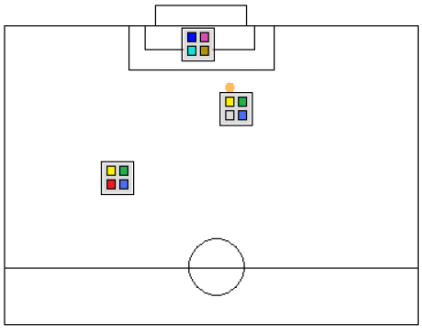

Fig. 3.1 – Position of the two attackers

We divided the playground in small areas so based on them we managed to orientate to robots and to predict the ball movements. In this way the game is coordinated so the flow of the game is conducted. It means that during development of the strategy from the scratch we use the divide and conquer strategy to divide to playground so we could manage it easily and without any hassle.
System-future developers will be mainly in software side first of all, to restructure (modifying) the way of communication between robots and computer centre, image processing to modify its algorithm in order to make better system solution this will be short future where will be included new function and new strategy. In long term development to become completed new software and to make possible to use these function development in

this short period of time. Except some changes in control centre unit and visual sensors (camera) there will not be any big development in short future in hardware.

Robot Soccer is game that is played with two teams, where each team should consist of five robots, where four robots play during the game as midfielders or attackers and one should be as goalkeeper. The game of the robot consists of two parts where each part is of 5 minutes and in between the parts there is a break of 10 minutes that in mean time we do the wheels cleaning and also checking if any of robots has weak battery we do charge them. Aftermath this 10 minutes break there is second part to the game that takes place. During the game it might occur to have any offensive interventions and then the game timer is stopped so based on arranged punishment in the game it can be accorded a penalty kick, goal kick or free ball. The game timer can be stopped in case of timeouts. Each team has right to call two timeouts during the game so the timer is stopped. This is all that is related to the time span and the timing of the game.

Until now the robots are completely unintelligent they have no sensors and are controlled by the host computer. In the future robots will be more and more intelligent and will be equipped with different sensors (ultrasonic, infrared, laser.....). This offers the possibility for the robots to adapt the commands of the host computer.

4 MoveMaster II – RM 501

The move master is consisting on some components that make him to move, and they are:

- Base - is define the motor that is responsible for master hand moving Waist - does rotation for 360 deegres of the robot
- Curlea wiring – transmit electricity and signal from base to the body.
- Body – hasn't any special function just holding the arm.
- Shoulder – make the connection between body and upper arm, this part makes able the movement of upper arm for 110 degrees.
- Upper arm – is static part in middle from Shoulder to Elbow.
- Elbow – makes able the rotation of forearm for 90 degrees.
- Forearm – have the same function like Upper arm but is in the middle from Elbow to Wrist roll
- Hand attachment site - is connected with wrist pitch and move with it
- Wrist pitch – used for open and closed to catching something.

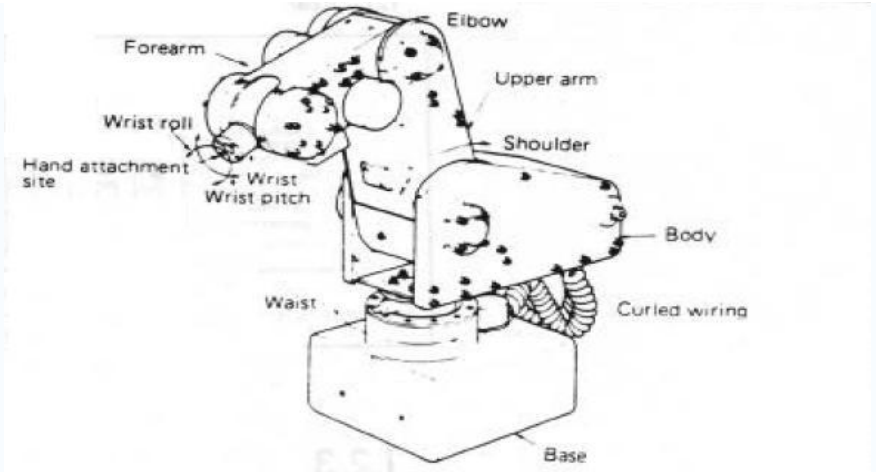

Fig. 4.1 – Move Master Units

Drive unit (DU)

As we can see the picture below, this device has a lot of function, first and the most important is that is going to save all the movement that we had make with external device “teaching box”. Also drive unit support to connect this device with computer, to comunicate with computer and taking orders from it. So anyway this is the brain of Move Master and everything is related with it (movements, stored positions, special instructions).

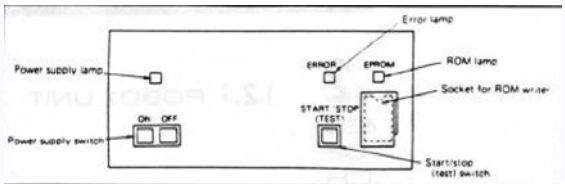

Fig. 4.2 – Drive Unit (DU)

Teach box is used to control the hand moves. You can command the hand to move or to do anything that we want to include on master hand movement.

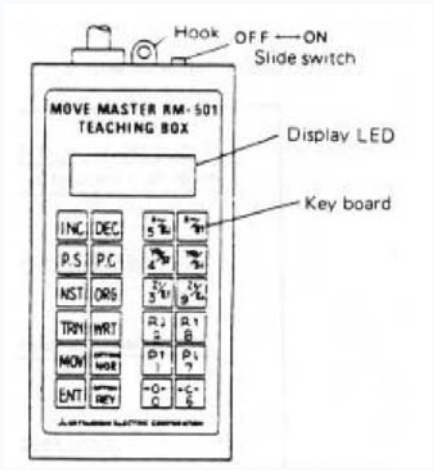

Fig. 4.3 – Teach Box

Also in this part the students have programmed an interface in order to command and move machine directly from computer, and not only from teach-box. In general the students spread this project on three steps: 1. Manual Movement, 2. Stored Movement , 3. Coordinate Movement.

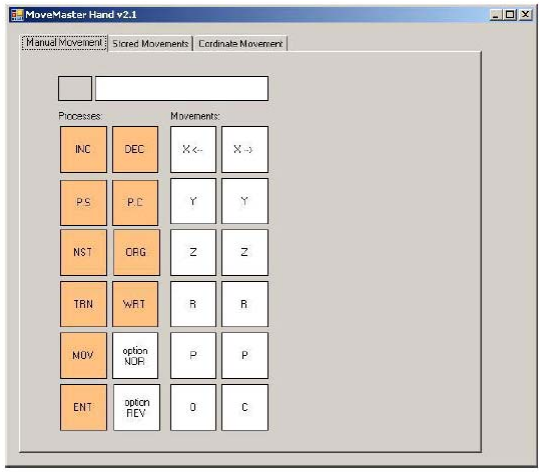

Fig. 4.4 – Teach Box (Programmed)

Stored Mo vement is used when first we want to store all position and than execute, all instruction will execute one after one automatically.

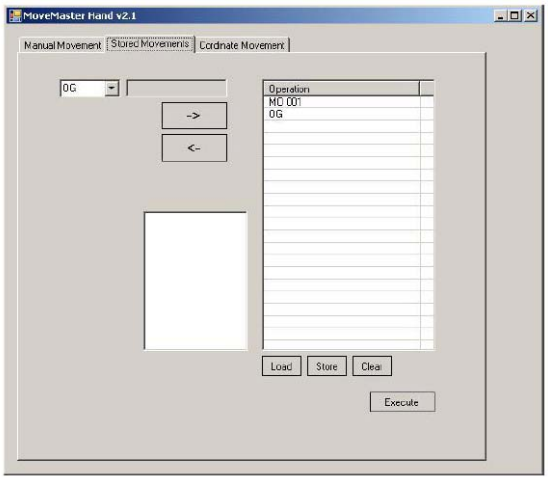

Fig. 4.5 – Stored Movements (Programmed)

The Coordinate Movement works on concept of idea that we write the coordinates that we want to move and the robot will move as soon as possible. There is also the idea to extend this project in this tab in computer graphic programming, so that if the robot skeleton is drawn and if we are moving on the point on our drawing the robot will move on exact same position. There is another improvement in future to do. The students work on the guiding of the robot using a camera. This would work as follows: Using robot's camera we have to select an object that would be traced and then the robot would follow those coordinates. Based on this the programming of the robots would become easier.

