Preliminary examination of a failed motorbike fuel tank.

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Fuel tank leakage observed to a motorbike in less than three years time after covering ten thousand kilometers of distance. The reservoir replaced by a new one which also presented a leakage after 4 months of use. The failure of the fuel tank was investigated. Visual inspection of the component was carried out and color photographs were taken of all parts, fixtures, and failed surfaces. Technical specification data of the component were recorded. Thickness and homogeneity of the material from which it was constructed, was inspected by ultrasonic gauging and non destructive tests were applied to detect the region of leaks. Chemical analysis was carried out for the material identification and hardness measurements were conducted. The tank constitutes of two parts (the surface plate and the base) joined with seam welding. Strips and sheets are used for the assemblement with the main body of the motorbike. Spot welding is considered to be the main cause of the failure.

1. Introduction and Background Information

Increasing competition in global markets and economic recession lead the automotive industries to improve the product quality and reliability. Any vehicle which gets into the market has a predicted guarantee. Fierce competition pushes manufacturers in this field to make better and better offers. In these conditions, they have to face the continuous vehicle lifetime improvement. The vehicle lifetime is mainly determined by the service life of its components [1]. If a component becomes incapable of satisfactory performance for its intended function before its predicted life, it is considered as failed [2]. The failure may be catastrophic in automotive industries and should be immediately reported and carefully examined. The failure analysis is looking for the failure causes. Once the reason is determined, helpful measures can be suggested in order to avoid future similar problems. Failure investigations often uncover information that led to improvement in design, manufacturing, use or maintenance.

Welding is remaining the most frequently used sheet metal joining process in automotive industry due to its high productive rate which can be achieved and reliability in service. However, because the welding operations are relatively simple to perform, it is easy to forget the complexity of the chemical and metallurgical actions that are taking place during and after operation [3]. Therefore, not surprisingly welds occasionally fail. Weld may fail due to

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overstress [4-6], under-design [7], bad welding method [8], metallurgical reasons [9] and weld defects [10].

This paper refers to the failure of a motorbike fuel tank (Fig. 1a). Leakage of fuel was observed while cumulatively covered ten thousand kilometres, in less than three years time. The fuel tank was replaced by a new one of the same company which failed by the same way after four months of use, proving that it is not a random incident. The initial fuel tank was subjected to failure analysis.

Figure 1: (a) General aspect of the motorbike, (b) Point of the fuel leakage.

2. Experimental Details

The study comprises several areas of interest. Starting with initial observation, detailed study by visual inspection of the failed component that was carried out and color photographs were taken of all parts, fixtures, and failure surfaces. Witnesses of the failure were interviewed and all information were recorded. Data concerning the construction specifications of the part were studied. Specifications such as drawings, component design fabrication methods, welding procedures, use and repair in service were recorded. Part of the information were available on the vehicle technical manual [11]. Thickness and homogeneity of the material used for the manufacturing of the tank were inspected by ultrasonic testing. In an apparatus for Positive Material Identification, a twin-head type Croud Crammer (D=10mm, 5 MHz) and an electronic digital (DM4) were used. Non-destructive tests using water were applied to detect the points of the leak. The component was cut by a hand wheel cutter and samples were selected for in-depth examination. Chemical analysis was carried out for the material identification. An optical emission spectroscope, type Thermo Scientific ARL was used. Vickers Hardness testing was conducted using an Alpha Duromatic instrument [12].

3. Results and Discussion

As the fuel flow outside the tank was impalpable, it was not possible to estimate the exact moment of the failure. According to the owner of the motorbike, operating conditions and maintenance were conformed to technical requirements.

The main role of the tank is for fuel storing and preventing its inflammation. Gasoline is a flammable material and the sealing of the fuel tank is essential for the security of the passenger and the environment. The tank consists of two parts (the surface plate and the base) joined together with seam welding. Strips and sheets are used for its assemblement with the main body of the motorbike (Fig.2).

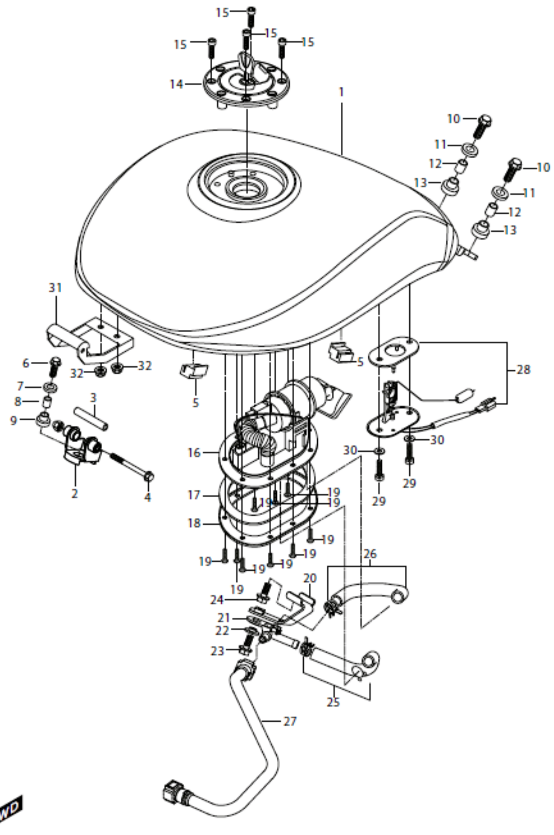

Figure 2: Assembly drawing of the fuel tank [11].

The fuel tank has dimensions of 680mmX410mm and its gray color is due to its galvanized surfaces (Fig. 3a). It displays aerodynamic complex geometry (Fig. 3b). Visual inspection revealed small scratches throughout the surface that could have been caused by part disassembly or its replacement, or during refuelling process.Its surface quality could not lead to failure.

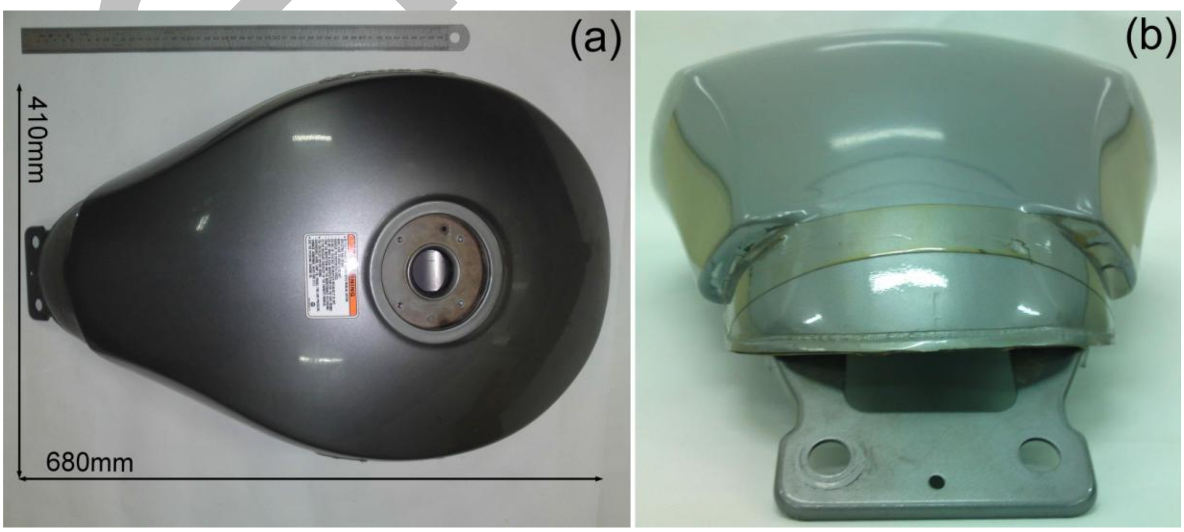

Figure 3: General aspect of the fuel tank: (a) Upper side, (b) Back side.

On the upper side the refueling hole consists of four concentric circles (Fig. 4). Four threads, a hole and a connective plate configuration ensures sealing fit with the cap. This area is corrosion free.

Figure 4. Fuel tank detail; hole for fuel supplement.

The bottom part of the tank is a cold drawn sheet where secondary components are welded onto it (Fig.5). These two configurations (top and bottom) welded by resistance seam welding. On the back side, a protrusion used for the attachment to the main body of the machine (Point 1 on Fig.5). Near the engine, foam (porous) material coated with aluminum tape, ensures fire protection (Point 2 on Fig.5).The fuel is flowing from the tank through the weldment (Point 3 on Fig.5).The surrounding area is partly covered of spatter, originated from excessive use of current during welding. The tank is attached to the main body of the vehicle through four guiding curved sheets. Half of them are flexible, located close to the center and welded by stud welding. The rest of them are non flexible, located on the side of the part and are welded using low temperature melting alloy (Point 4 on Fig.5).

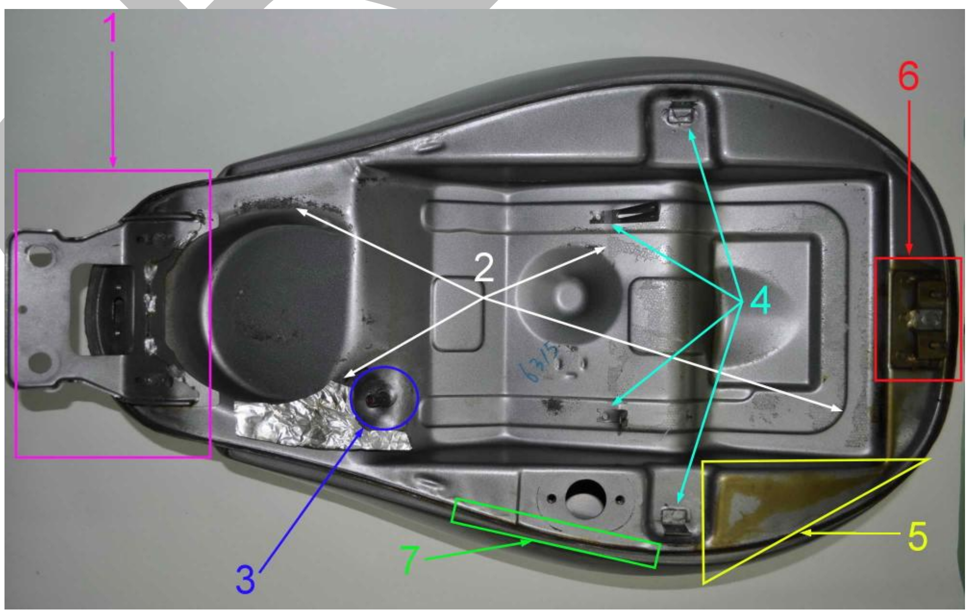

Figure 5: General aspect of the fuel tank; Bottom view of the tank.

A golden color area is observed due to the continuous flow of fuel (Point 5 on Fig.5). The location can be justified because while parking the vehicle leans to the left side. The failure point is located on the connecting component on the front part of the tank (Point 6 on Fig.5). Firstly, the modulated sheet is fixed by resistance spot welding with the main body, and then the formed strip was welded on it by resistance and arc welding accordingly. (Fig. 6a). On the part of the tank which was seam welded, twenty two (22) perimeter linear discontinuities were observed. (Point 7 on Fig.5 and Fig. 6b). There was no leakage at this area.

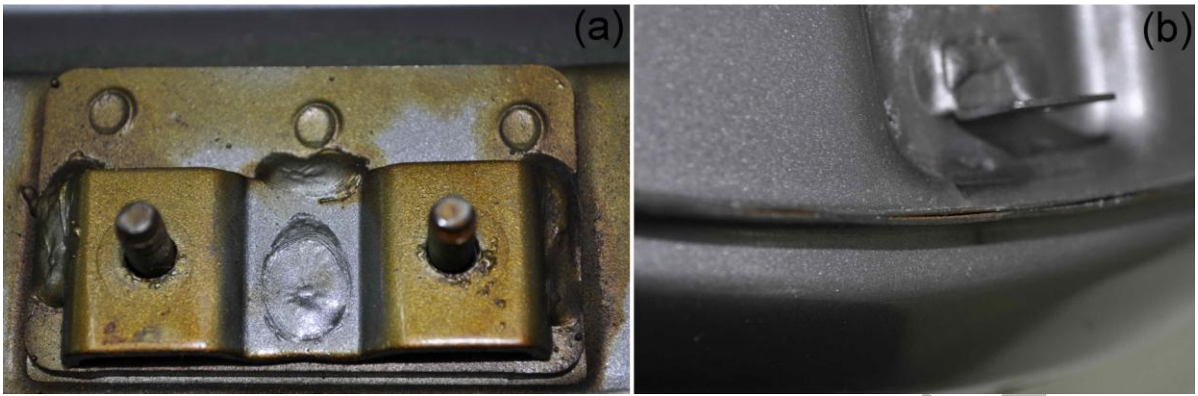

Figure 6: Fuel tank details; (a) Welding points on the failure area (b) Cracks on the circumferential seam welding line.

The thickness of the sheet metal was measured by ultrasonic test. For this purpose, the surface was scrubbed in order to remove the protective coating layers. Found homogeneous sheet metal thickness of 2,15 mm. To identify leaks, the tank was supplied with 10L of water and placed horizontally for 15 hours. No efflux detected. During operation, the machine is heated and gasoline is evaporated. The high pressure steam which is produced opens the fuel tank capillary cracks. The water pressure was insufficient in detecting extremely thin cracks, proving that the existence of this kind of cracks need further examination. Samples were selected and prepared for chemical analysis and hardness measurements. Firstly, the fuel tank was cut in three pieces (Fig. 7a). The first fragment was cut into smaller parts and suitable samples were taken (Fig. 76b).

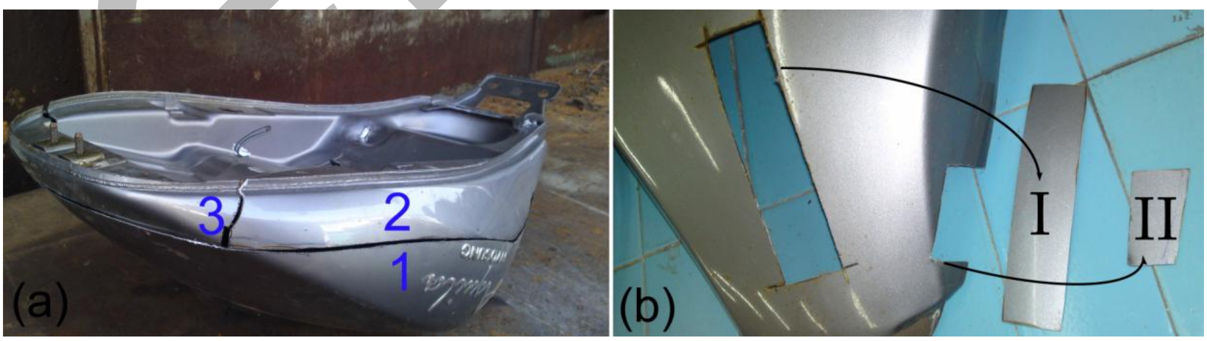

Figure 6: (a) First fuel tank fragmentation, (b) Sample selection from the first fragment; I-sample for chemical analysis, II- sample for hardness measurements.

Hardness measurements were performed on different points on the internal surface of the sample I. The piece exhibits a uniform hardness of 113-114 HV. This is a way soft material.

The fuel tank was manufactured from 18CrNi8 (W.Nr:1.5920) steel according to DIN 17007.Table 1 presents the chemical analysis of the fuel tank compared to the typical chemical analysis according to EDELSTAHL WITTEN-KREFELD GMBH [13] and the International Standards [14]. The results proved that the steel used for the tank manufacturing was the expected one.

Strips and sheets made of case hardening steels are used for parts with improved wear and fatigue resistance [15]. Other benefits derived from surface hardening are resistance to plastic deformation of the part surface, good capacity for contact load, free of quench cracking, good dimensional control and greater ease in grinding and polishing to smooth surface.

Elements[%]	C	Si	Mn	P	S	Cr	Ni
Fuel Tank composition	0.183	0.257	0.431	0.025	0.040	1.910	1.81
Edelstahl Witten-Krefeld GmbH	0.15-0.20	0.15-0.40	0.40-0.60	≤0.035	≤0.035	1.80-2.10	1.80-2.10

Table 1: The chemical composition of the tool compared to the nominal composition proposed by Witten- Company and international standards.

4. Conclusions

Upon visual inspection of the tank, imperfections detected due to careless welding of the parts on the base. In specific:

- Cracks all over the region of seam welding, which used for the joining and sealing of the two main pieces of fuel tank. Imperfections are generated by a local disruption of the weldment which may result due to the effect of cooling or induced stresses.
- In the majority of the weldings, arc show ejections (spatters). These are bead, weld metal or metal filling, which during welding are ejected and adhere to the surface of the parent material or the solidified weld metal. (Globules of weld metal or filler metal expelled during welding and adhering to the surface of parent material or solidified weld metal).
- It also seems incompletely filled groove in many arc weldings. It is longitudinal, continuous or intermittent channels (notches) on the surface of a weld, due to inadequate welding filler material deposition.
- Also, in many welding electrode appears arc strike (Stray Arc). This localized damage to the surface of the parent material near the weld, results from arcing or striking the arc away from the joint preparation.
- Surface pores are appearing in some of the welds. They are gas pores (inclusions) that break the surface of the weld.
- Discoloration. Visibly tinted surface layers in the weld metal and heat affected zone caused by weld heat and/or by lack of protection.