5 Larm Hand

The LARM Hand is composed of three fingers whose design is aimed for an anthropomorphic behaviour as shown in Fig. 5.1 Each finger is actuated by a DC motor. The operation of the DC motors are managed by using a PLC LOGO! that is provided with the LARM Hand. A force sensor is installed on the palm of the hand. It is used for limiting the maximum grasping force and prevent damages to the hand itself. An amplifying board is provided together with

the hand. This amplifying board is also used as power supply for the operation of motors, PLC and force sensor. The amplifying board requires a standard 15V power supply. Fig. 5.2 shows a scheme of the wire connections of the LARM Hand with the amplifying board, motors, PLC and force sensor.

Fig. 5.1 – Casino Larm Hand

The operations of the DC motors are managed by using a PLC LOGO! which is provided with the LARM Hand. The students use PLC LOGO! to develop some cases where fingers opens ore closes in different times.

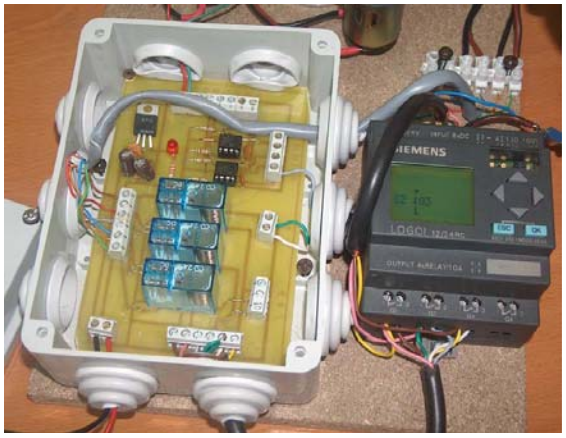

Fig. 5.2 – PLC Logo

6 Humanoid Robots - Bioloid

The humanoid robot consists of several parts. It is like human with all extremities, so it has legs and arms. This robot is small sized robot approximately it is tall 60 cm. The robot is designed to perform certain functionalities like moving of arms, legs, to walk, to grip small objects, to detect obstacles. The package comes with all parts that are disassembled, charging unit, Quick user guide and user guide and a CD-ROM. Later on the parts of robot are scheduled to be assembled and then to perform first operations with the robot. The installation of software can be easily installed into computer and it can be installed in various versions of Windows, this software package has been installed in Windows XP SP 2 and in Windows Vista.

Fig. 6.1 – Biloid Robot

The software is divided in two parts Behavior Control Program (Bioloid) that is used to model movements and then the program is stored into computer so then using the second program called “Robot Terminal v1.07” can be transferred into the robot.

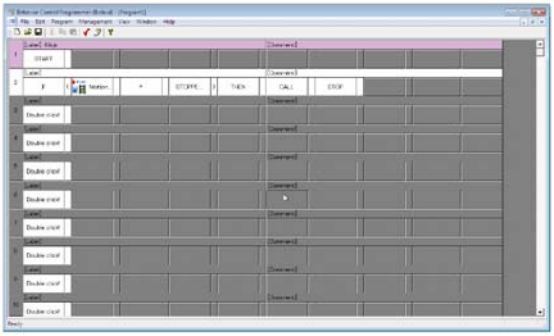

Fig. 6.2 – Robot Control Programming

The Robot Terminal v1.07 is used to upload the designed movement to the robot and also to download the software from the robot to the computer.
The students at UBT have managed to prepare the robot to perform several actions like repetition of hand clapping, defender from different attack like in karate, walking in long distance. During the walking it has different sensors located in different locations. For example if the robot faces an obstacle in front then it returns to the back then it turns for 90 degrees on the left. If the obstacle is locate near the head, where the sensors are located, and then it returns on the left or the right slightly by diverting the path. All those actions the steps are programmed using its software for every step. The angles for each step are set by perform multiple calculations that are used to measure the force and to reach the stability we had to arrange every motor of the robot. In this way we managed to perform the complex movement of walking of humanoid robot where the maintenance of the stability is the hardest topic.
This is first time that in Kosovo there is such robot with legs and hand, a humanoid robot. In such case we tend to develop some movements of the robot among the internal area of the ground floor of the university. In this aspect we will have to develop certain modules like path planning, and maybe to work on obstacle detection but due to lack of sensors this idea should run not to be conducted.

7 Summary

According to our first experiences in the Mechatronics Laboratory the Robotsoccer system (originally developed in TU-Wien, Austria) is an excellent tool to teach students essential subjects in Mechatronics e.g. mobile robots, path planning, path following, cooperation etc.
Another researching project done at UBT is “Move Master II – RM 501” where the students use computer languages and they have programmed an interface in order to command and move machine directly from computer, and not only from teach-box.
“Larm Hand” is another exercise done at UBT. This robot has a numerous sensors which make possible identification of stuff touched from robot hands and regulate automatically a pressure on this stuff. This is possible because a force sensor is installed on the palm of the hand. The robot is originally developed in Cassino University. Each finger is actuated by a DC motor. The operations of the DC motors are managed by using a PLC LOGO! which is provided with the LARM Hand. The students use PLC LOGO! to develop some cases where fingers opens ore closes in different times.
There is also humanoid robot “Bioloid”. It is like human with all extremities, so it has legs and arms. This robot is small sized robot approximately it is tall 60 cm. The humanoid robot – is designed to perform certain functionalities like moving of arms, legs, to walk, to grip small objects etc. The students have managed to prepare the robot to perform several actions like repetition of hand clapping, defender from different attack like in karate, walking in long distance. The programming is done in software called “Robot Terminal v1.07”
The UBT is in its beginning of Mechatronic and Robotic fields. These research-experiments are only the first step toward the development of mechatronic and robotic technology in Kosovo.

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A Globalisation Perspective of Trends in Mechatronics and Advanced Technology Business Management: A Review of Technology Transfer & Innovation in Ireland & Kosova

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Abstract

This survey paper reviews developments associated with technology-driven innovation processes in organizations in the Republic of Ireland. It sets out some of the ways in which technology-driven innovation is inculcated in products and processes in Irish high technology small and medium–sized businesses, focusing in particular upon the management of knowledge and intellectual property. In respect of technology-transfer and innovation, the paper presents a globalization perspective, and so sets out the particular economic and cultural context in Ireland as a player in the global, interconnected economy. Finally the paper outlines issues facing Kosova as a fledgling state in this regard and presents a summary of some findings in this respect, setting out both opportunities and challenges for Kosova going forward.

1. Background

The Republic of Ireland is a small outlying country of 4.5 million people on the edge of Europe. It has had a troubled history and experienced poor economic development until mid-1990s. The country has relatively low levels of natural resources and by the mid-1960s it was clear to industrial development agencies that the protectionist approach of the first forty years of the state were not working. A decision was made to open up the economy and create, what has been termed as, a classic ‘small open-economy’ (O’Hagan, J.W., 1981). At this time important new educational structures were put in place so that by the early-1970s free secondary vocational education had been established alongside a new network of regional higher-education centres, enabling the many disadvantaged regions to access vocational second and third-level education more easily. New National Institutes of Higher Education (NIHEs) were also established, and later became autonomous universities of Limerick and Dublin City. Many years later this latter structure eventually evolved into the autonomous, university-level ‘Institutes of Technology’. The country joined the EU (then the EEC) in 1973, as part of this opening-up of the economy.

However, by the mid-1980s the economic situation had deteriorated to crisis point. Massive emigration and high unemployment were endemic. A national consensus began to emerge that

job-creation and economic growth were critical if the nation was to remain viable. Political parties, even opposition parties, began to construct a national consensus. For example, the so called “Tallaght Strategy” in 1987 was a drawn up by Alan Jukes, leader of the opposition, which effectively suspended opposition politics in order to address the national crisis and pave the way for the consensus approach. The national consensus developed into a social partnership model which focussed upon creating and maintaining jobs. Through this model a series of national economic plans were agreed by all the major stakeholders, including labour unions, employer federations and government ministries. These provided an important basis for operating the economy and moving out of the crisis.

During this time the question arose: with few natural resources, how could economic growth be developed in the Irish Republic.

Some particular features of the Irish context should be noted at this point. Firstly, that the remoteness of Ireland meant that there was a relatively high cost base for business. Secondly, that there was a strong sense of connectedness to the world through the diaspora: the Irish which had emigrated over the past-two hundred years but still had a sense of ‘Irish-ness’ and, in particular, the Irish who had emigrated in the 1980s. Globalisation was emerging as a major opportunity and challenge for economies, and Ireland would need to take this into account, either as an opportunity or a threat.

The situation was clearly complex and dynamic, and would need several dimensions including an attractive corporate tax regime, a careful branding of the country as a good place to do business, enterprise-oriented incentives, support from the EU, a move towards a solution in the North and so on.

One aspect of the solution was that strong educational infrastructure had been developed, and that this could provide a basis for growth going forward, in spite of the lack of natural resources. The industrial development agencies began to focus upon high-value added, knowledge-based industries such as the emerging information technology, financial services and bio-technology sectors, and to develop more traditional agriculture-related industries through innovation and related processes.

2. Current Innovation Concerns for Mechatronics and related business

Irish high technology companies in mechatronics as well as other related industries are now deeply concerned about how to generate and harness innovation capabilities in

1. New and Existing Products

2. New and Existing Processes

The light-engineering sector in Ireland has faced particularly difficult challenges arising out of the geographical and historical context. Ireland is remote geographically from many of its markets. It does not enjoy many of the diplomatic connections that are available to nations who, because of empire or other reasons, have well established networks in European markets.

It was apparent that innovations in processes may, themselves, be tradable as licensed knowledge, whilst aiding the firm internally as part of a continuous improvement programme. This trade is not so encumbered by geography or political boundaries, as it could be made available anywhere using the emerging global technological capabilities. Furthermore, innovations in products offered opportunities in developing new markets and extending old markets. Irish firms could compete effectively by becoming more innovative in the suite of products and services they offered.

The questions arose: how could companies effectively engage with and manage innovation processes?

Over the years government agencies, in particular Enterprise Ireland and organisations such as the Irish Chamber of Commerce, the Innovation Relay Network and the Industrial Development Authority, have fostered an innovation-orientation in their work with companies. By 2008 this had developed into specific training, education, technological, financial and other support programmes designed to help Irish firms, especially small and medium sized firms, to engage effectively with the twin challenges of

1. creating an innovation-oriented business
2. globalisation

The opening sections of this paper have reviewed the Irish context in detail. The next section examines some of the processes now at work in these firms, and how these challenges are currently being tackled.

3. Innovation and Technology Management

3.1 Towards Knowledge-Driven Business

In order to create a continuous stream of innovation which could be implemented in short lead times firms needed to adopt an effective change management initiative which created a pathway to what Bessant, J., 2003, calls “high innovation” capability. In firms with this capability:

1. People are trained in the practice of innovation and systems are in place which can capture innovations and ideas
2. Measurement frameworks exist for tracking project(s) progress
3. Projects are well defined and owned and policies for this are in place
4. Vehicles are in place to maximise involvement and interactions across the organisation
5. Reward and recognition systems are in place to share gains emerging from innovation
6. A philosophical shift towards controlled risk taking has been successfully fostered

However, high level innovation capability has significant challenges and difficulties that must be overcome and managed on an ongoing basis. These include:

1. Organisational change: in many cases high innovation firms have had to overcome severe obstacles in changing the way the organisation functions. This often included the introduction of new information technology infrastructure and new business processes more amenable to the disciplines associated with high innovation activities. These projects are fraught with difficulties including challenges in the area of organisational politics, coordination, communication structures , knowledge sharing etc., especially where project teams may be dispersed across a geographical area, or even involve partnerships across more than one functional unit or organisation (c.f. Mullally, B. & Stapleton, L. 2006, & 2008; Ovaska, P. & Stapleton, L., 2008). Firms who do not carefully and successfully manage these aspects of the change initiative will experience very serious consequences, including possible inability to operate business processes effectively (Goulielmos, M., f2003).

2. The challenge is to develop high technology, innovation driven business processes, This includes nurturing the ability to operate both technically and organisationally in knowledge and value webs in which, for example, ICT is used to control and manage supply chain arrangements including contracts, procurement, payment, quality control etc. (Tidd, J., Bessant, J., & Parfitt, K., 2005). This capability is not easy to achieve nor manage.

3. Leadership: the leadership style needed to direct such organisations must be quite different to that needed to direct more traditional organisational forms. Von Stamm, B., 2003, shows how particular leadership styles are associated with ‘innovation leaders’. These styles and value types are not easy to locate nor easy to inculcate.

4. Management: the management style also must be quite different. There are real difficulties in ensuring that creativity and innovation are controlled within tight budgetary and strategic parameters. Furthermore, Tidd, Bessant & Parfitt, 2005, demonstrate how all the various management, organisational and technological factors must be managed in a coherent and coordinated way in order to be effective. This suggests significant management training programme in order to develop the new skills needed to manage these processes successfully.

5. Culture: high innovation companies have unique cultural traits and sets of values and visions which are not easily inculcated or replicated. Bessant, J., 2003, cites the example of Chaparral Steel in this regard p. 171). These are typically associated with 1 and 2 above, where companies must be careful that they recruit particular individuals with particular sets of values capable of operating in these environments

The issue of ‘innovation culture’ remains one of the most difficult problems and few companies have been able to create a truly innovative culture. Academically, one of the difficulties is that there is a lack of sufficiently rigorous instruments for measuring and analysing the values which underpin innovation. Very recently tools have begun to emerge which can illuminate these aspects of innovation in organisation. The tools are largely based

upon Schwartz' universal value set (Schwartz, 1992; 2006). Whilst these tools have been used to explore export performance of firms, they have not been much used to explore values underlying innovation. However, the work of Byrne, G., & Bradley, F., 2007, Byrne, G., & Stapleton, L., 2008 and Lyng, B., 2008, may provide a basis for moving forwards in this regards.

3.2 Streams of Innovation: Two Pathways

Bessant, J., 2003, saw high level innovation as the completion of a process through which innovative capability is developed in organisations. This capability provides the basis for adopting pathway one and two orientations. These two orientations will now be examined in more detail.

4. Pathway 1: internal innovation-orientation

Traditionally, firms have been very hierarchical in structure, with most direction and ideas (including innovations) coming down the management structure from above. This is particularly true in transition economies where old bureaucratic structures are still very evident.

As a system of innovation, this is not very effective as it relies on a narrow, and often incomplete view of what is happening in the organisation, including the markets it needs to tap, the technical problems likely to be faced in implementing an innovation either in a process or product, and the opportunities that a new piece of knowledge might afford to an organisation. Many firms in Kosova have adopted this approach to implementing and managing innovation.

Internal innovation orientation refers to the idea that the organisation must develop processes and structures by which it can effectively leverage its own internal innovation capability. In pathway one the firm builds an internal innovation capability which harnesses the capacity of the organisational as a whole to effectively innovate. This will typically require significant changes in management style and organisational culture.

Even though it is clearly a team effort, Bessant, J., 2003, notes the critical role of "champions" who have been shown to be critical success factors in instigating and driving internal-changes towards innovation-driven organizational activity. Champions are central to the success of change-management work in this space. Typically, there are 3 types of Champions on technology-driven change initiatives in this context:

1. Top-down – these champions are important in times of major change as initiators and drivers

2. Bottom-up – important due to their proximity to technical or market interface. These champions can create momentum at operational level and can draw out key technical and market knowledge which may affect both the shape and direction of the change-management initiative

3. Dual - combines the role of bottom-up and top-down.

Summarising, the outcome of pathway 1 is the creation of internal innovation-orientation enabling the leverage of a firms own stream of innovations for products and processes

The upside of this approach is that it leverages internal knowledge. An internal orientation is excellent for harnessing previously un-tapped organizational capacities to innovate.

The downside is that there may be a long-time to value creation for any particular innovation project. Also, it is highly reliant on the inherent capacity of the local organisation, and does not make use of or develop the knowledge networks typically needed to successfully operate in a global, inter-networked context in which a variety of different firms may be inter-dependent upon each other in a web of technologically-enabled value-added activities.

5. Pathway 2: External innovation-orientation

In addition to pathway one, firms are now focussing more upon pathway two where external orientations are developed. An external orientation involves the systematic creation of management and organisational systems, structures and processes which help the firm to identify sources of external knowledge, useful intellectual property etc. For instance, imagine a firm has an innovative idea for a new product which clearly fits into its overall strategy. The problem for the firm is how to get this innovation to the market as quickly as possible. Typically, the small firm does not have the internal research and development capability to bring the project to end result quickly enough for it to compete effectively for business with larger players in the market.

Pathway two enables firms to respond quickly and efficiently to perceived, innovation-oriented opportunities. In pathway two firms create a series of structures and processes with an orientation towards drawing in knowledge from outside, with the specific purpose of streamlining and speeding up the innovation-to-first-revenue-ship process.