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Preliminary examination of a cutting-forming tool used in a bridge slot filterpipe machine.

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A local company produces bridge slot screen filter pipes used in drilling industry. Specific cutting tools part of the bridge slot forming machine, brake down repeatedly, interrupting the production process. The paper refers to the preliminary examination of the failed parts. Historical data and recorded background were collected. Visual inspection and macroscopic examination were performed and a complete photographic file was created. Hardness measurements were carried out and chemical analysis was applied for tools steel evaluation.

The failure mode and its potential causes are presented. The failure investigation of these vital for the production tools is essential for industries related to sheet metal cutting/forming as conduce to diminution or elimination of similar damages.

1. Introduction

A local company produces bridge slot screen filter pipes used in drilling industry. They use a specific self-construction cutting-forming machine (Fig.1).

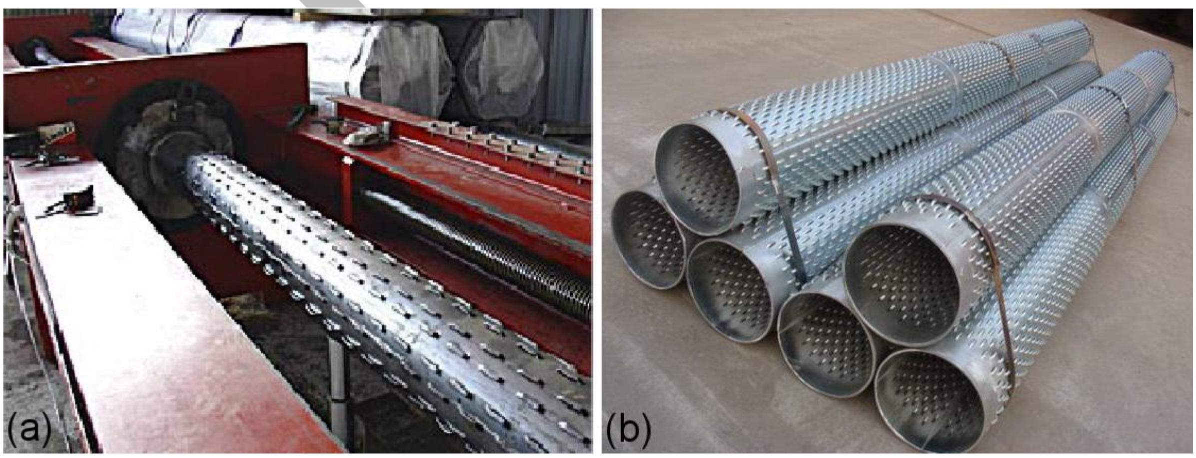

Figure 1: (a) Bridge slot forming machine, (b) Bridge slot filter pipes.

Cutting tools are circumferentially located in a cylindrical, hydraulic, forming die (Fig.2). The cutting tools have extensions to their base. These extensions act as fit and containment guides at their joining with the cylindrical die.

Figure 2: The assembly of cutting tool on internal cylindrical forming dies.

To prevent the linear movement of the tool, they are restrained by two mold caps applied at the two ends of the die. The level of the die, where the cutting tools are based, is inclined so that they can move vertically as the die moves linearly. During the cutting procedure, the cylindrical die is pressed via a hydraulic system. As the die moves, the cutting tools, exit from the die moving perpendicular to the cross section of the tube, forming the bridge slots on the surface of the tube (Fig.3). At the end of their movement the cutting tools interlock at receptors located on the outer mold (external pipe surface). The cutting tools perform a consecutive, repeating motion, perpendicular to the tube, forming the bridge slots, as the tube passes through the die. The stabilization and centering of the forming die, in relation to the external die, where the cutting tools interlock during the procedure, is accomplished through the tube its self.

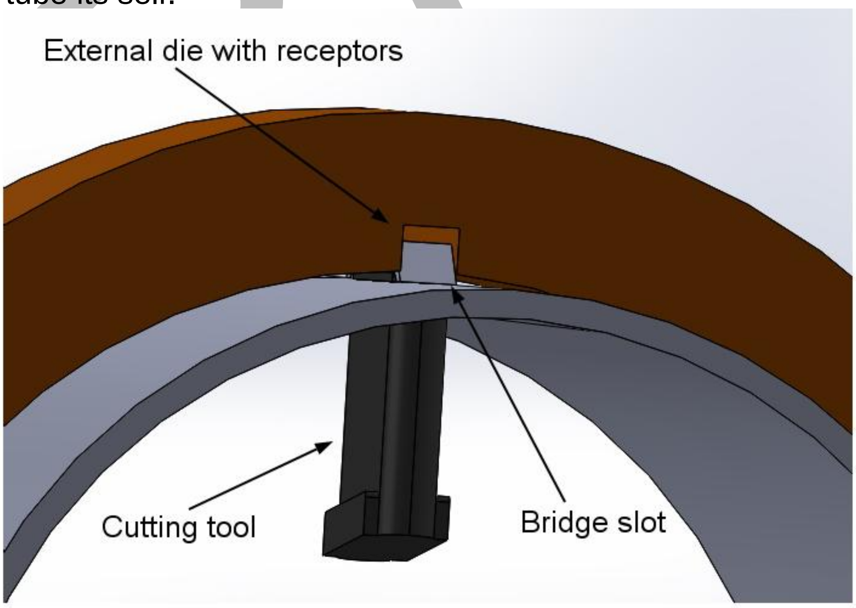

Figure 3: 3D representation of the procedure

The cutting tools are liable to damage as they are typically subjected to extreme compressive stresses during operation. In this case, the cutting tools fail repeatedly during the production process. Their predicted working life is a few hundred working cycles (one bridge slot tube is produced in every working cycle). The life span of the tools varies from two working cycles to one hundred.

The machine is a self-constructed and the cutting tools which are used are designed to the R'n'D department of the company. They were manufactured using Unddeholm Sverker 21(AISI D2) [1]. The material selection of the cutting tool is an important decision as it affects its working life to a reasonable cost [2]. AISI D2 is one of the most characteristic (in terms of cost and material performance) cold working tool steel with extended use in applications that are not involve prolonged or repeated localized heating above 260^{o}C [3]. Relative research conducted on the failure in cutting tools made of AISI D2 steel underlined the importance of correct design, appropriate material selection and suitable steels properties [4-7]. The study of various types delivered practical solutions and significant productivity improvement [8, 9].

2. Experimental Details

The paper refers to the preliminary examination of three representative cutting tools. Historical data and recorded background (concerning the manufacture processing and operation) were collected. Visual inspection and macroscopic examination were performed and a complete photographic file was created. For detailed observation the pieces were cleaned by sandblasting in a machine type Guyson. Sand Guyson grade 13 was used. Dimensional measurements were carried out with a micrometer and a 3D design was created. Hardness measurements were carried out [10]. The steel selected for manufacturing the tools was identified by chemical analysis with a spectrometer.

3. Results and Discussion

For the best understanding of the production process the researcher visited the workplace. It was observed that the machine operates under unsuitable working conditions, in a rather improper industrial environment. Neither cooling system, nor waste absorption system (vacuum system) applied during the operation. The cutting tools are in-house manufactured to the machining department. The final heat treatment of the machined too was performed to exterior shop. The heat treatment sequence (hardened and tempered) was as followed: preheating at 650^{o}C for 45min., austenitizing at 1020^{o}C for 35 min., martempering at 180^{o}C for 30 min, 1st tempering at 180^{o}C for 2 hours, 2nd Tempering at 545^{o}C for 2 hours, 3rd tempering at 490^{o}C for 2 hours. The steel manufacturer proposes a final hardness for the tools in a range between 56-60 HRC [2].

According to surveillance and maintenance operators of the machine, in some cases, during the operation, as the cutting tools exit the die and form the slots on the tube, they do not interlock uniformly in the receptors. As a result, the tools are locally stressed, facing unilateral wear. Unilateral stress could be provoked due to variations of the cross section of the pipes, throughout their length (pipe ovality). It was noticed that the stabilization and centering of the internal forming die and shaft, in relation to the external die, is accomplished through the tube, once it is fastened. Tubes' cross-section dimensional differentiations throughout their length are not taken into account, resulting in a displacement of the internal cutting die during their movement.

Three failed pieces were given to the researcher (Fig. 4). All of them were brittle fractured on top. The tools had extended oxidation on their surface. Galling and scratching on the surface of the parts can be observed.

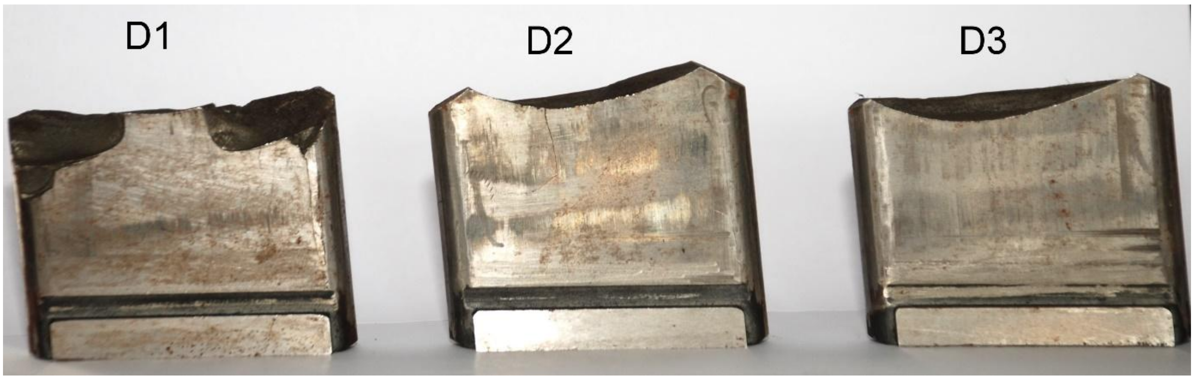

Figure 4: The fragment of the three failed cutting tools.

For more detailed observation the pieces under examination were cleaned by sandblasting. The tools fractured by the same way and approximately to the same area. The fractured surfaces present a typical brittle aspect of very hard steels (Fig.5a). Fatigue striations can be observed (arrows on Fig.5b). Secondary cracks were developed on the fracture surface (arrow on Fig.5a) and perpendicular on the lateral surface (arrow on Fig.5c). Galling is observed on the left side, just over the cutting tool's base extensions as to the cylindrical side of the tool (arrows on Fig.5d).

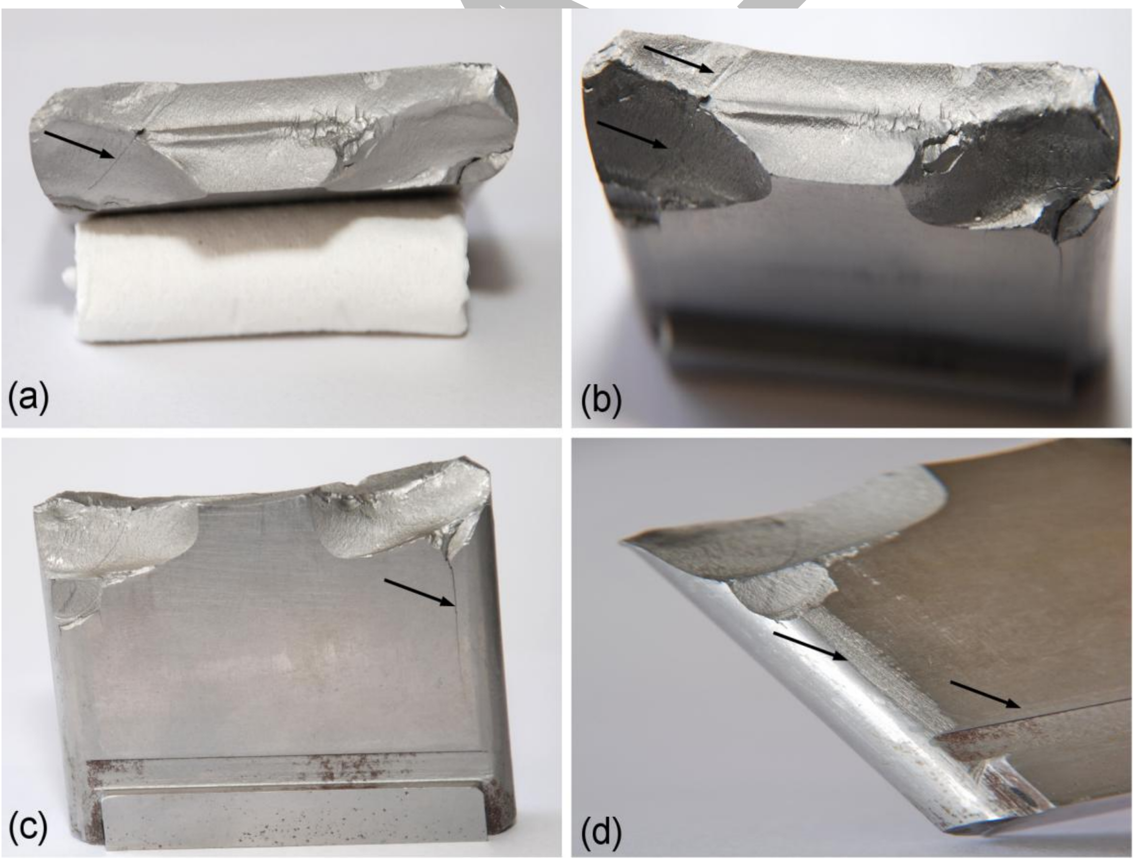

Figure 5: General aspects of the fragment of D1cuting tool; (a) Fracture surface, (b) Striations on the fracture surface, (c) Secondary crack on the lateral surface, (d) Abrasion on the lateral surface of the tool.

A dimensional check was carried out using a micrometer and a 3D design was created (Fig. 6). The dimensional measurements show that the dies were manufactured according to the direction of the designer.

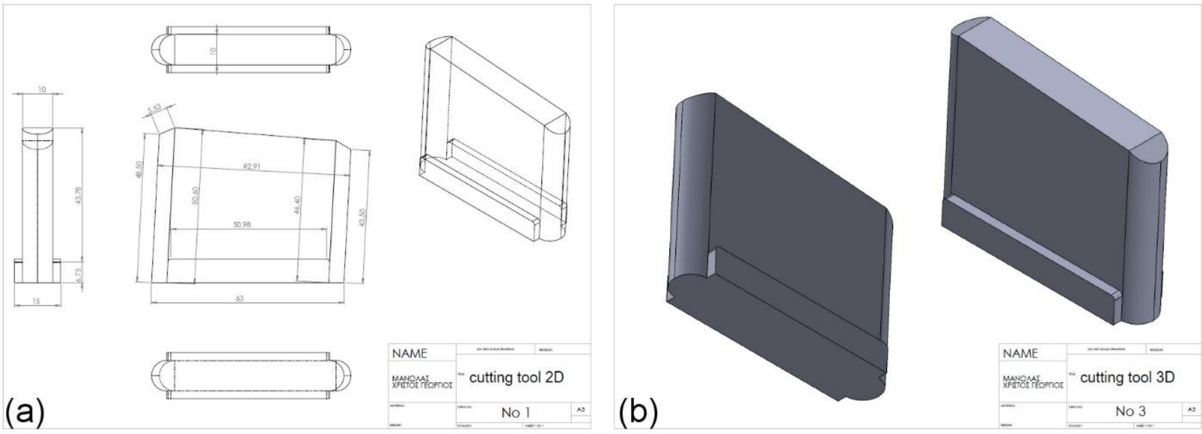

Figure 6: Cutting tool drawing; (a) 2D, (b) 3D.

Hardness measurements were performed on several parts of the fragments. The measuring points on the tool D1 and D3 showed on Fig.7 and the results given on Table 1 respectively.