Organisationally, firms using pathway two incorporate a variety of tactics into their business. These include:

1. Obtaining breakthroughs through interdisciplinary ‘boundary spanning’ activities. ‘Boundary spanners’ speak the language of two or more environments (companies, fields of expertise, networks) and act as interpreters between these environments

2. Setting up gate-keepers: “Gatekeepers of knowledge” are a small group of key staff members to whom the organisation could turn to for information on ideas and innovations. These individuals constantly expose themselves to a variety of technological, market and other information outside their own organisation. They are typically academically oriented practitioners who can translate difficult material into a language the organisation can understand and incorporate. They can frame the organisational environment that "Enables" innovation; however innovation is "Enacted" - recognised, developed, applied & adopted - through individuals

In pathway two business value is created by:

1. Identifying the external knowledge/innovation needed and license the IP inward
2. Identifying internal tradable knowledge/innovations and securing license arrangements for this intellectual property
3. Weaving in others' solutions into internal innovation capability
4. Quick return on process innovation through licenses and strategic alliances deliver new knowledge inward
5. Faster delivery of new products to market by leveraging existing knowledge and intellectual capability

Summarising, the basic strategic aim in pathway two is to be able to effectively connect to external innovation webs and draw knowledge into the business. A major organisational goal of pathway two is to reduce leadtimes from idea/concept to revenue stream.

The upside of this approach is that it connects the organisation to a broad base of knowledge from which to build value-added processes and products.

The downside is that this external focus requires new management thinking, an outward looking, open culture and leadership style. It must be carefully balanced with the internal focus to ensure that the firm is internally capable of harnessing incoming knowledge effectively and that this activity is aligned with the firm's values, vision and strategy.

6. How can this be achieved? Challenges for Irish Firms

Both pathway one and two imply the creation of an 'innovation culture'. What is an 'innovation culture'?

An innovation culture is one where the core value system deeply motivates the creation of innovative solutions and the desire to bring these to market as quickly as possible. Barrett, R., 1998, has demonstrated a clear relationship with the personal values of the members of organisations and the sustainability of business activity over the long term.

This innovation-oriented cultural value system will have incorporated specific sets of values according to the universal values model of Schwartz, S., 1992 & 1996. Byrne, F., & Bradley, G., 2007 link explicitly the values of leaders and their organisations to business performance in this space. Consequently, particular leadership styles are likely to be in play. As indicated earlier in this paper, techniques for measuring value systems in this respect are emerging and are being applied (c.f. Byrne, G., & Stapleton, L., 2008; Stapleton, L., & Byrne, G., 2008. This will prove central to any understanding of innovation cultures and their development into the future.

7. The Role of National Support Agencies

In order to effectively operate an Irish system of innovation-driven economic activity, an innovation-oriented infrastructure also needed to be in place. If government and other agencies could provide effective knowledge supports, in many cases it should be possible for the firm to identify intellectual property which can be inwardly licensed in order to solve various technical and other issues associated with the bringing of the innovation to the market. These might include complex manufacturing solutions to the development of a mechatronics system, or might include actual solutions within the mechatronics system itself which the small firm does not have the expertise to solve.

Through their connection to this web of knowledge the small and medium sized firm would not have to find all the solutions itself. Instead it could license in the intellectual property it needs to progress the project, and solves the problems it can itself, only if those internal solutions are best resolved by the firm.

This approach would have the added impact of linking the firm to knowledge which would normally be far beyond its internal capacity. It creates a new knowledge exchange environment which supports innovations-to-market. It also brings the firm into the knowledge marketplace. Innovations that the firm identifies for its services, processes or products can be licensed by that firm and traded in the knowledge-web.

7.1 Supports for Knowledge Exchange in Ireland

In order to support this approach at European Union level the European Commission has developed a database system of innovations and the owners of those innovations. Also recorded in this database are actors who are seeking solutions to specific problems within their own innovation activity. This database can be located at www.innovationrelay.net which is now part of Enterprise Europe Network, a new flagship initiative providing integrated innovation and business support to small businesses across Europe. The database is searchable and is supported by local actors (in Ireland Enterprise Ireland and the IRC-Ireland network). It holds information on 500 organisations in 40 countries across Europe. This support system offers all the innovation and technological cooperation services. This has now become the largest network of commercial innovators in the world.

In Ireland the national innovation-support system is largely managed and promoted by Enterprise Ireland, a government agency dedicated to the development of enterprise in the Irish economy. The innovation relay network in Ireland has been coordinated through IRC-Ireland (www.irc-ireland.ie). This provides main pillars in the innovation-oriented infrastructure designed to support Irish business.

For example, Enterprise Ireland, in collaboration with IRC-Ireland currently offers a service called ‘techsearch’. This is a portal which facilitates the kind of licensing arrangements discussed above. The techsearch system (www.enterprise-ireland.com/TechSearch) is designed to provide companies, in particular small and medium enterprises (SME's), with tools and information to investigate inward and outward licensing for Irish enterprise. The system recognises that licensing can be a fast and cost-effective way to source new products

and technologies. To help people understand licensing, and to use it successfully, they have prepared publications and a toolkit which can all be accessed though the site.

7.2 Some Key Issues Involved in Operating Pathways One and Two

Whilst the infrastructure and other supports are reasonably sophisticated, in reality the process of building and sustaining pathway one and two activity within a firm is far from simple and raises big questions for Irish businesses, particularly those seeking to operate in pathway two. These questions include:

1. What are the legal and other related issues?

2. How do Irish firms form alliances (value-oriented knowledge webs) across national boundaries? This concept is still quite new and this country does not have extensive experience of European colonial powers of operating in many countries

3. What are the implementation challenges for Irish firms? For example, in an innovation-driven continuous improvement process involving inward licensed knowledge and innovations there will be continuous destabilisations of existing processes as new innovations come continuously onstream. Also, the advanced technological infrastructure needed to enable the sharing of information rapidly in knowledge webs, is very difficult to implement, requiring a great a deal of business process discipline and a well-educated workforce, well prepared organisation and so on (e.g. see Wider, B., Booth, P., Matolscy, Z., & Ossimitz, M-L., (2006)).

4. Culture: What is an innovation culture in organisations with both pathway one and pathway two in operation? How does the organisational culture currently compare with the target culture? How do we measure culture in this context?

5. Leadership and Management: What kind of leadership and management styles are associated with effective pathway one and pathway two activities? How do we measure the leadership values currently in operation? How do these compare to target value systems and styles?

8. Opportunities and Challenges in Kosova

So far this paper has focussed upon the unique set of circumstances which arose in the Irish Republic, and the response of both government agencies and firms to these challenges and opportunities. Kosova itself presents unique challenges and opportunities which need some consideration.

It is clear that advanced technologies, and especially information and communications technologies (ICTs) present a real opportunity (and potential threat) in enabling economic growth in developing and transition economies like Kosova. Research on other transition and developing regions has clearly indicated a link between effective ICT penetration and economic development (e.g. see Janson, M., Cecez-Cekmanovic, D., & Zupancic, J., 2007; Adam, L., & Wood, F., 1999).

Using a similar analysis as that presented in respect of Ireland, it was clear that Kosova had special opportunities. In 2005-2006 the author gathered interview data from 76 Kosovan managers in 68 firms. This data is published elsewhere and therefore is only presented here in summary form (Stapleton, L., 2009). These interviews assessed the extent to which advanced information technologies had penetrated Kosovan business life. The data, plus data published elsewhere[1], presented a unique picture of the current situation in Kosova. This can be summarised in terms of particular opportunities and challenges faced by Kosovan business.

8.1 Opportunities

This can be summarised as:

1. ICT Penetration: The author's study indicated that 96% of firms were using ICT regularly in daily business life, with a high penetration of internet-based technologies when compared with other developing and transition economies. This high take up of high technology, especially IT for internal business processes, is very encouraging and points to an openness to change which is a core value of many innovation-driven organisational cultures.

2. Demographics: Kosova has an energetic young population which again points to openness-to-change and the energy to embrace and implement different thinking.

3. Low wage costs: this suggests a highly competitive labour-cost base from which the Kosovan firms can operate in a global market

8.2 Challenges

1. The author's study indicated that there was extremely poor take-up of technology in the supply chain. Consequently (or perhaps a cause of this) were poorly developed inter-organisational relationships generally, both with the customer and supplier sides of Kosovan businesses

2. The author's study indicated that Kosovan firms found it difficult to identify or locate third party service providers who could help create the technology-enabled relationships which can form a basis for knowledge-based value webs. This presented a particular challenge to Kosovan government agencies seeking to develop and foster Kosovan enterprise. The development of foreign markets for Kosovan products has been extremely poor, and the balance of payments was reportedly 4% in 2006, indicating that economic activity was not oriented to generating wealth by developing and penetrating export markets for Kosovan goods and services.

3. Awareness: the author's research findings indicated low levels of awareness of e-business and technology-driven business value propositions. This presents a

[1] In summary, the main sources of other data were as follows: COM (2007); EUinKosovo(2007); MTI (2004)

particular challenge to third level institutions in Kosova, who need to develop and nurture educational pathways in this space

4. The research indicated that there were low levels of experience amongst Kosovan managers in seeing organisational and external knowledge as crucial in business performance. This suggests a weak platform for the participation of Kosovan businesses in value-webs, and in the trade and licensing of knowledge either inwardly or outwardly.

9. Conclusions

The situation in Ireland is still unfolding and there are significant challenges facing that country in terms of further developing innovation in firms in the economy. The country has few natural resources but has developed a socio-economic and technological infrastructure for encouraging and nurturing innovation within enterprises.

Aspects of the Kosovan situation are similar to the Ireland of the 1970s and especially the 1980s. However, some aspects are very different. Kosova is significantly less developed in terms of infrastructure, whilst both the costs base of the labour market, plus the availability of natural resources suggests possibilities in terms of export growth. On the one hand Kosova is geographically very central in the Balkans, so has a good position vis a vis a potential marketplace. However, it is still in recovery from the calamities of the 1990's, is experiencing very difficult economic circumstances (even greater than those of Ireland after the credit crunch), and has only begun to build many of the political and economic infrastructures needed for it to operate effectively in a global context.

Clearly the challenge for Kosova is extremely great. It is also very urgent given the balance of payments and unemployment statistics[2]. The country needs to rapidly develop educational, enterprise and technological infrastructure in order to provide a basis for innovation-driven business. Much work needs to be done in order to progress along both pathways to innovation-lead organisations and Kosovan participation in knowledge-based wealth creation.

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[2] Unemployment has been variously estimated between 47% and 60% in Kosova in 2006-7 (EUinKosovo(2007)) .

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An Investigation into Internet Users' Perception Regarding the Data Privacy Policies of Virtual Companies Operating in Ireland

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Abstract: *Virtual companies (i.e. a company that does not have a physical footprint and exists only on-line) have introduced new elements of risk and trust criteria for Internet users, and consumer concerns surrounding this medium have not been fully investigated to date. This paper examines the privacy concerns that the consumer has when providing personal details when transacting with virtual companies. The paper goes on to explore consumer awareness of virtual company's privacy policies and seal programmes that were designed to address these concerns. The key objective is to: identify and analyse the concerns of the Irish population in relation to data privacy when purchasing from virtual firms. The researchers have taken a quantitative approach to the research, having developed a survey questionnaire for the purposes of eliciting consumer views relating to privacy concerns when purchasing from virtual firms in the Irish context. A literature review preceded the research instrument development, which consisted of a pilot study and expert advice. The main survey was conducted throughout Ireland's South East region, in selected cities, and small towns. Results suggest that privacy concerns are high, but conversely, that there is little awareness of privacy policies or seal programmes among Irish consumers. Notably, consumers are unlikely to have read a virtual organisation's privacy policy despite identified concerns, and this finding is consistent among survey participants. Statistical analysis of the survey findings has given meaning to the results.*

1. Introduction

This paper explores Internet users' perceptions regarding the data privacy policies of virtual companies operating in Ireland. Virtual companies have introduced new elements of risk and trust criteria for Internet users (Arcand et al., 2007; Wirtz et al., 2007), and consumer concerns surrounding this medium have not been fully investigated to date (Arcand et al., 2007). The paper examines the privacy concerns that the consumer has when providing personal details when transacting with virtual companies. The paper goes on to explore consumer awareness of virtual company's privacy policies and seal programmes that were designed to address these concerns. The key objective is to identify and analyse the concerns of the Irish population in relation to data privacy when purchasing from virtual firms. The researchers have taken a quantitative approach to the research, having developed a survey questionnaire for the purposes of eliciting consumer views relating to privacy concerns when purchasing from virtual firms in the Irish context. A comprehensive literature review preceded the research instrument development, which consisted of a pilot study and expert advice. The main survey was then conducted throughout Ireland's South

East region, in selected cities and small towns, and a statistical software package was used to analyse the customer views collected in the main study.

2. Literature Review

From a privacy perspective, while information building from data collected in earlier communication methods was incidental (Nissenbaum, 1998; Clarke, 1999) technological advances in the 1990s meant that data capture and analysis was feasible (Turner and Dasgutpa, 2003; Smith et al., 1996), and therefore valuable from a business perspective. As a result, increasingly detailed technologies have emerged for information gathering and storage such as data mining and data warehousing in the last 15 years – although businesses argue that mining personal information is used to advance consumer convenience in addition to furthering their own business objectives (Flammia, 2000). For example, these technologies allow firms to target consumers in one-on-one marketing campaigns and offer a more personal shopping experience (Wirtz et al., 2007). This data can then be merged and manipulated to build a detailed picture of a person's buying behaviour, search patterns, and 'online' activities; and companies can now connect this information with amassed data offline, such as demographic data, to build very powerful and detailed profiles of a person, for all aspects of their business (Garau and Serban, 2003; Graeff and Harmon, 2002).

As the number of on-line consumers grow[i], concern relating to trust, information usage, information storage and the ethical use of data is likely to increase, and have an impact on on-line activity (Lee and Turban, 2001). For example, three quarters of Internet users are concerned about having control over the release of their private information when using on-line services (Ashrafi and Kuilboer, 2005), and this appears to be having a direct negative impact on projected on-line sales figures (Arcand et al., 2007; Meinert et al., 2006). This perspective is reinforced in Graeff and Harmon's (2002) research, which found that while 25% of respondents felt comfortable providing their credit card details online, 86% would be willing to use their credit card in a shop. Thus consumers' willingness to provide personal data online is directly linked to the success of online sales and the virtual firm (Malhotra et al., 2004; Meinert et al., 2006). This has created new issues around privacy and respect for consumer information, unforeseen in the earlier stages of Internet development (Shea, 1990), and it is this aspect of on-line consumer activity that is the focus of this paper.

2.1 The virtual firm and consumer data privacy concerns

A virtual store as one that: "represents a private retailer, without a fixed showroom and face-to-face contact, utilising information techniques and the media to communicate with consumers" (Lee, 2007, p.182). Because these firms do not have a physical presence on the High Street, consumers' assurance signals and risk management strategies may be altered when contemplating a purchase from these firms (Milne & Culnan, 2004; Gefen et al., 2003), which in turn may impact the sale. For example, the perceived risk to consumer privacy may be higher when the consumer does not have a firm to physically visit (Hoffman et al., 1999), or when they cannot 'see' the virtual firm's customer base (Steward, 2003), or ask about its reputation (Milne and Culnan, 2004). Privacy concerns may be amplified when an organization does not have an offline presence (Gefen et al., 2003; Steward, 2003), as is the case with a virtual store. Notably, despite the many commercial and convenience advantages for the consumer, including 24-hour access, wide ranges

[i] As of June 2008, 1.4 billion people use the Internet (Internet World Stats, 2008), and this is predicted to increase, with advances in technology expanding uses for the medium (Caudill and Murphy, 2000).

of products and services on a global scale, and lower cost (Lee, 2007; Tapp, 2001); there has been a relatively low consumer acceptance of virtual stores. Studies have shown that online shopping activity is relatively small compared to alternative shopping methods, and security and privacy fears are regularly cited reasons for the slow uptake of electronic commerce by end consumers (for example: Jarvenpaa and Todd, 1997; Kotzab and Madlberger, 2001; Chen and Tan 2004).