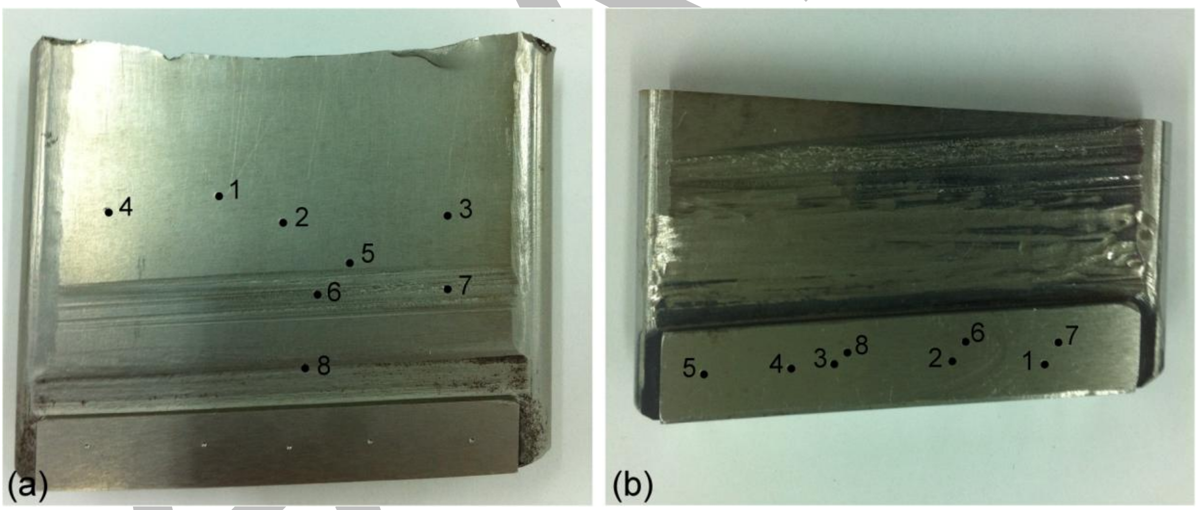

Figure 7: Hardness measurements points; (a) D1 cutting tool, (b) D3 cutting tool.

Measurement Points / Hardness[HRC]	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D1 Cutting tool	58	58	58	60	59	60	63	59
D3 Cutting tool	45	61	53	59	57	59	57	58

Table 1: Hardness of D1and D3 fragments

D1 cutting tool's hardness ranges between 58 HRC and 63 HRC while D3 cutting tool's, between 45 HRC and 61 HRC. On some points, the existence of secondary cracks on the subsurface of the tool leads to lower hardness readings. The results prove that the initial tools' hardness was according to the steel maker's recommendations (57-61 HRC), although, it is inhomogeneous. Hardness values variation at 4 HRC, are likely possible due to insufficient removal of the hot rolling oxide layer created during the manufacturing procedure of the steel plate. The insufficient removal of the oxide layer led to inhomogeneous mechanical properties of the tools during their heat treatment. In any case the material can readily acquire high hardness after heat treatment. Hardness must be high enough to enable the tool to withstand the forces exerted on cutting process. However excessive hardness makes the material brittle and unable to withstand the loads applied in use without shattering [6]. In these case, it is essential to be an optimum combination of hardness and toughness in the die material.

The cutting tools were manufactured by Uddeholm Sverker 21 steel (AISI D2). Table 2 presents the chemical analysis of the tools material compared to the typical chemical analysis according to Uddeholm Company [1] and the International Standards [11]. The results proved that the steel used for the tools manufacturing was the expected one.

Elements [%]	C	Si	Mn	Cr	Mo	V
Cutting Tool	1.559	0.260	0.265	10.945	0.793	0.685
SVERKER 21	1.55	0.3	0.4	11.8	0.8	0.8
AISI D2	1.4-1.6	0.1-0.6	0.2-0.6	11.0-13.0	0.5-1.1	0.7-1.2

Table 2: Chemical analysis results.

Sverker 21 is a high-carbon, high chromium tool steel alloyed with molybdenum and vanadium. It is characterized by high wear resistance, high compressive strength, good through-hardening properties, high stability in hardening and good resistance to tempering back. The steel is recommended for tools requiring very high wear resistance, combined with moderate toughness (shock-resistance). It is used for cutting thicker, harder materials, for forming with tools subjected to bending stresses and where high impact loads are involved.

4. Conclusions

Preliminary examination led to the following conclusions:

4.1 Design

The machine is a self-constructed and the cutting tools have been designed by the manufacturer. The cutting tools are machined in accordance to the design and are submitted to heat treatment, quenching and tempering for a given final hardness. The machine does not have a cooling system and operates under higher temperatures than expected. In addition, the machine does not have chip absorption system (vacuum system) and as a result chips insert the cutting die causing wear and unilateral stress and strain.

In order to prevent failures and achieve the optimal operation of the machine, improved design of the process and its stages should be proposed.

A tube cross-section shaping system must be added in order to achieve identical cross-section throughout the tube's length and avoid any dimension differentiations (tube ovality). By applying this method, alignment and stabilization of the internal cylindrical die in reference to the outer receptor die, can be achieved, in order to avoid random displacements during the tube's movement which leads to non-uniform stressing of the cutting tools.

Adequate cooling system must be supplied to the contacting surface of the cutting die in order to reduce heat build-up and to improve the machine function. A chip absorption system should be added (vacuum system), in order to prevent the entrance of the chips, produced during the cutting procedure, in the die and the cutting tools route, avoiding wear and unilateral stress/strain during their movement. Finally, an appropriate lubricant specialized in outdoor applications and characterized by high oxidation resistance should be used.

4.2 Material Selection

Although, the selected material (Sverker 21), can meet a variety of cold working tool applications, it's replacement is proposed with steels that present higher toughness in the same hardness. Using this kind of steels, a better wear resistance in combination with high compressive strength will be achieved and similar failure can be avoid.

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Preliminary examination of a cutting tool failed in a coiled re-bars machine.

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A manufacturing company delivers a variety of products (such as steel cages, steel grids, column steel covers, etc) according to customers' requirements of the local market. The production is divided in three steps. Initially, the material which comes in rolls is straightened by passing through the first section of the machine. Accordingly, the bars are cut and then bended to the desirable shape. The bars are moving fast during the whole process and consequently high impact stresses are applied to all parts of the machine. The machine exhibits problems to the cutting tool which fails repeatedly.

This paper refers to the preliminary examination of two failed pieces. Data referring the manufacturing, processing and operation of the cutting tool were collected and a complete photographic file was created. Dimensional measurements were carried out and optical inspection was performed. The hardness of the tools was measured and the material selected for their construction was identified by chemical analysis.

This paper presents conclusions on the crack initiation and propagation and the main causes that led to the systematic failure.

1. Introduction

A manufacturing company produces products used for the reinforcing of concrete for the local market. A variety of products such as steel cages, steel grids, column steel covers etc. are delivered according to customers' requirements. Concrete reinforcement steel and stainless steel bars are used, with a range of diameters from 4mm to 20mm. The surface of the bars is either smooth or ribbed. The steel is delivered in rolls and is fed through a special support device (Fig. 1a). The bar is inserted in a chamber and with the use of rollers securing it's alignment (Fig.1b).

Figure 1: (a) Roll of raw material, (b) Machine detail: chamber of material alignment.

At the exit point of the chamber, a die cuts the material to the specified dimensions (Fig. 2a). Then the part is led to a forming die that subjects it to subsequent bends in order to take its final shape (Fig. 2b). The manufacturing steps of the products are set by a CNC program. The process is carried out at high speed subjecting the parts that take part in the process to increased impact stresses.

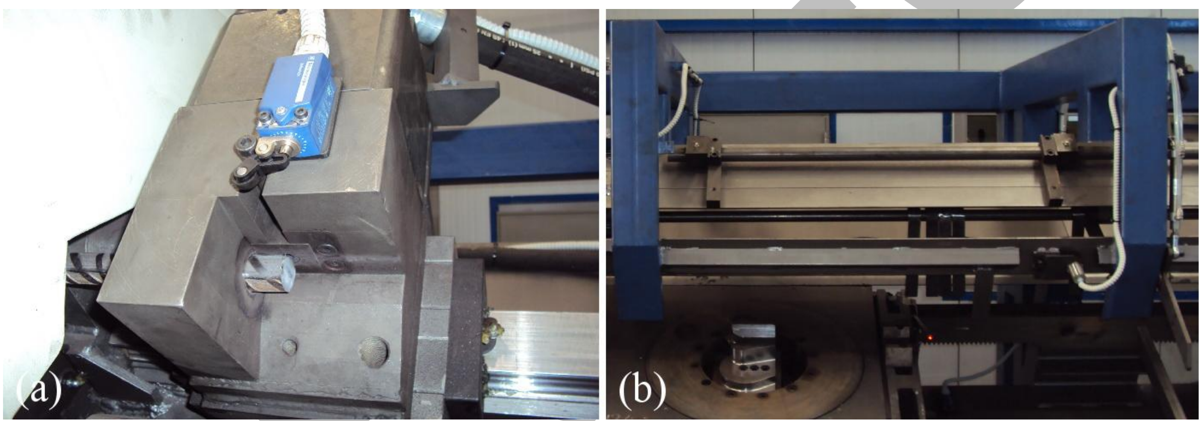

Figure 2: Machine detail; (a) Cutting die placed at the exit of the alignment chamber, (b) Forming die.

The failure appeared repeatedly on the cutting die. The die consists of the stable and the moving cutting part (Fig. 3a). The cylinder shaped stable blade receives the bar through a center hole (Fig. 3b). It is fitted in a case for protection reasons.

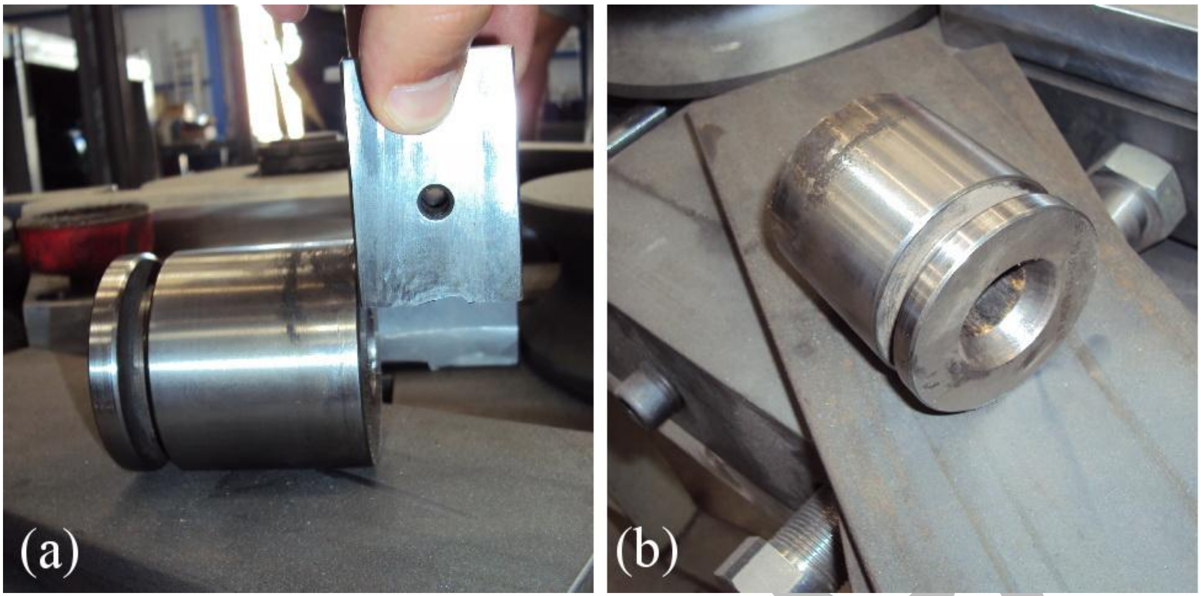

Figure 3: (a) General aspect of the cutting die, (b) The stable blade of the cutting die.

The moving blade is placed in series with the stable one (Fig. 4). During cutting, it is pressed via a hydraulic system perpendicular to the bar axis, provoking shearing stresses as co acts with the stable blade. The side surfaces of the two parts are tangent during cutting.

The dies where manufactured from a powder metallurgy tool steel Vanadis 4 Super Clean constructed by Uddeholm. Tool steels produced by powder metallurgy have extremely refined, homogenous microstructure such as the distribution of the primary carbides created through steelmaking resulting to a more efficient alloying process compared with conventionally produced cast and wrought equivalent steel grades [1]. This allows powder metallurgy steels to exhibit unique properties when compared to conventional steels. They are mainly used in cutting blades, rolling

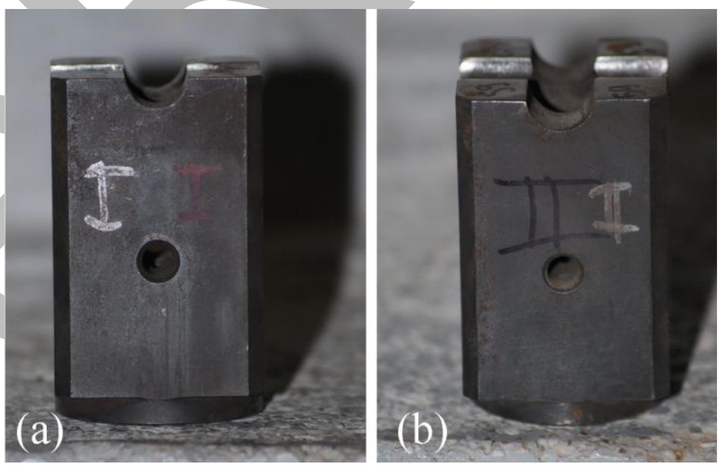

Figure 4: General aspect of the moving part of the blade. (Two failed pieces)

lanes, forming, deep drawing and spinning applications, die materials which is considered a wide range of applications. When high impact stresses are applied on the tools the main aim of the designer is to create a tool that has increased ductility. The carbides that are used will make the material keep its hardness and wear resistance [2]. Since toughness and ductility are generally contradicting properties when the material is subjected to stresses that require both the best combination must be found in each case. In some cases of failure of powder metallurgy steel parts the cause can be found in the manufacturing process of the steel and specifically in the sintering process that sometimes may be insufficient [3]. Adding to that, tools that are used in punching and cold forging need to be designed carefully because the stresses that are applied on the tools usually lead to fatigue failures and cracking [4]. Also since the working conditions of these tools are so hard on the tools themselves, an optimal replacement time for the tools must be taken under consideration in order to avoid failures [5].

2. Experimental Details

The paper refers to preliminary examination of two failed pieces. Data concerning the manufacture, processing and operation of the piece were collected and a complete photographic file was created. Dimensional measurements were carried out with a micrometer and a 3D drawing was created. Optical inspection was performed and hardness measurements (HRC) were carried out. The material selected for the manufacturing of the tools was identified by chemical analysis with optical emission spectroscopy (OES).

3. Results and Discussion

The moving blade often fails causing malfunction of the machine. The predicted working time of the cutting die is two hundred thousand (200,000) pieces in case of cutting concrete reinforcement steel and six thousand (6,000) pieces in case of cutting stainless steel. During the machine operation, the processed material changes based on customers' demands, makes impossible the estimation of a mixed life span of the part. In any case, the failure appeared much sooner than the expected lifetime of any material used.

During the failure analysis of the parts, the researcher visited the work area. It was observed that the machine works under optimum conditions in suitable industrial premises. Experienced personnel monitor the machine during operation. Whether conditions considered to be impossible as the main cause of the failure of the die.

The dies where designed to the run's department of the company. After the predicted machining they where subjected to heat treatment of hardening and tempering to a final hardness of 58-60HRC. The process sequence followed consists of: first preheating at 600^{o}C for 30 minutes, second preheating at 900^{o}C for 20 minutes and austenitizing at 1050^{o}C for 30 minutes. Martempered to salt bath of 180^{o}C. First tempering at 510^{o}C for two hours, second tempering at 540^{o}C for two hours, third tempering at 525 ^{o}C for two hours. After heat treatment, the same company carried out hardness measurements and delivered the dies in 59-60HRC.

The part has a complex geometrical shape. The top side has a square cross section which consists of the working area (Fig. 5a). Through this the bar is pressed and cut with one of the four cutting edges. The cut is executed in high impact stresses. During production, when an edge loses its cutting ability, the position of the die is changed by simply rotating the tool. The blade, due to its shape, has four available cutting edges. The work surface has two semicircular cross shaped grooves. During cutting, the grooves allow the insertion of the material and carry out a quality cut. The dies are used for cutting bars with different diameters. In case of cutting products with smaller diameter than that of the groove is appropriate, precise alignment of the products is mandatory to avoid applying uneven stress to the die.

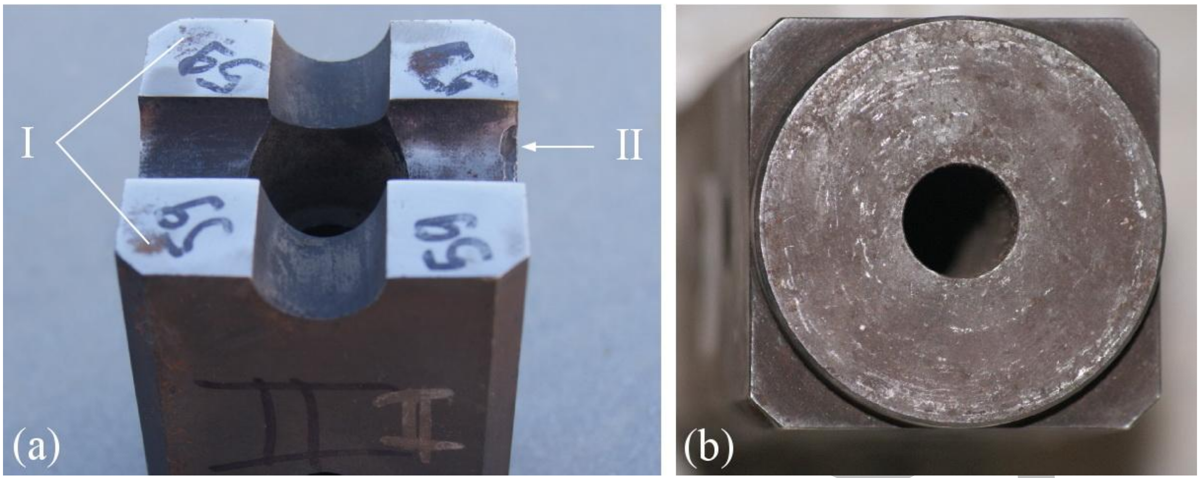

Figure 5: Detail of the moving blade: a) Working surface b) Oposite side.