Privacy in this regard relates to information privacy, which is the ability of an individual to personally control information about one's self (Stone et al., 1983) while data privacy refers to the evolving relationship between technology and the legal right to, or public expectation of privacy in the collection and sharing of data. Foxman and Kilcoyne (1993) argue that information privacy exists only when a person is (1) given control over personal information and (2) informed about data collection and other issues. Users control of information is an essential part of information privacy, and can be fulfilled when users can agree how their information will be used, when users can modify their information, and when users can choose to opt in/out of any activity when online (Foxman and Kilcoyne, 1993). As people begin to depend on the Internet as a part of their daily lives, they are starting to find that they lose a sense of control over their personal information, and how that information is used by companies (Chen and Rea, 2004). The sophistication of the collection and manipulation of information makes it difficult for an Internet user to keep track of their personal information, as a profile of them can be built up from many different sources (Caudill and Murphy, 2000). This linking of data means that users can only control parts of their own profiles, and can be left unaware of collective information held about them (Turner and Dasgutpa, 2003; Caudill and Murphy, 2000). In fact, it has been found that the public can be unaware of how much their information is being manipulated, or how much their privacy is being put at risk (Kruck et al., 2002). Notably, information privacy has been called "one of the most important ethical issues of the information age" (Smith et al., 1996, p.168), while privacy concerns or an unwillingness to disclose personal information are seen as threatening electronic commerce and the digital economy (Culnan, 2000). Therefore, clear privacy policies may provide consumers with greater comfort when managing the risk of disclosing personal information on-line (Milne and Culnan, 2004), and ultimately impact their willingness to buy.

In recent years, a number of virtual firms have established data privacy policies and statements in an attempt to (a) alleviate consumer's privacy concerns, and (b) differentiate between legitimate and disreputable businesses operating on the Internet. As there are several dimensions to individual concerns about an organisation's personal information practices: collection of personal information; internal or external unauthorized use of personal information; errors in personal information, and improper access (Smith et al., 1996). A virtual firm's privacy policy should address each in order to alleviate consumer concerns when interacting with their website, while the privacy statement should present *"Information on a web site explaining how and why an individual's data are collected, processed and stored"* (Chaffey and Wood, 2005, p.631). Findings suggest consumers tend to trust published privacy statements or privacy seals located on websites (Ackerman et al., 1999; Westin, 1996), while subsequent studies found that the presence of these privacy tools increases trust in the system and in the virtual company (Pan and Zinkham, 2006; Liu et al., 2005; Lee and Turban, 2001).

Notably, it has been found that users do not read privacy policies (Arcand et al., 2007), and are largely unaware of the privacy technology solutions available to them (Turner and Dasgutpa, 2003). This may be due to the fact that reading privacy notices is only one element in an overall strategy consumers use to manage the risks of disclosing personal information online (Milne and Culnan, 2004). Furthermore, privacy policies sometimes do not include all data handling practices, and can leave out potentially vital information about those practices. Users can also have difficulty understanding verbose legal policies, and have no way of checking if a company is fulfilling the claims made on their privacy policy (Lawton, 2001; Pollach, 2006). Sometimes the policy is simply a statement of intent by a website that they intend to share information gathered with third parties, rather than explaining the data management process. The privacy policy is then a means of protecting the website from any legal issues, as the user has been informed that the website intends to share the information provided by the user (Meinert et al., 2006). Interestingly, the relationship between privacy concern and motivation to read a privacy statement has not been tested empirically (Milne & Culnan, 2004), suggesting that these criteria may be inconclusive.

Finally, although many websites have adopted a more privacy friendly face, with the majority of sites containing some type of privacy policy and/or statement (Adkinson et al., 2002), effective deployment of these policies is not evident (Ashrafi and Kuilboer, 2005; Clarke, 1999; Greisigner, 2001). When people realise their information is being used in ways that are not obvious from how it is gathered, they can become concerned, and alter how they behave online (Cranor, 1998). Survey analysis by Hoffman et al. (1999) found that 95% of Internet users have declined to provide information to any given website when asked, with 40% of those who have provided their details, providing false information. Furthermore, Cranor et al. (1999) found that users were more likely to provide information when not identified, and that data sensitivity has an impact on declaration (a view supported by: Milne, 1997; Phelps et al., 2000). These concerns are not without justification. A study by Pollach (2006) has shown that companies admit to practices which do not uphold user privacy, such as data sharing (that is the sharing of users' email addresses and personally identifiable information) with third parties, selling customer data, and allowing third parties access to data, without agreeing to any privacy protection in the interests of the consumer. There have also been accusations of 'big brother' activity by firms operating on the Internet (Cutler, 2006), an example of which includes Amazon's announcement in the year 2000, that in the event of the company's bankruptcy, databases of customer information would be treated as an asset, and sold as such (Gurau and Serban, 2003). Despite these findings, there is little evidence in existing literature that Internet usage, privacy policies and users' privacy concerns have been investigated in any real depth, and there have been numerous calls for further research to be carried out in this arena (for example: Bellman et al., 2003; Arcand et al., 2007; Ashrafi and Kuilboer, 2005; Writz et al. 2007). To the authors' knowledge, user perception regarding virtual firm's data privacy policies has not been studied at all in the Irish context. Thus, the aim of this research study is to explore Internet users' perception regarding data privacy policies of virtual firms operating in Ireland.

3. Research Methodology

As this research aims to quantify user perception regarding virtual firm's online data privacy policies, a survey of the attitudes and comfort levels with information disclosure, using a

questionnaire, with quantifiable results for analysis is deemed the most appropriate methodology in context (a view supported by: Oates, 2006). The authors took an iterative approach to the design of the research instrument, in pursuit of triangulation (as advised by Denzin, 1970). Thus, a pilot questionnaire was designed as informed by the literature review, which was then brought through several iterations, with advice from multiple experts (as advised by: Easterby-Smith et al., 1991; Oppenheim, 1992). The pilot consisted of the face-to-face administration of the questionnaire, followed by a short follow-up interview to further explore the questions asked in the survey, the results of which led to small refinements to the research instrument.

3.1 Survey Development and Sample

The authors considered appropriate question wording, sequence and response choices (Dillman, 2000) when designing the research instrument, in an attempt to ensure that both the response rate (Dillman, 2000; McNeill and Chapman, 2005) and the reliability of the resultant responses (Robson, 2002) were maximised. The researchers' further deliberated on the optimum data collection approach (Oppenheim, 1992), in light the research question [to investigate Irish perception regarding online data privacy of virtual firms operating in Ireland], and agreed that a face to face survey would: offer control over how the questions were asked; offer an opportunity to clarify any issues or confusion that may have arisen; and have a positive effect on the response rate (McNeill and Chapman, 2005; Robson, 2002). To overcome the potential introduction of bias (Oppenheim, 1992), the main study was conducted in a carefully selected city (42% of respondents), town (34.6%), village (12.3%) and rural setting (11.1%) within the south east of Ireland. By selecting different times of day and different days of the week to conduct the study (e.g. weekend versus weekday; mornings versus afternoons) the researchers ensured the sample consisted of a wide range of people. Researcher bias was further addressed by employing quasi-random sampling, choosing every third person who passed by the researchers on the street, thereby ensuring stability, representative, and equivalence reliability (Sarantakos, 2005). Each survey took on average 10 minutes to complete, and each respondent answered the questionnaire in full. A total of 81 respondents successfully completed the survey (Tab 1).

3.2 Data Measurement

As the purpose of the questionnaire was to survey user opinions on Internet data privacy, the authors' used the research objectives as a starting point in the construction of the research instrument, which was ultimately broken into seven sections to reflect its purpose:

1. General Internet usage: This section gathered information about the amount of time respondents spent on the Internet, what they used it for, and online purchasing habits.
2. Consumer interaction with virtual firms: This section examined if the respondent used virtual firms, and examined the importance of website features while using virtual firms. These features included privacy policies and procedures.
3. Attitude toward online information requests: The purpose of this section was to understand the attitude the respondent has when asked for personal information while online, and if it differs when the information is linked to the purchase transaction, or not linked to the transaction.
4. Comfort with information disclosure: This section examined how comfortable the respondent was disclosing different types of personal information to an online company.
5. Company collection, storage and privacy policies: This section assessed awareness of how and where information gathered by online companies is used and stored. This section also assessed awareness of terms and phrases used in relation to online privacy, and opinions regarding privacy policies found on websites.