Other blades have a smooth working surface. In this case there is no demand for quality cutting on the cutting surface of the products. The tail of the die has a cylindrical shape (Fig. 5b). There is a hole of 13mm in diameter to the center which is used for the assembly with the press. At the side surface of each piece a hole with a thread is used for the assemblement with the rest machine. The corners have been cut in order to play the role of radius. The touching surfaces exhibit points of corrosion (Point I on Fig. 5a). The cutting edges have broken (point II on Fig. 5a). On the side surface scratches are observed around the forming area (point I on Fig. 6). The wear is due to insufficient spacing between the touching areas of the two parts of the die. Poor quality of the surface appears which is possibly due to insufficient finishing.

For better observation of the part the pieces were cleaned via sandblasting process. All cutting edges used exhibited chipping (point I on Fig. 7) and partial plastic deformation. During operation, the cutting edges are subject to complex contradicting conditions. The violent impact stresses demand high toughness of the material and the conditions of cold cutting require high strength in combination to good elasticity.

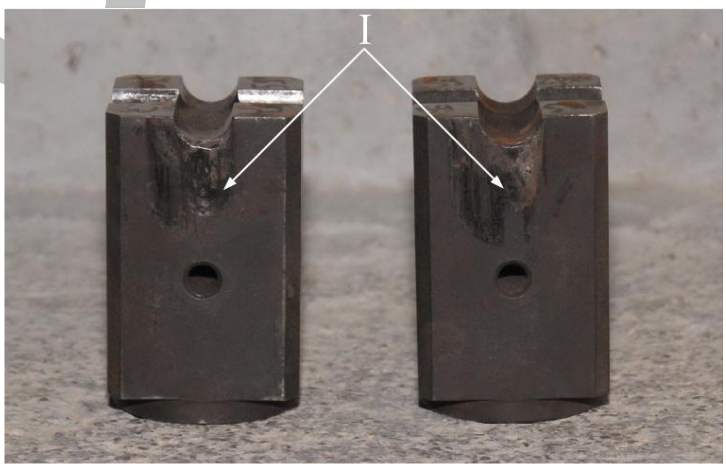

Figure 6: Side view of the movable die.

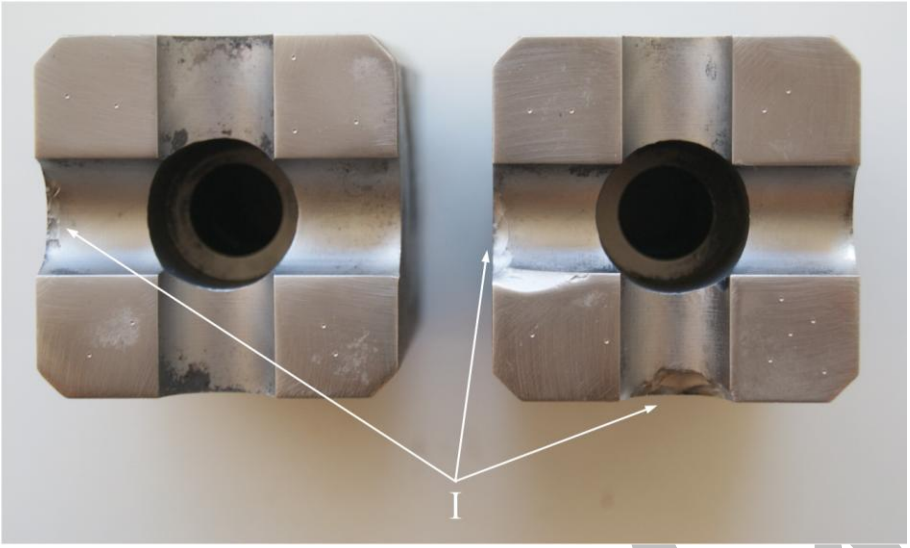

Figure 7: General aspect of the working surface of the dies.

In some cases the wear is restricted to the side surface (Fig. 8a) and in other cases, it extends on the working surface (Fig. 8b). The depth of the wear indicates the working time of each edge. The edge of figure 8a carried out more cuts than the one on figure 8b because in every cut, the stable part wore the side surface of the moving blade deeper. The edge of figure 8b exhibits intense plastic deformation that extends to the inner part of the working surface. In all the other cases the fracture appears almost symmetrical to the curved working surface, while on the last case the fracture is asymmetrical and situated on the deformation side.

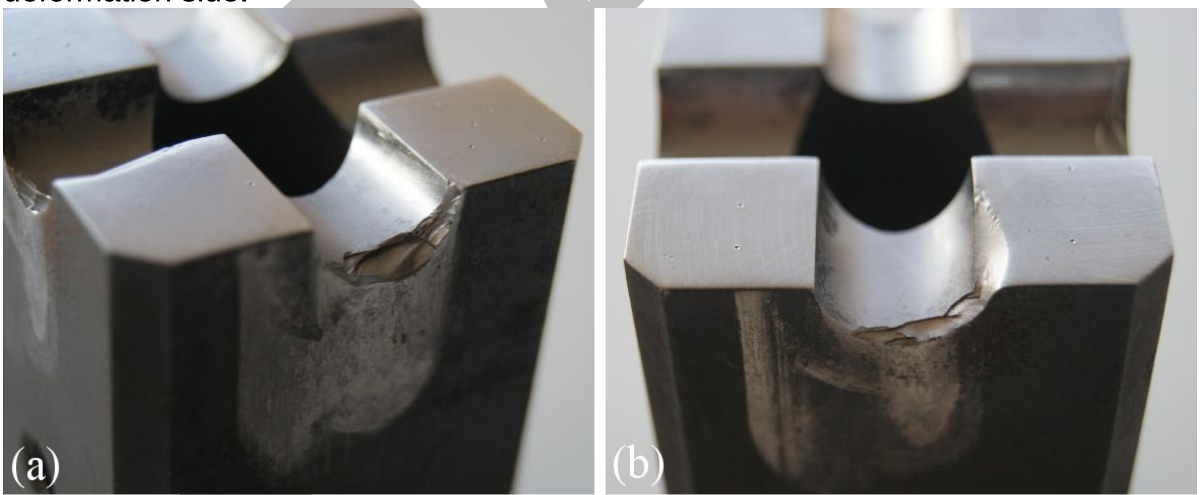

Figure 8: Detail of the dies; fracture of the cutting edges: (a) Piece I, (b) Piece II.

A dimensional check was carried out using a micrometer. After that, a design was created (Fig. 9). The dimensional measurements show that the dies were manufactured according to the drawing of the designer.

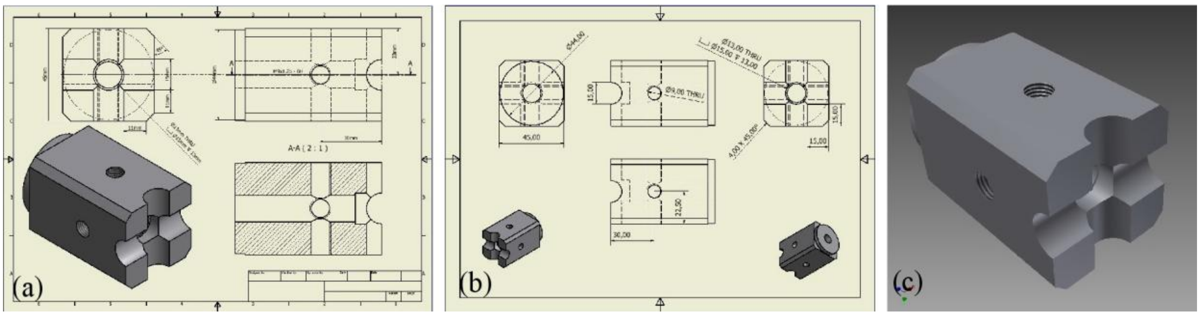

Figure 9: (a) Projection of the dimensional measurements, (b) Projection of the dimensional measurements (manufacturing details), (c) Moving blade: three dimensional presentation (3D).

After cleaning of the parts, hardness measurements were carried out on their working surface [6]. Before the measurements, the surfaces were grinded on a suitable grinding wheel. Figure 10 shows the points that the measurements were taken and table 1 show the results.

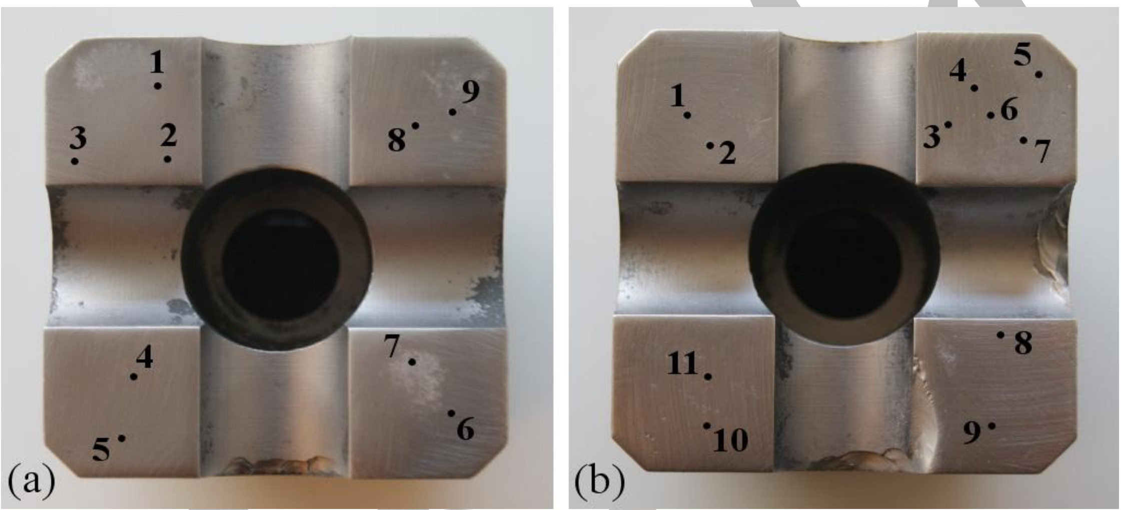

Figure 10: Hardness measurements points on the working surface; (a) Piece I, (b) Piece **II**.

The two pieces exhibit a uniform hardness at 59-60 HRC. The value is according to the predicted hardness after the final heat treatment.

The parts were manufactured of Vanadis 4 Super Clean [7]. On Table 2 are presented the chemical analysis of the material in comparison with the typical chemical analysis of the steel stated by Uddeholm. Powder metallurgy steels do not have a universal standardization. The typical chemical composition is given by the manufacturer. It is assumed that each material belongs to a specific quality when the chemical composition does not deviate from the ± 5% of the typical value of each element. Chemical analysis showed that the material of the tool is equivalent

Measurement points / Hardness[HRC]	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Piece I	59	59	59	59	59	59	59	59	59		
Piece II	59^+	59^+	59^+	59^+	59^+	59^+	59^+	59^+	59^+	59^+	59^+

Table1: Hardness measurements

to Uddeholm Vanadis 4 Super Clean. It is a powder metallurgy steel that provides high wear resistance in combination with high ductility. Due to the manufacturing process, machinability and heat treatment of Vanadis 4 is similar to the AISI D2 which reduces the problems that many high alloyed steels have in machining and heat treatment. Vanadis 4 is mainly used for applications where adhesive wear or chipping are the dominant failure mechanisms. Generally, this steel is characterized by high wear resistance, high compressive strength, very good hardening properties, very good ductility, and excellent dimensional stability after hardening and tempering and good resistance to tempering back.

Elements [%]	C	Si	Mn	Cr	Mo	V
The steel of the cutting die	1.6	0.99	0.39	8.1	1.43	3.4
Vanadis 4 Superclean	1.5	1.0	0.4	8.0	1.5	4.0

Table 2: Chemical analysis of the steel [7]

4. Conclusions

After the completion of the preliminary study, the following conclusions exited:
For the manufacture of the dies the material chosen was the powder metallurgy steel Vannadis 4 Super Clean. The material is suitable especially for applications where abrasive wear and peeling wear are dominant given that it has the ability to exhibit good toughness and ductility for a specific hardness. Consequently it can satisfy the requirements of the tool and the choice is considered correct. According to the chemical analysis the identification of the material used by the manufacturer was achieved.

Hardness measurements showed that the material has a uniform hardness of 59-60 HRC according to the designer, leading to the conclusion that the heat treatment was carried out correctly.

The cut is carried out with high speeds, subjecting the parts to increased impact stresses. At the moment of the failure, the tools were cutting an especially hard (and work hardened) material. The cut using impact forces, does not allow a precision cut (a great part of the material breaks instead of being cut). For a good performance the tool must have appropriate hardness, increased wear resistance and ductility. Increased wear resistance is usually connected to low ductility and vice versa. These properties are conflicting, so for the best performance of the tool the best relationship between the two must be found. In this case the high hardness was chosen to ensure the required durability in expense of the toughness and wear resistance.

Finally, the tools fail prematurely by fracture on the cutting edges. A serious cause of the failure on this part of the case study is considered to be the design of the die. In order to avoid future failure, a deeper study is proposed. Nevertheless some corrections will have a direct result in the improvement of the machine operation.

The manufacture of a die with two movable cutters will reduce the stress concentration because it will be grossly divided in both parts of the die. In this case the hardness of the dies could be decreased a bit in order for the toughness to be increased. This solution increases the cost of the machine operation a lot and it is maybe uneconomical for the specific company.

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Preliminary examination of a mould-printing die prematurely failed.

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A progressive die, mounted in a hydraulic press station, performs consecutive forming and selective cutting stages. During the last stage, the die marks by mould-printing the assembly configuration of the wheel cover onto the wheel rim. The forming punch broke-down prematurely interrupting the production process.
This paper refers to preliminary examination of the failed die. Historical data and recorded background were collected. Non-destructive tests were carried out, including hardness measurements, optical inspection and chemical analysis. A complete photographic file was created. Chemical analysis was carried out using optical transmission spectroscopy method and the material used to make the die was identified. Analysis under a stereoscope revealed the surface quality of the tool. This paper presents the first conclusions of the crack initiation and propagation and the causes that led to the premature failure. The machining process should be redesigned as it is considered the main cause of the failure.

1. Introduction

Dies are extensively used for the mass production of a large variety of metal-formed products [1]. The workpiece may pass through several stages using different tools or operations to obtain the final form. For the forming of sheet metal two parts may be used; the punch (performs the stretching, bending, and/or blanking operation) and the die block (securely clamps the workpiece and provides similar stretching, bending, and/or blanking operation) [2]. The increasing competition in global markets contributes in their continued evolution. Its performance is strongly affected by the tools material, by the processed material and by performance conditions (as use, maintenance or wear conditions). Die service life is considered in terms of the number of piece parts which the die can produce from the time it is new until it is worn out. The production potential of a die determines the quality of metal-formed product and the production cost [3].

In the rolling of silicon steel the use of die manufactured by a sintered carbide steel conduce to a successfully production of fifty million (50.000.000) pieces. The expected service life of a high carbon oil hardened tool steel is about five million products, whereas the selection of a conventional oil hardened tool steel would conduce to premature failure. The production potential of a die varies according to the processed material. If a given die is capable of producing one

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million (1.000.000) piece parts from AISI 1020 cold-rolled steel strip, and approximately twice as many piece parts from free-working brass.

Insufficient performance can significantly reduce the predicted service life. Faults of performance result from insufficient care or negligence [4]. Negligence involves such things as misreading of drawings, inadequate specifications and defective manufacturing and workmanship.

Recorded history of operating conditions regarding a large group of cutting dies indicate that the punch life varies in relation to die-block life. When a die is running and producing, cutting edges wear faster. They must be renewed from time to time by sharpening or by superficial heat treatments (e.g nitriding) as required. When a die perform a productive function, its cutting edges wear faster. [5]. Damage degree depends on the friction conditions between the die and the processed material. The literature data highlight the peculiar role of the surface quality on the wear resistance of the dies as the surface roughness has direct influence in friction degree [6]. Excessive wear can be caused by any one of the following conditions: cutting clearance (insufficient or excessive), input position/ entry (punches are too close to each other), punch height (vertical punch length is too big in relation to the cross sectional area of the punch), hardness (the material is not sufficiently hard), finishing (the side walls of the punch or the die openings are not smooth enough or the layout of the finishing lines are not parallel to the direction of punch travel), materials compatibility (components are made of unsuitable material for working the required stock material), mounting (components not mounted securely), mounting surfaces must be clean as well as flat and perpendicular to the punching axis, punches should be properly aligned with their mating die openings), stripping (not properly planned and calculated friction stripping), excessive runs (the mould should not produce too many parts between sharpening the cutting edges), press conditions (dies do not produce if presses are not in a good condition), careless setup (check especially for security and parallelism of mountings) [7]. Also, dies should be ensured that are adequately mounted in the press). The list can be extended and refined. However, in most cases premature wear or failure can be linked to one or more of those conditions.