Table 1: Respondents' Profile

(N=81)

Parameter	%	Parameter	%
Gender		**Employment Status**	
Male	50.6	Full-time	66.7
Female	49.4	Part-time	8.6
Age		Self employed	1.2
18-25	30.9	Homemaker	3.7
26-35	34.6	Unemployed	2.5
36-45	16.0	Student	11.1
46-55	8.6	Other (Retired)	6.2
55 and over	9.9	**Income**	
Education		Less than 10,999	8.6
1st level	2.5	11,000-20,999	3.7
2nd level	38.3	21,000-30,999	34.6
Technical	11.1	31,000-45,999	19.8
3rd level	39.5	46,000-69.999	4.9
Professional	7.4	Above 70,000	2.5
Omitted	1.2	Omitted	25.9

6. General Internet usage: This section gathered information about the amount of time respondents spent on the Internet, what they used it for, and online purchasing habits.
7. Consumer interaction with virtual firms: This section examined if the respondent used virtual firms, and examined the importance of website features while using virtual firms. These features included privacy policies and procedures.
8. Attitude toward online information requests: The purpose of this section was to understand the attitude the respondent has when asked for personal information while online, and if it differs when the information is linked to the purchase transaction, or not linked to the transaction.
9. Comfort with information disclosure: This section examined how comfortable the respondent was disclosing different types of personal information to an online company.
10. Company collection, storage and privacy policies: This section assessed awareness of how and where information gathered by online companies is used and stored. This section also assessed awareness of terms and phrases used in relation to online privacy, and opinions regarding privacy policies found on websites.
11. Non Internet users: This section assessed those respondents who do not use the Internet.
12. Demographic information: This section records the respondents' demographic information.

The statistical software package SPSS was used to collate and the collected data, and to carry out a range of data analysis, the results of which are outlined in the findings.

4. Discussion

The selected context, South East Region offers a fair representation of the rural/urban mix prevalent in Ireland, and national statistics offered a basis from which to gauge the research findings. Irish use of the Internet has steadily grown over the last decade, from 5% of households in 1998 to 57% in 2007 (CSO, 2007). National statistics show a regional divide in access to the Internet, with 47% of the population of the South East of Ireland having Internet access at home, compared to 39% of the Midlands and the West of Ireland (CSO, 2005) Notably, many of the population who do not have Internet access at home have access to the Internet at work, and an estimated 528,800 people in Ireland use this communications medium at least once a day (CSO, 2005). Finally, more than 587,000 Irish people bought goods and services online in 2005 (CSO, 2005), compared to just 76,000 in 2003 (Amas, 2006a), thus online consumer activity is growing exponentially in recent years. The most popular purchases are travel related (flights and accommodation), followed by music and film, and event tickets.

4.1 General Internet usage

Over 75% of respondents had Internet access at home, with 59% having access at work. General Internet usage was found to be significant among all the respondents, with over 80% using the Internet on a daily or weekly basis. These Internet usage levels are consistent with the findings of the CSO (2005) national and regional studies and the Internet world statistics (2008) from a global perspective. Factors which affected Internet use included age, the older the respondent, the less likely they were to have used the Internet, and higher education levels were likely to equate to higher Internet use, reinforcing the findings of Moorman (1990), Cole and Gaeth (1991) and Stewart and Martin (1994). Income levels, gender and place of residence had little impact on Internet use. The primary reasons for going online were to use email, for entertainment, to shop and for 'travel', implying both booking travel and travel related searches. These online purchase patterns reflect those of Amas (2006a), wherein travel and entertainment topped the online acquisitions among surveyed users. Respondents indicated that they enjoy browsing the Internet, and each felt they were confident using Internet search engines. 71% of respondents who had used the Internet had purchased good and services online, and had used virtual firms on a regular basis. Of those respondents who had shopped online, 45.5%, purchased from the Internet 2 to 3 times per year, while 34.1% purchased once per month. Notably, 90.9% of respondents used their personal credit card rather than a payment vendor when purchasing online, suggesting that consumer concern is not impacting willingness to provide personal data online, in contrast to Malhotra et al. (2004), Ashrafi and Kuilboer (2005), and Meinert et al.'s (2006) research findings/

4.2 Consumer interaction with virtual firms

From a consumer interaction perspective, respondents attached a high level of importance to the presentation of elements of a website, and each felt it was important that the website's instructions be easy to read and understand, and that the site be easy to use (Tab 2)

Respondents also placed a high level of importance in the capability of the site, that their transaction be processed quickly, and that a contact phone number or email address be displayed

Table 2: Features impact on satisfaction with site

Site Features	N	Mean	Standard Deviation
Information on procedures and policies easy to find	58	3.86	1.083
Recognizable icons/logos	58	3.38	1.182
Website easy to use	58	4.43	0.775
Purpose of information collection clearly stated	57	4.02	0.954
Website has privacy seal of approval	58	2.93	1.461
Website storing preferences/details for a return visit	57	2.81	1.202
Other	9	3.56	1.590

on the site, implying that even though the respondent was not carrying out the transaction in a face-to-face environment, they still require the ability to contact the website operators directly. This behaviour points to some of the underlying privacy fears that online consumers face when transacting with virtual organisations, as outlined by Jarvenpaa and Todd (1997), Kotzab and Madlberger (2001) and Chen and Tan (2004) in the literature review. They also reinforce Hoffman et al.'s (1999) perspective, as consumers appear to be attempting to alleviate a perceived risk to consumer privacy by ensuring they can physically contact the virtual firm.

4.3 Attitude toward online information requests

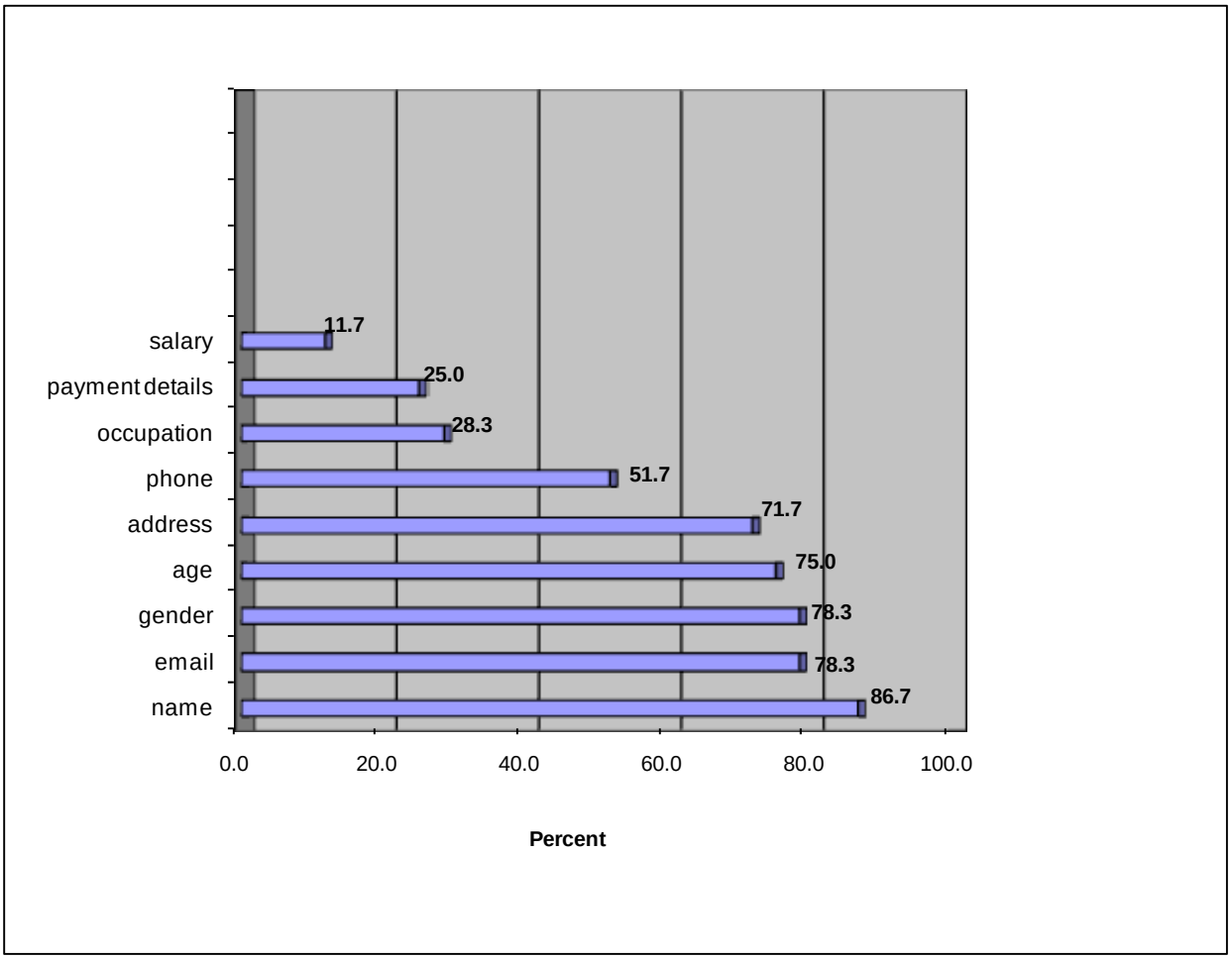
With reference to online consumer attitude toward information requests, respondents indicated that the purpose of information collection being clearly stated was an important factor in adding to their comfort when using a website. These surveillance concerns echo those found in Kruck et al. (2002) and Caudill and Murphy's (2000) research. Respondents agreed that an online company needed their personal data to process a transaction, and were not concerned by online company requests for relevant information. However respondents were always concerned by personal information requests when the information was not linked to the transaction. The underlying 'big brother' perception held by respondents in relevant research studies (for example: Cutler, 2006; Turner and Dasgutpa, 2003; Chen and Rea, 2004) was again reflected in this study, with a mean response of 3.92 out of 5 when asked if it was necessary for an online company to collect personal information to process a transaction, yet a higher response of 4.45 when the respondent was asked if they were bothered by the request for information not directly linked to the transaction. The length of time respondents had been using the Internet, and the frequency of their Internet use also had an impact on their comfort levels with the request for personal information not linked to their transaction. Those who had been using the Internet for one year to less than two years (11.3%) were bothered by the request, as were those who had been using the Internet for two years and over (74.2%). However those who had been using the Internet for less than one month to less than one year