2. Experimental Details

This paper refers to the preliminary examination of a failed die, used in the manufacturing of spare parts for trucks and fractured during production.

Historical data and recorded background were collected. Non-destructive testings were performed, including hardness measurements and optical inspection. A complete photographic file was created in two stages. Just after the component was received the die was photographed with a digital camera under physical light (in outdoor conditions). The piece was cleaned by sandblasting and photographed under the same conditions. Dimensional measurements were carried out with a C.M.M. (Coordinate Measuring Machine) followed by a stereoscope examination. The hardness of the tool was measured using an Alpha Duromatic testing machine [8] and chemical analysis was performed using an optical emission spectrometer type Thermo Scientific ARL.

3. Results and Discussion

A company manufactures various products for the automotive industry which they dispose as spare parts in the local market. They also produce truck wheel covers from stainless and DKP sheet steel with thickness of about 2 ÷ 2,5mm. A progressive die, mounted in a hydraulic press station, performs consecutive forming and selective cutting stages, which give the shape and dimensions of the finished product. During the last stage, the die marks by mould-printing the assembly configuration of the wheel cover onto the wheel rim. The forming punch broke-down prematurely.

The failed component, goes under configuration tasks in the sheet metal having a functional role in the final product. Its predicted working life was about 10.000.000 pieces of DKP and 300,000 pieces of stainless steel. The machine is cooled by specific oil during DKP steel processing and by gelatin film in the case of stainless steel. During the machine operation, the processed material is shifted based on customers' and market requirements. Prior to failure the mould had performed successfully shaping of 130,000 pieces of DKP steel and failed after producing some thousand pieces of stainless steel.

The die consists of two parts: male and female. The failure occurred in the male part (Fig.1). It has a cylindrical shape with complex geometry (Fig1a). On the working surface 16 teeth serve as the mapping project on the sheet. A centered hole serves for ejecting the forming material.

Extensive areas of corrosion can be observed on the working surface (Point I on Fig. 1a) even within the fractured surfaces (Point II in Fig.1a). In the peripheral surface small gradations serve for assembling (Fig.1b). The peripheral region has been probable eroded due to lack of final machining (Point I in Fig.1b).

The back face has three holes; a big one in the center as bore ejector and two smaller close to the edge for supporting the die on the base of the press. Signs of corrosion can be observed in this area (Point I in Fig1c).

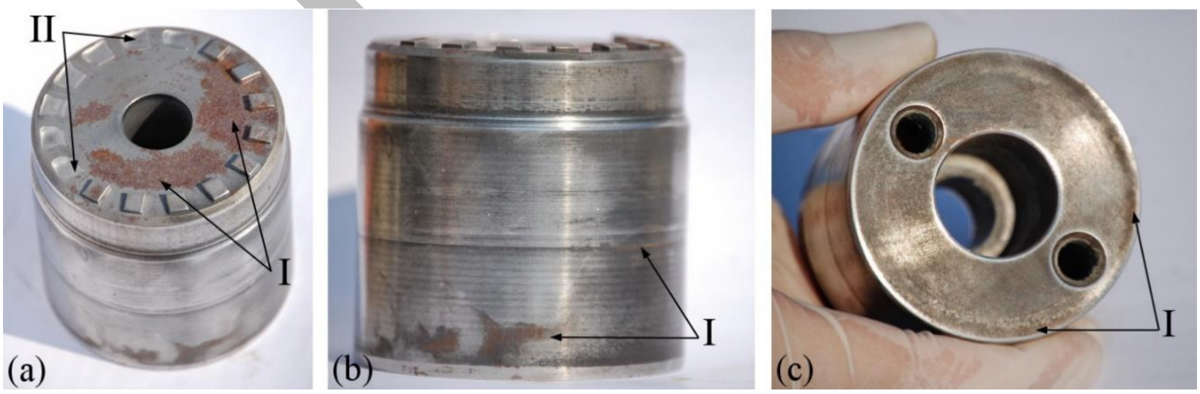

Figure 1: General aspect of the mould: (a) working surface, (b) rear side, (c) back side.

Seven of the projection teeth have undergone total fracture. The fractured surfaces exhibit plastic deformation with mixed orientation. Four of the teeth converge from left to right (Point I on Fig. 2a), two of them converge from right to left (Point II on Fig. 2a) and the third from the right part was subjected to a symmetric deformation proving an endpoint stress concentration (Point III in Fig.

2a). Obviously the fracture seems to have been initiated in the region of the teeth adjacent the central bore. Marks due to rough CNC machining are visible on the working surface (Point IV on Fig. 2a). "Fingerprints" of the female die can be observed around the teeth (Point V in Fig. 2a). Dimensional measurements revealed difference in their depth. Fingerprints up 0,035mm deeper were observed around the fracture surfaces (Point I on Fig.2b) compared to the fingerprints around the healthy teeth (Point II on Fig.2b). The punch pressed the die-block in an angle of 0.015 degrees as result of incorrect positioning (insufficient or excessive mounting of the die on the base).

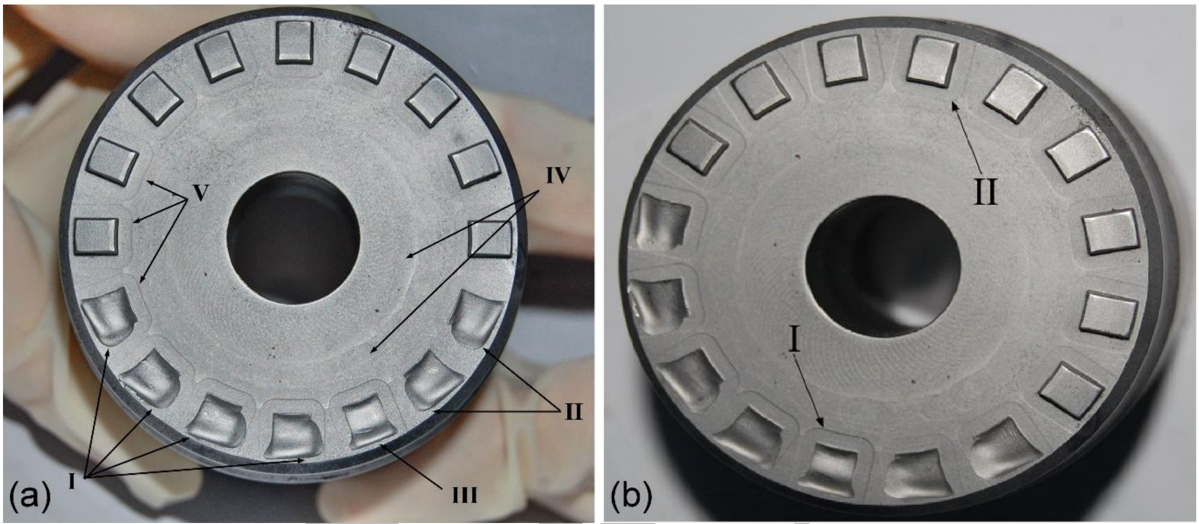

Figure 2: (a) General aspect of the working surface after cleaning, (b) Fingerprints around the teeth.

Poor surface quality was observed under a stereoscope. The analysis revealed pores in the inner region near the central hole (Fig. 3a), circular striations due to improper machining (Fig. 3b) and ridges around the teeth (Fig. 3c).

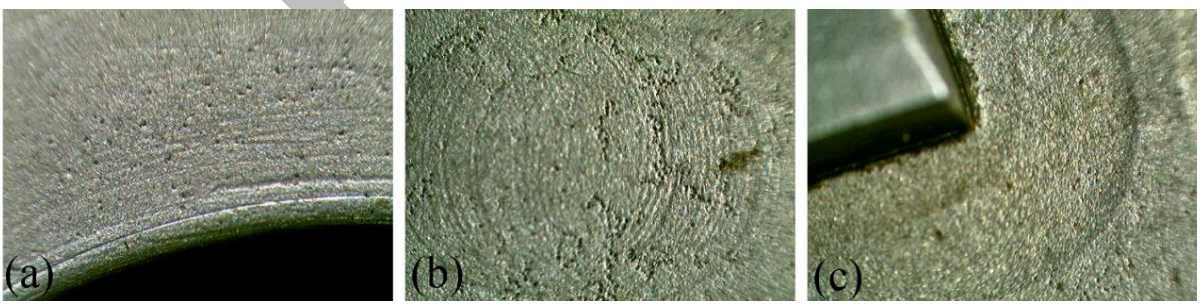

Figure 3: Detail of the working surface; (α) Pores, M×20, (b) zone with rought surface finshing, M×20 (c) Fingerpritns around an unfractured tooth, M×20.

The geometry on the working surface of the die was assured by electrical discharge machining. EDM processing is a very efficient and economical method of producing tooling. This manufacturing process allows the production of tooling with very intricate shapes that could not be produced by any other means. The influence of spark erosion on the machined material is completely different to that of conventional machining methods. During EDM high temperature is generated causing significant changes to the surface [9]. The

surface of the steel is subjected to very high temperature causing the heat affected zone. Due to the extremely-high temperature of the spark in the EDM process, a heat-affected zone, or HAZ is produced. There are four layers of the heat-affected zone (Fig.4). These four layers are: re-cast surface, re-hardened layer, re-tempered layer and the unaffected base layer.
The external, solidified layer (melted zone or white layer) is full of craters. This surface is not acceptable and usually is removed by super finishing. In this case the finishing did not remove the entire porous layer, leaving the bottoms of the craters. Below the external zone a rehardened layer consist of hard and brittle martensite. In the tempered layer the steel has not been heated up so much as to reach hardening temperature and occurred tempering-back.

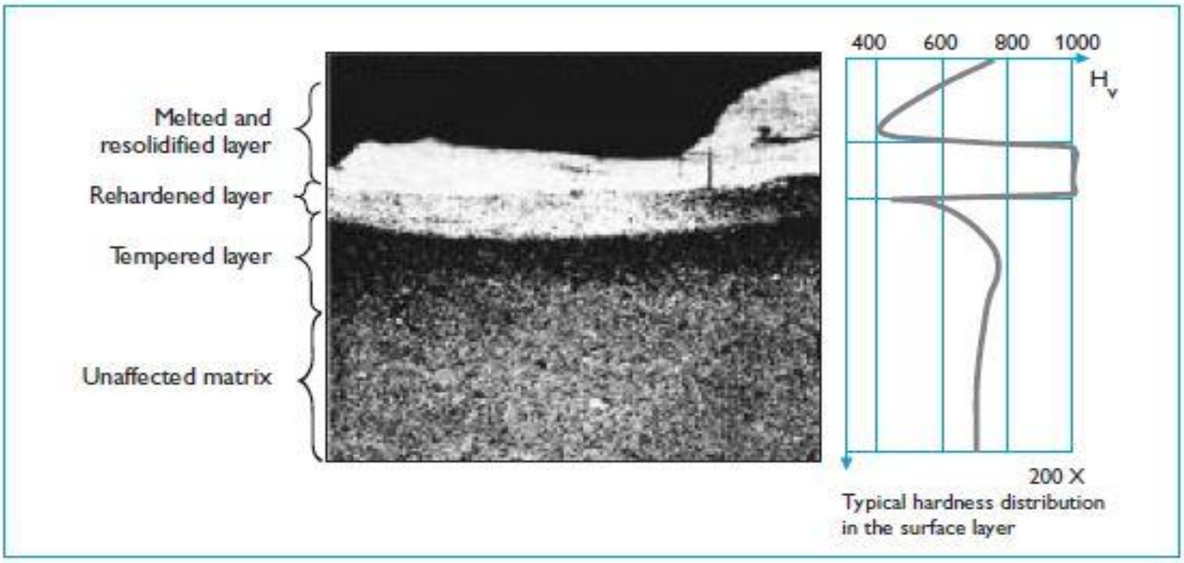

Figure 4: The heat affected zone after EDM machining [9]

A careful examination of the teeth indicates a seating. In absence of radius the edges have been eroded (Fig. 5a). In some areas aubergine color is distinguished. Insufficient cooling produced a temperature increase up to 300^{o}C resulting in micro welding (Fig. 5b).

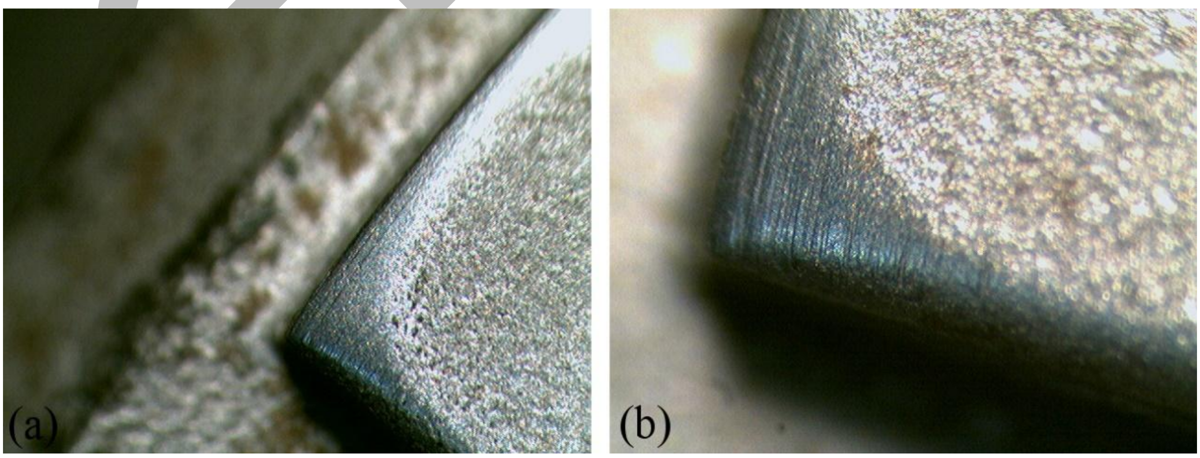

Figure 5: Teeth detail; (α) Radius due to erosion on the edge, (b) Microwelding zone.

Stink (slime) was accumulated at the base of the teeth (Fig. 6). Due to insufficient lubrication the dust adheres to the lubricant and accumulates at the base of the teeth through the forming process.

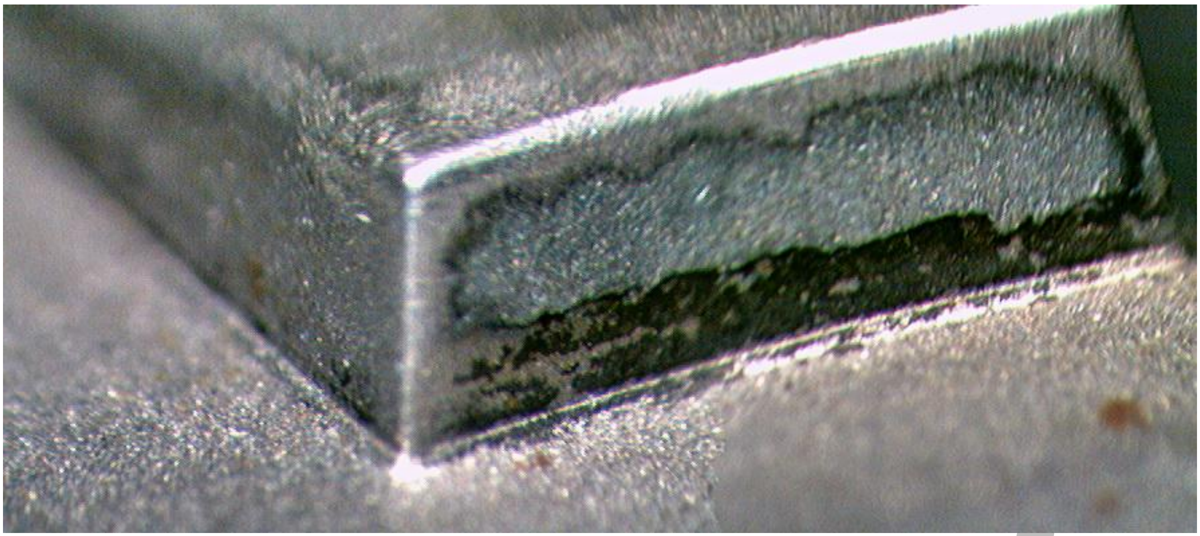

Figure 6: Slime accumulated at the baze of the teeth.