(14.5%) were not as bothered by the request. Frequent Internet users, those who used the Internet daily or weekly were more bothered by personal information requests not linked to the transaction, than those who used the Internet monthly/few times per year/rarely. Respondents' privacy concerns do not appear to have an impact on the use of virtual firms however, with 67.7% of Internet users in this study having purchased from at least one, and 90% having used their personal credit card when paying for transactions. This represents a disconnect between privacy concern and action on the part of the consumer, and is at odds with previous research (for example: Malhotra et al., 2004; Meinert et al., 2006; Graeff and Harmon, 2002, among others).

4.4 Comfort with information disclosure

User comfort was dependent on the type of information requested. Specifically, comfort was high when the user was asked to provide their name (86.7%) and email address (78.3%). However this comfort diminished on a sliding scale as they were asked for their postal address (71.7), phone number (51.7%), occupation (28.3%), payment details (25.1%), and salary (11.7%) – Fig 1.

Figure 1: Comfort levels with Information Disclosure



Company collection, storage and privacy policies

Respondents were asked on a scale of one to five, how much they agreed with a set of seven statements about Information collection, storage and use, with "1" meaning "Strongly Disagree", and "5" meaning "Strongly Agree". Respondents indicated that they are satisfied that an online company will protect their data, with an average response of 3.29 for this question. 42% of the respondents to this question selected either 4 or 5 for their response (Tab 3). These findings contrast to responses given in Figure 1, where respondents were uncomfortable disclosing certain information.

Of note is the finding that while respondents are willing to give their name and email address with relative ease, they were more sensitive when providing their postal address, phone number, occupation and salary. These findings reflect those of Milne (1997), Phelps et al. (2000) and Cranor et al. (1999) who pointed to data sensitivity as a significant factor when providing information in a virtual environment, although the authors assume that data sensitivity is at least partly justified based on the historic activities relating to the selling of data (Cutler, 2006; Gurau and Serban, 2003).

Table 3: Information use

Site Features	N	Mean	Standard Deviation
A: All Information is private when using an online company	59	3.46	1.330
B: Online companies use my information indefinitely after the transaction	59	3.37	1.425
C: Online companies require user permission to use the information after the transaction	59	4.22	1.018
D: Online companies must disclose use of my information	59	3.61	1.414
E: I am satisfied that an online company will protect my data	59	3.29	1.301
F: An online company can use my personal information with my permission	58	4.12	1.061
G: An online company can sell my personal information to a third party with my permission	59	3.66	1.397

4.5 Privacy policy awareness

While respondents indicated they were familiar with the term/phase: 'privacy policy' and the 'Data Protection Act', information on the website owner's privacy procedures and policies, and the

presence of a privacy seal of approval were not rated as being as important by these respondents. Notably, reading a site's privacy policy was not seen as a priority, just 30.6% of respondents have read a virtual organisation's privacy policy despite identified concerns (as predicted by Arcand et al., 2007). Notably, this finding is at odds with Foxman and Kilcoyne (1993) and Chen and Rea (2004) research outcomes. The respondents indicated that they did not always read the privacy policy before using a website, reinforcing the findings of Turner and Dasgutpa (2003). Furthermore, respondent awareness of how virtual companies' use and store information gathered about them while using the Internet is not affected by their prior knowledge of privacy policies (Tab 4).

Table 4: Multi-variable analysis - read a privacy policy*knowledge about information storage and use

		Information Use Statements						
Read a Privacy Policy		**A**	**B**	**C**	**D**	**E**	**F**	**G**
Don't Know	Mean	4.50	2.00	4.00	2.50	3.50	4.00	3.00
	N	2	2	2	2	2	2	2
	Std. Deviation	.707	1.414	1.414	2.121	2.121	1.414	.000
No	Mean	3.58	3.26	4.32	3.89	3.39	4.16	3.66
	N	38	38	38	38	38	37	38
	Std. Deviation	1.388	1.408	.842	1.226	1.264	1.041	1.457
Yes	Mean	3.11	3.74	4.05	3.16	3.05	4.05	3.74
	N	19	19	19	19	19	19	19
	Std. Deviation	1.197	1.408	1.311	1.608	1.353	1.129	1.368
Total	Mean	3.46	3.37	4.22	3.61	3.29	4.12	3.66
	N	59	59	59	59	59	58	59
	Std. Deviation	1.330	1.425	1.018	1.414	1.301	1.061	1.397
P-Value (ANOVA)		.241	.192	.632	.093	.636	.925	.783

It is of relevance that these respondents believed the layout and cohesiveness of privacy policies they had read were not good, reinforcing Lawton (2001) and Pollach (2006)'s conclusion that users can have difficulty understanding site policies in this context. Surprisingly, respondents were under the impression that online companies require user permission to use information after the transaction, with a mean response of 4.22 out of 5 in agreement, and that online companies can only use personal information with user permission, suggesting lack of legal and regulatory awareness on the part of consumers. Notably, respondents' level of familiarity with the term 'Data Protection Act' appears to have little impact on what happens to their information once they have disclosed it (all P values are higher than 0.5), corresponding with the findings of Gurau and Serban (2003), who found that Internet users have little awareness of how companies use their information, and have little knowledge about laws and regulations in existence to regulate the

storage and use of their information. Finally, recognisable icons and logos did not have an impact on respondents' satisfaction when using a website, suggesting that brand identity does not have an impact on trust in the privacy context, in contrast to previous findings (Stewart, 2003; Milne and Culnan, 2004). Thus, user assumptions do not necessarily equate to the individual site's privacy policy, or to data and privacy laws and regulations under Irish jurisdiction.

5. Conclusion and Recommendations

This paper examined the privacy concerns that the consumer has when providing personal details when transacting with virtual companies, and has explored consumer awareness of virtual company' privacy policies and seal programmes that are designed to address these concerns. The key objective in this research was to: identify and analyse the concerns of the Irish population in relation to data privacy when purchasing from virtual firms. Research results suggest that privacy concerns are high, but conversely, that there is little awareness of privacy policies or seal programmes among Irish consumers. Notably, consumers are unlikely to have read a virtual organisation's privacy policy despite identified concerns, and this finding is consistent among all respondents. The privacy policy's accessibility in terms of language and flow is of particular relevance in this regard, and respondents indicated that the purpose of information collection being clearly stated was an important factor in adding to their comfort when using a website. Finally, respondents were unlikely to truthfully answer personal questions posed by the virtual firm if they perceived the question to be irrelevant in the commercial transaction at hand. This research study highlights the need for more user-friendly privacy policies, and more transparent information as to the intended consumer data use to be provided by virtual firms. Furthermore, the findings imply that more visible policies regarding a virtual firm's collection, storage and use of personal information can contribute to user comfort when purchasing on the Internet. As this study was confined to the population of the South-East of Ireland, rolling out this research to other regions in Ireland, or abroad, could provide cross-regional/cross-country data in relation to the studied criteria.

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