From the side near the center hole, the teeth present a chamfer (Fig. 7). This taper could have been created during the manufacturing of the tool as a result of design error. Alternatively it could have been created during operation, by setting of the material due to localized plastic deformation.

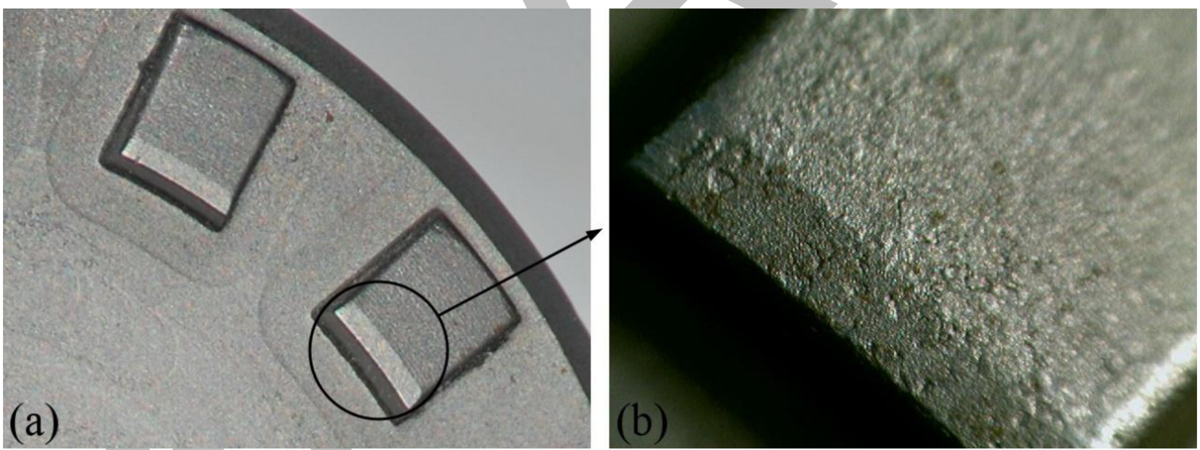

Figure 7: Detail of the seating on the teeth: a) General view, b) Taper on the inner edge of the teeth.

Hardness measurements were performed on peripheral cylindrical surface in ten different points as well on the working surface in five different points. The results are presented in Table 1.

Measurement points / Hardness[HRC]	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rear surface	63.5	64.0	63.5	63.0	64.0	63.0	64.0	64.0	64.5	64.0
Working surface	63.5	63.5	63.0	63.0	63.5	-	-	-	-	-

Table 1: Hardness of the die

The cylindrical surface exhibits 63,7HRC and the working surface 63,3HRC. This is a very hard material with uniform hardness.

The die was manufactured of Vanadis 4 Super Clean [10]. Table 2 represents the chemical analysis of the material in comparison to the typical chemical analysis of the steel manufacturer. Chemical analysis showed that the material of the tool is the predicted one. VANADIS 4 is a powder metallurgical cold work tool steel offering an extremely good combination of wear resistance and ductility for high performance tools. Its high wear resistance is often associated with low ductility and vice-versa. However, for optimal tool performance both high wear resistance and ductility are essential in many cases. Tool making with highly alloyed tool steels means that machining and heat treatment are often more of a problem than with the lower alloyed grades. The main advantage of VANADIS 4 is its dimensional stability after hardening and tempering, in comparison to all known high performance cold work tool steels.

Elements [%]	C	Si	Mn	Cr	Mo	V
Tool's composition	1.403	1.253	0.438	8.070	1.535	3.977
Vanadis 4 Superclean	1.5	1.0	0.4	8.0	1.5	4.0

Table 2: The chemical composition of the tool compared to the nominal composition proposed by Uddeholm Company.

4. Conclusion

The preliminary examination conduced the following conclusions:

4.1 Design

The absence of radius is considered an important omission because it favorites the accumulation of shear stress concentration at the base of the teeth. In this case, the creation of radius was practically impossible because the thickness of the sheet processed is 2 ÷ 2,5mm while the height of the projection teeth is just 1,5mm.

The geometry of the teeth is considered faulty. Creating chamfer in such a small size is not beneficial.

The selection of a high hardened (63-64HRC) powder metallurgy steel is considered to be the right one.

4.2 Manufacturing

EDM machining was chosen in order to create the specific surface details. This process re-melts a thin layer on the surface and generates craters. The porous layer was not completely removed. Careful observation of the working surface showed poor finish machining favoring local stress concentration and increasing stresses on the teeth. Poor surface quality increased the wear of the die and promoted further corrosion.

4.3 Use

The die used to process two different materials. In contrast to the DKP steel, the stainless steel is a soft and more ductile material; when the surface of the teeth is immersed into the stainless steel, then the stock material is adhered and embracing the teeth. A little disengagement movement (left to right) takes place in order for the extraction to occur. In this condition the teeth are submitted to increased shear stress. Radius should be provided in order to resist additional stress.

During dimensional measurements a height difference in the perimeter depth impressions was found, showing uneven strain on the working surface of the mould. In the area where the marks are more pronounced the mould strained more surpassing the tolerance of the material. Due to non-parallelism of the die parts in some of the teeth, the tolerance undergone. The die has unilaterally strained due to faulty cooperation of the male part with the female part.

The cooling was also found incomplete.

4.4 Maintenance

Improper maintenance of the tool was identified. The debris at the base of the teeth alters the geometry of the system in this region. To avoid this phenomenon, the mould should be cleaned from time to time (with hot water under pressure, pastes, or sharpening). Record keeping of the operating and the process history of the die is highly suggested.

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An approach for structuring and operating curriculum of engineering faculties based on international standards.

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It's a known fact that some Higher Educational Institutions (HEIs) from all over the world approach the structure of their faculty's curriculum on a different basis. In latest years student mobility has been increased. Thus, the need for a common language between universities created prototypes for the recognition of the courses. In several countries, as part of the nation's culture, university courses aren't offered in foreign language and most importantly in English. In such way, many benefits regarding students discretion in mobility, professors teaching abilities and university's international partnerships are compromised. A new approach should be taken into consideration changing the previous faulting situation based on international standards. Association for Computer Machinery (ACM) and Institute of Electronics and Electrical Engineering (IEEE) two well known international research organizations focused on computer science and engineering in general suggested modern curriculum for engineers based on the market needs and latest research edge. HEIs should take in consideration the suggested changes to modernize their engineering faculties curriculum. Additionally, e-learning techniques have been radically improved over the latest years, offering numerous advantages for distance learning, cost reduction and program flexibility. A joint approach of standards and new technologies may leverage up HEIs and consequently professors and students.

1. Introduction

During the design of a curriculum for HEIs it is important to keep a perfect balance between deep specialization and wide education. There are both supporters that agree that young students should learn the fundamentals of engineering and have a solid scientific foundation in order to avoid obsolescence and those that support the education specialized engineers that are much more competitive in the job market. Considering that and the fact that Greece is not a highly industrialized country and there are limited labour opportunities in all specialties, in this case, a good scientific foundation is a must.

2. The Problem

All these years, universities have been updating their curriculums, but they only alter what courses are offered, but now we are suggesting updates on both how and to whom these courses are being provided.

First of all it must been understood that every human has the right to join an HIE. Unfortunately this goal is not always achieved because most HEIs don't have enough amenities for foreign students that are not proficient or fluent to the local language.

Also it is noticeable that most of the non-government funding HEIs have lack of facilities to assist persons with disabilities that are being face all over the campuses, from parking spots, elevators, even inside the laboratories.

We are all facing around us the entire financial crisis affecting even our closest people. There is a lot of people that are unable to join HEIs because they cannot afford moving to a different city or country, because they need to work in parallel and it is not possible to adjust their schedule to fit both education and work.

2.1 International Students

One of the many reasons of the creation of such restricted boundaries are languages. Unfortunately not many Greek technological educational institutions offer degrees in foreign languages, let alone courses. We believe that there are many things students and institutions can benefit from, if a model like this is adapted.

Starting off, this will give the ability for foreign students to come and study in Greece. This will give economic, cultural and educational benefits. The incoming students will be able to interact and exchange opinions with Greek students about many topics. Hens learning about foreign markets, new approaches to problems and giving the ability to create a social network of peers in an international scale. This knowledge will broaden the views of students and maybe even create a professional collaboration in the future. In any case there is no doubt that a student of engineering will benefit from interacting with foreign students.

Offering courses in deferent languages will not only benefit student's future careers but also the knowledge. If courses are done in the most international languages, like English, students be able to apply that knowledge in a much greater market then just in their country. Companies all over the world are trying to create a more international profile and welcome engineers that have this ability. Also having the ability to work in other languages allow you to collaborate with people all over the world on projects and research teams. Let's not forget that the student's will also be able to experience how it is to study in a different languages, allowing them to consider if continuing the studying abroad is a valid chose.

As we have seen introducing courses taught in other languages will give the institute the ability to accept foreign students as well as giving its own students the tools they need for an international career. This will have as a result an improvement of the institute's reputation in a world wide scale. This can lead to the establishment of partnerships between institutes from all over the world and create double-degrees or research programs. This will improve even more the institutions standards having even a positive effect on the economy of the country by providing high level engineers.

As expected, there are problems that will be created in establishing English Courses. The main one is probably the fact that there will be need of a faculty that can teach in foreign languages. Even for professors that have studied abroad, it can be very challenging to explain and teach complicated subjects and theories in other languages besides their native one. Not only faculty but also staff, like the secretary's office, will need to be able to serve incoming students. This can escalate to a major problem, because the lack of extended knowledge, in foreign languages offered by the institute, can reduce the students experience and education, something that is forbidden.

Another drawback that is created by creating courses in other languages is the fact that there will be a need to increase resources, thus increasing expenses. A solution could be to cut down a Greek course to balance the budgets but we feel this is not a valid solution, especially since it can complicate things because of the model that the institutes use in Greece. For this reason we propose that for an institute to be able to slowly adapt this model it would be in its best interest to create freshman courses that are common for many degrees. Some good example would be:

- Math
- Physics
- Programing
- Circuits and Electronics
- Electricity and Magnetism

This courses are common for many engineering field, this way a much broader range of students are applicable. Another approach would be to have project driven courses. This solution is best suited if there is a small number of students. A great advantage of this approach is that the courses can be on senior year subject too. Since the professor will be interacting with a very small number of students, he will not have the pressure of teaching a subject in a foreign language in front of a class.

Starting courses in other languages will need a significant amount of attendees, having a course with only 4-5 students may not be acceptable. For this reason it is a good idea to let Greek student to apply for these course as well. It is possible that Greek students will avoid taking these courses because of the extra difficulty of foreign languages. We propose that they can get extra credit if they are able to pass one of this courses or if there normal curriculum has a course for English terminology, they can pass to English courses and automatically pass the English terminology course.

It is mandatory to note the fact that most of the books are translated from English, translating and publishing books in a foreign language increases the costs and of course these are transferred to the customer. Translating books that are expected to sell thousands of copies don’t face any mentionable financial risk. On the other hand books that are about a very specialized field in engineering and have just some hundreds of potential buyers, thousands of pages and expensive copyrights, are expected to cost more than two or three times more than the average.

2.2 E-learning

The term e-learning is formally the use of electronic media, educational technology and information and communication technologies (ICT) in education. The technological foundation of e-learning is the Internet and associated communication technologies. It includes numerous types of media that deliver text, audio, images, animation, and streaming video, and includes technology applications and processes such as audio or video tape, satellite TV, CD-ROM, and computer-based learning, as well as local intranet/extranet and web-based learning.

E-Learning can be divides into two categories:

Synchronous e- learning refers to the exchange of ideas and information with one or more participants during the same period of time even if they are in different locations. Synchronous e-learning can take a variety of forms, such as face-to-face discussion, real-time live teacher instruction and feedback, Skype conversations and chat rooms or virtual classrooms where everyone is online and working collaboratively at the same time.

Asynchronous e- learning does not require simultaneous participation of learners and instructors. It may use technologies such as email, blogs, wikis, and discussion boards, as well as web-supported textbooks, hypertext documents, audio video courses, and social networking using web 2.0. At the professional educational level, training may include virtual operating rooms.

Like every way of learning has pros and cons so and e-learning do. However e-learning has the opportunity of improvement and elimination of problems. Some of the important advantages of e-learning are:

- Class work can be scheduled around work and family.
- Reduces travel time and travel costs for off-campus students.
- Students may have the option to select learning materials that meets their level of knowledge and interest.
- Students can study anywhere they have access to a computer and Internet connection.
- E-Learning can accommodate different learning styles and facilitate learning through a variety of activities
- Improved open access to education, including access to full degree programs
- Better integration for part-time students, particularly in continuing education
- Improved interactions between students and instructors
- Provision of tools to enable students to independently solve problems
- Acquisition of technological skills through practice with tools and computers.
- No age-based restrictions on difficulty level, i.e. students can go at their own pace.

E-learning is the most efficient way to pursue a degree in higher education. It is particularly beneficial for students who attract to a flexible, self-paced method of education to attain their degree. It is important to note that many of these students could be working their way through college, supporting themselves or battling with serious illness. They have the opportunity to complete their work in a low stress environment and within a more flexible timeframe.

However, there are some points that we have to take care to make e-learning to be effective as the traditional class room lectures. Teachers' lack of knowledge and experience to manage virtual teacher-student interaction so have to be organized some educational seminars and workshops to teach them how to use the appropriate technology of e-learning. An online tutorial guide about e-learning and the use of electronic techniques that it needs will be very useful for both teachers and students. Furthermore there will be a dead line in every e-learning lecture so there will not be any lack of direct and immediate feedback from teachers or students. Last but not least is that somebody could say that e-learning could make easer for students to cheat but that's not true. All these years there have been developed a large variety of software that provide high quality anti cheat engines and identity verification.

E-Learning in Greece

In Greece there are plenty of Technical University and institution that have embedded e-learning in their curriculum. Some of them are Technological Education Institute of Piraeus, National Technical University of Athens and National Technical University of Crete. Unfortunately none of their curriculum is giving the opportunity to a student to take diploma only with e-learning lectures. By low the only university that has the right to offer full e-learning curriculum to students is the Hellenic Open University, which was created in the beginning of 19o in Patra. Hellenic Open University is organized in four schools: the School of Humanities, the School of Social sciences, the School of Science and Technology and the School of Applied arts. The School of Applied Arts offers only postgraduate degrees, while the other three schools offer both undergraduate and postgraduate degrees.

3. Conclusion

First of all high schools should offer pre-engineering curricula in order students in the engineering school, not to spend their semesters on of the very fundamentals of engineering material. Such as physics, chemistry, mathematics, algorithms etc. So students accepted in an HEI be able to focus in higher level engineering course and more sophisticated subjects.

Higher Education in engineering needs wide access to computational material and resources, high availability for two reasons.

First of all students have curiosity and willingness to discover the unknown. Just reading books is never enough. There is always willingness to act and interact with the studying materials that have access to. That may be even be computer programming, real source code exploration, command line interaction networking or even cryptanalysis and much more.

Secondly computer is the most powerful machine that the engineers ever created, and from the very first year of its appliance till today, the most usual intention on its use is to help engineering on solving real problems. From control system monitoring and management, any kind of engineering simulations, real world problem training. And that is very important because students may be danger if they start learning or real systems, or some simulations may be too expensive to be provided openly to the academic ecosystem.

One also very important issue on HEIs is that it is hard to transfer credits between each other. Even some universities from Europe have come to a common credit system agreed, that it is easier to transfer some between them. Unfortunately this system it is not widely enough applied, and also it lacks acceptance from non-European universities.

On the other hand two of the most important research organization in engineering ACM and IEEE have come to a common curriculum that has potentials of international acceptance, it actually depends on if any HEI is willing to help and support it students, that covers every necessary aspect of a high quality engineering department. This curriculum has been adopted by the best universities of the world including Rice, Washington, Berkeley, Harvard and Stanford Universities. Empirical evidence show that this curriculum prepares students to be ready and deploy high quality products and services in the market, competitive to existing multi-billionaire companies.

One last thing that is mandatory for a high quality HEI that offers engineering degrees is a resume lab. A good degree itself does not mean also an equally good job. The first impression always matter and there is where a good curriculum vitae maters. The Institution should provide a guided assistance on developing students and alumni their own resume, helping them to create their very own portfolio, highlight their skills and teach them how to write cover letter. A video resume is nowadays a must have, it makes potential employers easier to explore candidate’s skills without wasting too much time on paperwork.

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Adapting economic principles for engineering reality.

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It is fact that the base of the economic assumptions that are part of the nowadays theories about economics and are being considered for taking decisions for a company or an organization are based on old fashionated principles that used to seem logical by the view of well educated researchers by the years. Those assumptions have actual affect until now on the most of their applies, but once you study those a little bit more abstract and try to apply them on modern engineering based ecosystems you will fairly easy notice conflicts with engineering principles and theories that are also at least the same important. Some examples may be cloud computing and crypto currencies. Conflicts commonly occur in the topic of productivity where different standards have been set in each case. We could easily notice the minimum occurrences and affects of the bottleneck phenomenon on modern well designed infrastructures where it is fact that almost every single possible occur can be bypassed and minify its affect. Another parameter that should be applied is the probability and the randomness of some effects that they may affect a production environment, such as noise, system faults, downtimes and in some special cases the random character may be part of the design.
Keywords: ecomics, engineering, cryptocurrency, bottleneck

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1. Introduction

Modern economic principles are based on physical and mechanical productivity, back when the human was the worker and the result was some kind of physical object. Nowadays the worker is somehow a piece of software running on state of the art servers and the result usually is a digital product like a web or a mobile application or some sort of computational result. So these principles should be reviewed and re-concerned before applied, because that may have negative affect.

2. Discussion

The paradigm considered in this paper and the relevant economic principle, is supposed to apply on any kind of production environment. But, as we can realize in the continuation two widely used applications, are facing deferential results. That is because of the totally different nature between the productive environments nowadays and a few years earlier.

3. Examples of differences

The truth is that graduates from economic or business universities have vast possibilities to join a high-tech company. Being incapable to deal with engineering reality and adapt their knowledge will probably lead the company to inability to extend their processes and generally will cause delay at the financial growth.

In this particular paper we will discuss about the minimal product of labor (also known as MPL) and how this applies in new age technologies and infrastructures like bitcoin, cloud computing and how this situation is being handled.

Definition of MPL

The marginal product of a factor of production is generally defined as the change in output associated with a change in that factor, holding other inputs into production constant. The marginal product of labor is then the change in output per unit change in labor. [1]

Physical world example

Lets consider as an example a factory that produces furniture, when there are zero employees the furnitures produced per day are also zero. When there is one worker hired, six furnitures produced per day. When there are two workers, 11 furnitures produced per day. According to that the MPL of the first employee is 6 and for the second one is 5 (Table 1). This Phenomenon occurs because of variant reasons and factors like the inability of the suppliers to cover the new demands, or applying some kind of multiplexing access to some sort of engine, like time division.[2]

Labor (Employees)	Output (Furniture)	MPL
0	0	0
1	6	6
2	11	5
3	14	3
4	21	7

Labor (Employees)	Output (Furniture)	MPL
5	22	1

Table 1: *MPL example*

3.1 Cloud Computing

Cloud computing datacenter totally defers from a furniture factory. First of all the mean of the labor has a total different mean. Of course under the services there are no human workers but state of the art servers. Calculating the MPL for a cloud computing datacenter we can use different entities as "workers", either the software or the hardware that runs on. The first case is useful on Software as a Service (SaaS) applications where the abstraction level of the engines is so big that the developer does not care at all about the nodes. On the other hand, where the hardware is considered as the worker, usually applies on architectures like Infrastructure as a Service (IaaS), where the performance is highly connected to the hardware where the infrastructure is hosted.

Secondly the product is definitely hard to been measured because of its nature since it is not a discrete object. As an example on an Infrastructure as a Service implementation every single engine differs from any other in terms of storage capacity, network capabilities, process unit cores, flash memory storage and of course the software that is running. Adding an extra node on a system like that will configure some of these parameters. The system architect is responsible for selecting them taking into account the needs of the services, any possible bottleneck phenomenons and most importantly the available budget for the new node.

Lets consider as an example a small sized IaaS that has in total fourty cores, sixty giga bytes of Random Access Memory (RAM), two tera bytes of storage . The clients have the possibility to choose custom amounts of each resource and have already in use all together, thirty five cores, all sixty giga bytes of ram, but only five hundred giga bytes of storage. The need for extra nodes is definitely a need. The new nodes should be something like twenty cores, thirty giga bytes of ram, but only five hundred giga bytes of storage.

As we can see in this example the need for new compute nodes was incredibly huge, but there was spare space on the storage nodes. The product at this example are the Virtual Machines (VMs) and once this need occurred the compute nodes had vast factor on the product availability but the storage was almost zero. On the other hand if on that infrastructure was hosted a storage service provider, then the demands would be reversed.

3.2 Bitcoin

Bitcoin is a software based online currency designed by Satoshi Nakamoto in 2008 and launched as free software in 2009. Payments are not recorded on some repository, but there is a public peer to peer (P2P) shared ledger, that is why United States Treasury call bitcoin a decentralized virtual currency.[3][4]

Block chain

A block chain is a database with bitcoin's transactions and all the necessary information to link the blocks between them. This information is used in order to find at any time from the beginning of bitcoin's history how much value belongs to each address. Every single block is computationally impossible to been modified once it has been in the chain for a while because every block after it would also have to be regenerated. This is how bitcoin solves the whole double spending problem and this is what makes bitcoin innovative. [5]

Mining

mining is the process of adding transactions to the block chain. Mining is by design highly resource intensive in order to remain the daily amount of founded blocks steady. Every single block should contain proof of work (hashes) in order to be accepted in the block chain. This operation is also known as "hashcash proof of work function". Mining is also the mechanism used to introduce bitcoins into the system: Miners are paid any transaction fees as well as a "subsidy" of newly created coins. This method situationally motivates the peers to keep the bitcoin safe and secure.[6]

Mining is a really heavy and resourceful operation. In this particular example the workers actually are the miners, the computers in the peer to peer bitcoin's network that validate the transactions. Some miners are more powerful than others, that is calculateable as hashes per second sizing in megahashes or gigahashes. In order to prevent over produced bitcoin, there i a factor called difficulty and indicates how hard is for a miner to complete a transaction with fees. By its design it is almost impossible to predict or estimate the earnings from a miner o mining pool, since it is bonded to the term of luck (Figure 1).[7]

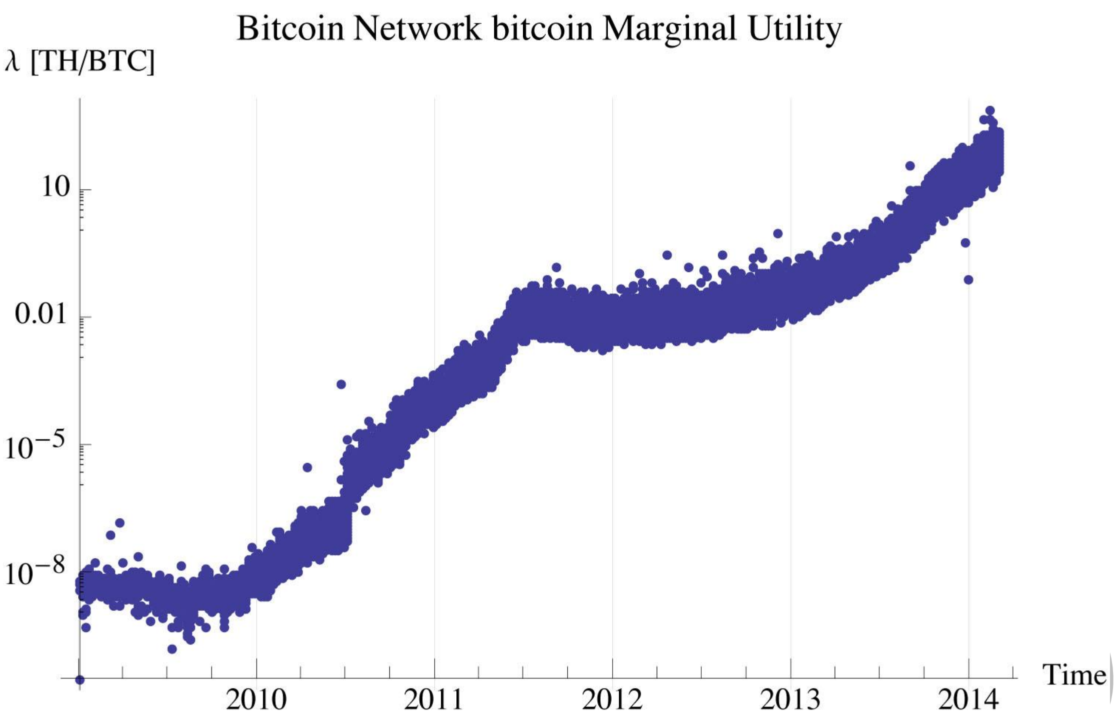

Figure 1: Bitcoin productivity

4. Conclusion

Engineering and computational principles totally defer from the every day edicts and the abstraction level in every single situation totally differs. It is simply impossible to approach the digital world with the principles of the analog one. It is a totally new era, and all the fundamentals should be adapted or changed before been applied. From productivity, economic and more aspects. The most important difference is productivity as a concept and productivity's scalability, which is getting more and more complicated in the modern engineering and computational reality.

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An analysis based on Discrete Wavelet Transform of two-dimensional gel electrophoresis images with application in proteomics

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Two-dimensional (2-D) electrophoresis of proteins has preceded and accompanied the birth of proteomics. 2-D electrophoresis is a powerful and widely used method for the analysis of complex protein mixtures extracted from cells, tissues and other biological samples. Image analysis tools have matured into a number of established commercial packages and freely available programs that underpin research in expression proteomics. In this work, we present an analysis of Discrete Wavelet Transform (DWT) of two-dimensional gel electrophoresis images. DWT as a mechanism of linear transformation for the separation of the data into different frequency components, is used for the joint observation of results with other widely accepted methods.

Keywords: 2D gel electrophoresis, image analysis, discrete wavelet transform, proteomics,

1. Introduction

The burgeoning field of Proteomics, the analysis of protein expression in biological samples of an organism, is widely regarded as one of the key factors of biomedical technologies. The analysis of images resulting from an electrophoresis process in a two dimensional gel (2D –gel) has been widespread used as a method for the measure of protein expression [1] [2]. In a typical experiment, two phases of a protein expression are measured with a 2D-gel along with a control sample. The protein, which could have been transfected is expected to be either over-expressed, either under-expressed. The so far techniques, require a strong human interaction in the experiment and consequently large amounts of time. 2-D gel images can be viewed as blob spots with various gray scales and sizes on the light background [3]. Furthermore, 2-D Electrophoresis [3] [4] has been widely used to separate proteins in samples prepared from tissues, cells, or body liquid. For the study of differential expression between different stimulations of the experiment samples new challenges arise, due to the nonrigid nature of gel materials and protein spots, and imperfection of experiments. For example, the image patterns are distorted, some spots are very light, spots can be overlapped on each other, corresponding spots may not be found between images, the background intensity is non-uniform and noise is present.

Although some work has been done in this area [4], it does not address the key sources of variability in gel images. These are twofold: a) images of 2D gels show significant variation in their geometry, which must be taken into account in any comparison b) variations in resolution, caused by variability in the processing of the biological samples, mean that two images with nominally the same content may appear quite different [2], even when properly aligned. In order to carry out a successful experiment, a correspondence between spots on sets of gel images must be determined. This implies that a transformation relating one gel image to another is required. The production of 2-DE gels varies inherently.

In this paper a new 2D image gel electrophoresis analysis is presented based on discrete wavelet transformation (DWT) [5] [6]. An automatic process has been developed, for the identification of expressed proteins through a peak detection technique in the DWT of the original experiment images. The program is able to quantify the number of the expressed proteins. Thus, a comparative genomic analysis could be performed for discovering the differential expression of the proteins. The effectiveness of the algorithm has been tested in proteomic images with known results.

2. Material & Methods

2.1 The Wavelet Transform

Wavelets are signals which are local in time and scale [7]; and generally characterized by a peculiar shape. A wavelet is a waveform of effectively limited duration that has an average value of zero. The term ‘wavelet’ comes from the oscillation (like waves) with the time axis. Many wavelets also display orthogonality; a property ideal for compact signal representation. This property ensures that data aren’t over-represented. A signal can be decomposed into many shifted and scaled representations of the original wavelet. A wavelet transform can be used to decompose a signal into component wavelets. Thus, the coefficients of the wavelets can be used in order to handle specific details. Wavelets have the great advantage of being able to separate different levels of information in a signal. Very small wavelets can be used to isolate very fine details in a signal, while very large wavelets can identify coarse details. In addition, there are many different wavelets for an appropriate implementation. Such types of wavelets are: Morlet, and Daubechies [8] [5].

2.2 Discrete Wavelet Transform

The discrete wavelet transform (DWT) is a linear transformation that operates on a data vector whose length is an integer; power of two, transforming it into a numerically different vector of the same length. The given data set is separated into different frequency components, and each component is analyzed with resolution matched to its scale. DWT is computed with a cascade of filters [6] followed by a 2-factor subsampling (Figure 1).

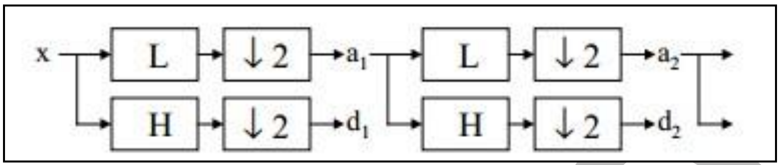

Figure 2. Discrete Wavelet Transform tree diagram.

In Figure 1, H and L denote, high and low-pass filters respectively, ↓ 2 denotes subsampling. Outputs of this filters are given by equations (1) and (2) presented below.

$$\alpha_{j+1}[p] = \sum_{n=-\infty}^{+\infty} l[n-2p]\, a_j[n] \quad (1)$$

$$d_{j+1}[p] = \sum_{n=-\infty}^{+\infty} h[n-2p]\, a_j[n] \quad (2)$$

Elements a_j are used in the next step (scale) of the transform and elements d_j, which are called wavelet coefficients, determine the output of the transform. The terms l[n] and h[n] are the coefficients of low and high-pas filters respectively. It can be assumed, that on scale *j+1;* elements *a* and *d,* remained half on scale *j*. This means that DWT can be done until only two *aj* elements remain in the analyzed signal. These elements are called scaling function coefficients.

2.3 Analysis of 2D-gel electrophoresis images using DWT

In image analysis another version of the DWT is used, the two dimensional DWT algorithm, which is similar to the previous referred (one-dimensional) DWT [9]. The DWT is performed firstly for all image rows and then for all columns (Fig.2).

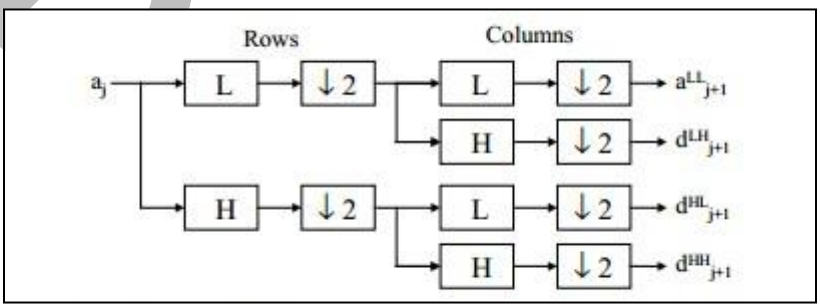

Figure 3. Wavelet decomposition of two dimensional pictures.

With wavelets the analysis of textures of different resolution is efficient and their use in proteins could be advantageous. In the present implementation, the 2D-gel images that have been used include: a) the human megakaryocytic cell line

DAMI containing 10% fetal bovine serum (Figure 3a) and protein DAMI transfected with neuraminidase of Boehringer-Manheim (Figure 3b) [1] b) Qiagen Q5 Phosphoserine and Qiagen Q7phosphothreonine from Kendrick Labs (Figure5a) [2] c) brain tissue of C rats and HA rats homogenized with SDS buffer (20% glycerol and 6% SDS in 0.12 M Tris buffer with a pH of 6.8), centrifuged at 14,000 rpm for 20 min at 4°C, and boiled for 10 min (Figure 5b). The protein concentration of the brain specimens was quantified by the Bradford method (Bio-Rad Laboratories, Hercules, CA) [3] d) E. Coli prepared in SDS Buffer and E. Coli prepared in Urea Buffer from Kendrick Labs (Figure 5c) [2] e) Cytosolic fraction of W138 cells untransfected (left) and transfected with hTERT (right) as shown in Figure 5d [4].

2.4 Autonomous peak detection of DWT

From the original image, as mentioned before a DWT is implemented. The new picture is used as an entry for the next process of the peak detection. The program in order to separate peaks from background noise, use a combined methodology of robust local maxima finder with 1 pixel resolution and weighted centroids with sub-pixel resolution. From the image analysis theory, every peak is considered as a smooth Point Spread Function (PSF) of Gaussian type. In real datasets, background noise usually exists with typical 1 pixel variation. However, the peak’s PSF is assumed to be larger than 1 pixel and a local maximum of this PSF can be obtained with the removal of the single pixel noise variations. In order to apply such a method, a two-dimensional median filter is used. An image smoothing will be followed with the two-dimensional convolution [6]. Thus, it is expected that one pixel will characterize each peak, corresponding to the actual PSF local maximum. The weighted centroid approach uses the same methodology, with the difference that a centroid of each connected object based on weights is computed. The disadvantage of this method, is that despite the sub-pixel resolution, it could possibly miss peaks close to each other. The combination of the two methods, provide more accurate results, as tested.

3. Results

In order to understand the functionality of the algorithm, the DWT of the 2D-gel image of the human megakaryocytic cell line DAMI and its transfection with neuraminidase is presented in Figure 3 [13]. As it is shown, the neuraminidase differentiates the DAMI protein negatively and reduces its quantity. Thus, it can be concluded that the DAMI protein is down-regulated from the transfection with neuraminidase.

In Figure 4, the process of the peak detection is show analytically. The original 2D-gel image is inserted as an entry to the DWT, where the energy of the coefficients is computed [14]. The three-dimensional histogram of the DWT is presented. The cutoff threshold derived from the combination of the local maxima and weighted centroid methodologies is presented with the light blue plane. Values above that threshold will be denoted with a cross mark in the final DWT picture shown on the top of the diagram.

For a further implementation of our approach, different kinds of experimental 2D-gel images have used. The selected study represent the most common types of comparative genomics analysis including: a) inherent phospho-proteins [10] b) cross specie tissue analysis [14] c) differentiated used buffer [12]d) transfected and untransfected cell line [13]. The initial images without the implementation of the DWT is shown in Figure 5. Furthermore, Figure 6 represents the DWT and Figure 7 the developed methodology for the autonomous peak detection quantification. More analytically, for the Phosphoserine (Figure 7left-a) 87 peaks detected in total (51 detected with local maxima and 36 with weighted centroids), for the Phosphothreonine (Figure 7 right-a) 59 peaks detected (36 with local maxima and 23 with weighted

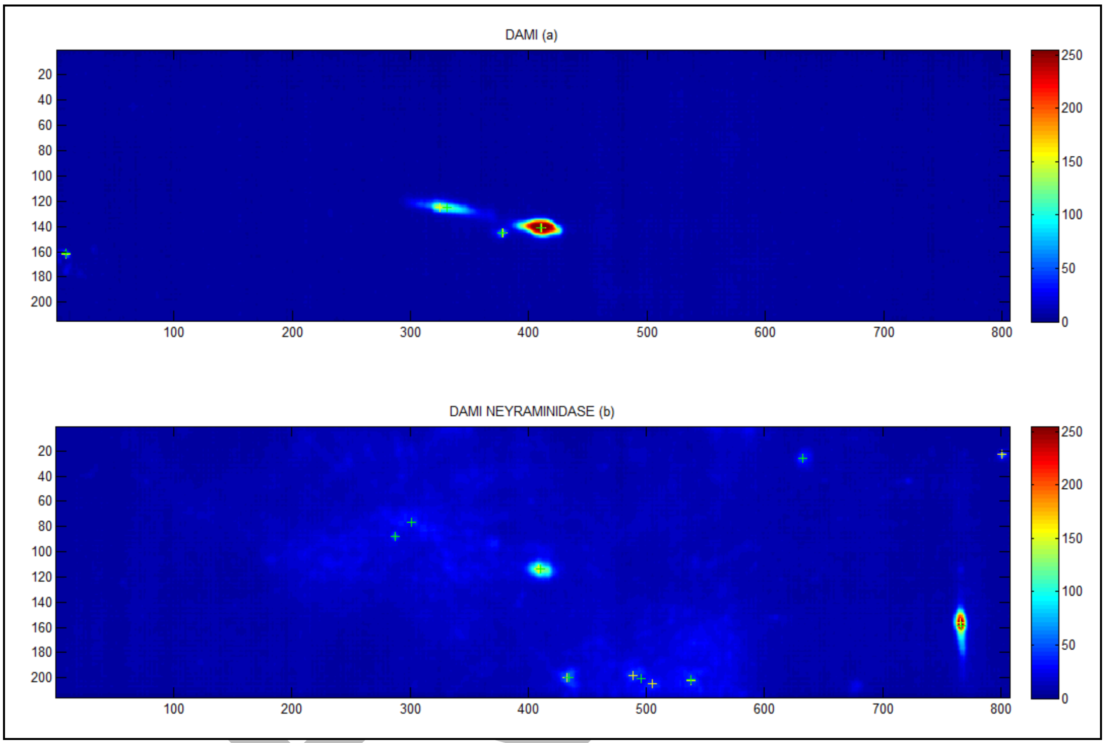

Figure 4. Human megakaryocytic cell line DAMI (upper) and protein DAMI transfected with neuraminidase (lower)

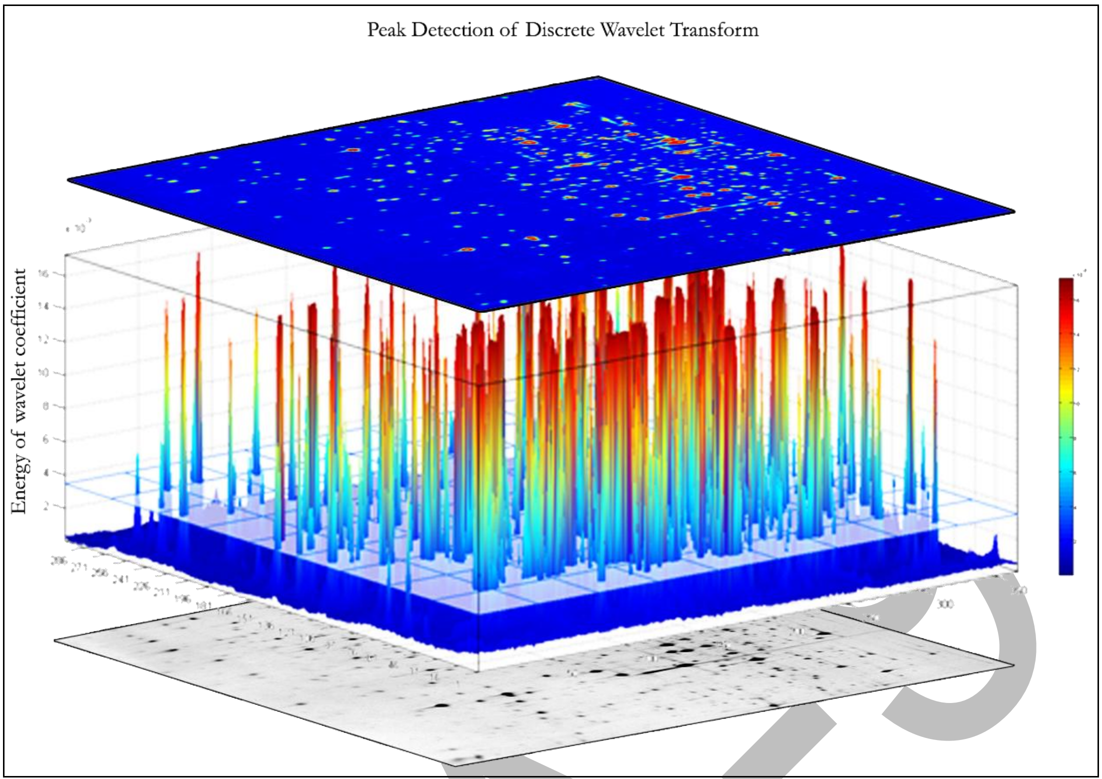

Figure 5. Peak detection from the DWT of the original image. The light blue semi-transparent plan symbolizes the noise cutoff threshold

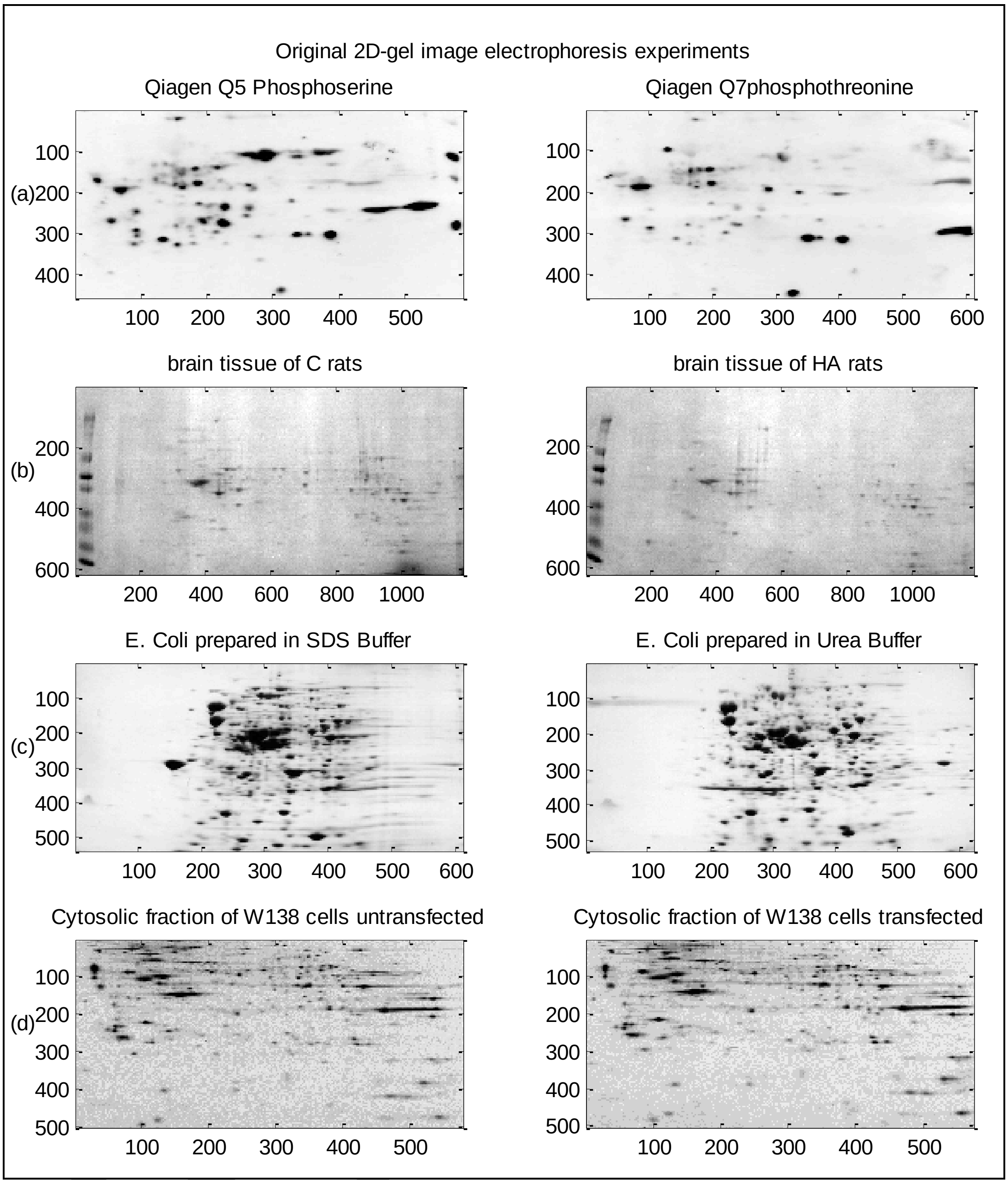

Figure 6. Original images from 2D-gel electrophoresis experiments. Protein differentiation analysis includes: Phosphoserine (left-a), Phosphothreonine (right-a), brain tissue from C-type rats (left-b) with included control, brain tissue from HA-type rats with included control (right-b), E. Coli in SDS Buffer (left-c), E. Coli in Urea Buffer (right-c), untransfected W138 cells (left-d), transfected W138 cells (right-d).

centroids) for the brain tissue from C-type rats (Figure 7 left-b) 167 peaks detected (121 with local maxima and 46 with weighted centroids), for the brain tissue from HA-type rats (Figure 7 right-b) 104 peaks detected (77 with local maxima and 27 with weighted centroids), for the E. Coli in SDS Buffer (Figure 7 left-c) 214 peaks detected (149 from local maxima and 65 from weighted centroids), for the E. Coli in Urea Buffer (Figure 7 right-c) 210 peaks detected (135 from local maxima and 75 from weighted centroids), for the cytosolic fraction of the untransfected W138 cells (Figure 7 left-d) 335 peaks detected (247 from local maxima and 88 from weighted centroids) and finally for the cytosolic fraction of the transfected W138 cells (Figure 7 right-d) 295 peaks detected (208 from local maxima and 87 from weighted centroids). The local maxima method seems to detect more protein spots in comparison with weighted centroid, however it is strongly recommended the in-common use of these techniques for the detection.

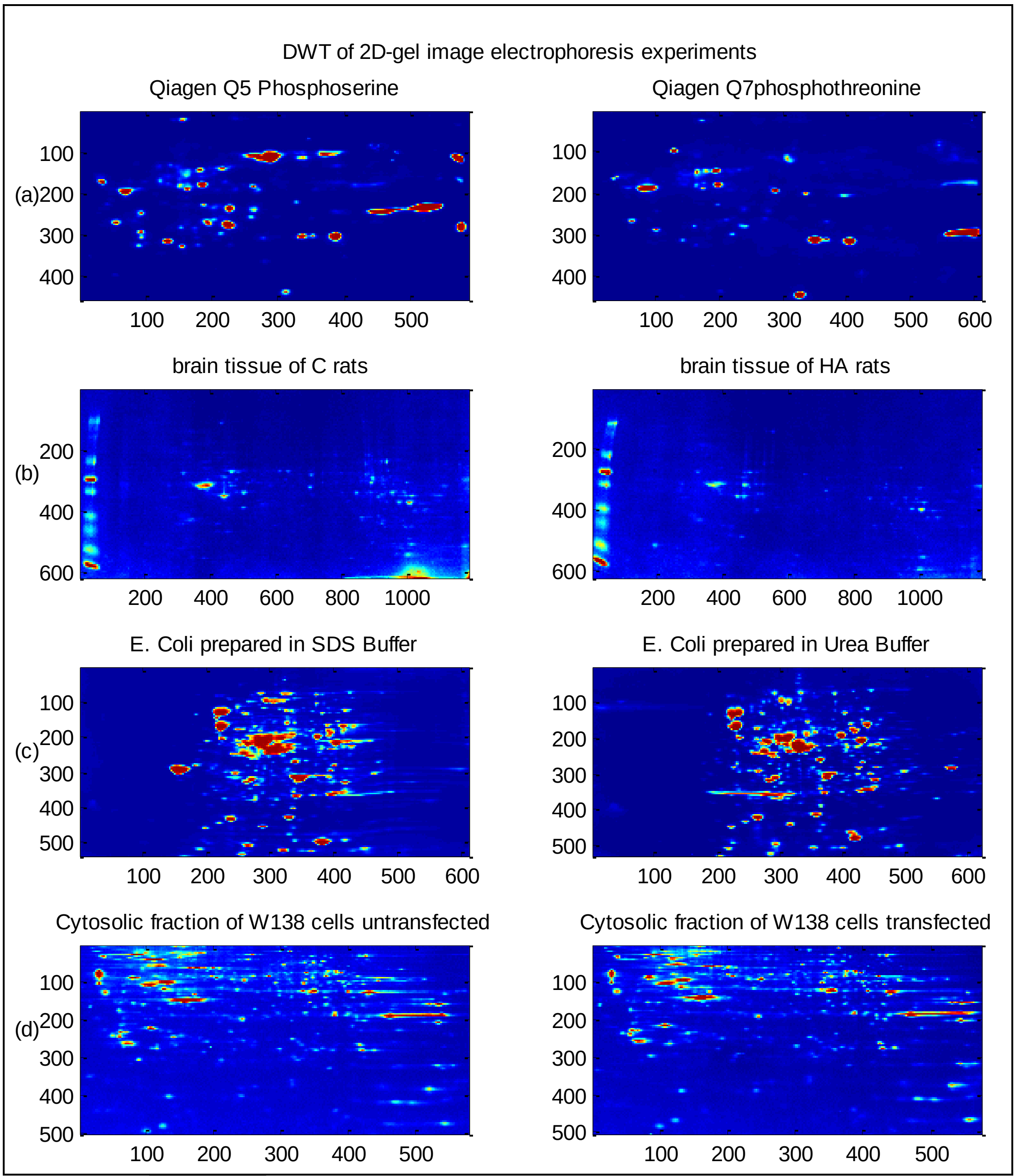

Figure 7. Discrete Wavelet Transform of the original 2D-gel electrophoresis experiments. Protein differentiation analysis includes: Phosphoserine (left-a), Phosphothreonine (right-a), brain tissue from C-type rats (left-b) with included control, brain tissue from HA-type rats with included contro (right-b), E. Coli in SDS Buffer (left-c), E. Coli in Urea Buffer (right-c), untransfected W138 cells (left-d), transfected W138 cells (right-d).

4. Conclusion

Two-dimensional gel electrophoresis (2DE) is an important and fast growing method for the separation, identification and quantification of proteins in tissue samples. Discovering the differences between images is extremely difficult and requires increased human interaction to the experimental analysis. As it can be derived, for a large image dataset the handling is even tougher. A new technique for the automated processing of the differentiated expressed proteins with a peak detection method was implanted in 2DE images. Quantification of the proteins was also available for an improved analysis. The proposed algorithm could strengthen the efficiency of an experiment by supporting findings with an extra validation technique. For spots that have been identified to be present in both groups, the technique could be further extended to determine consistent differences in the spot size and shape.

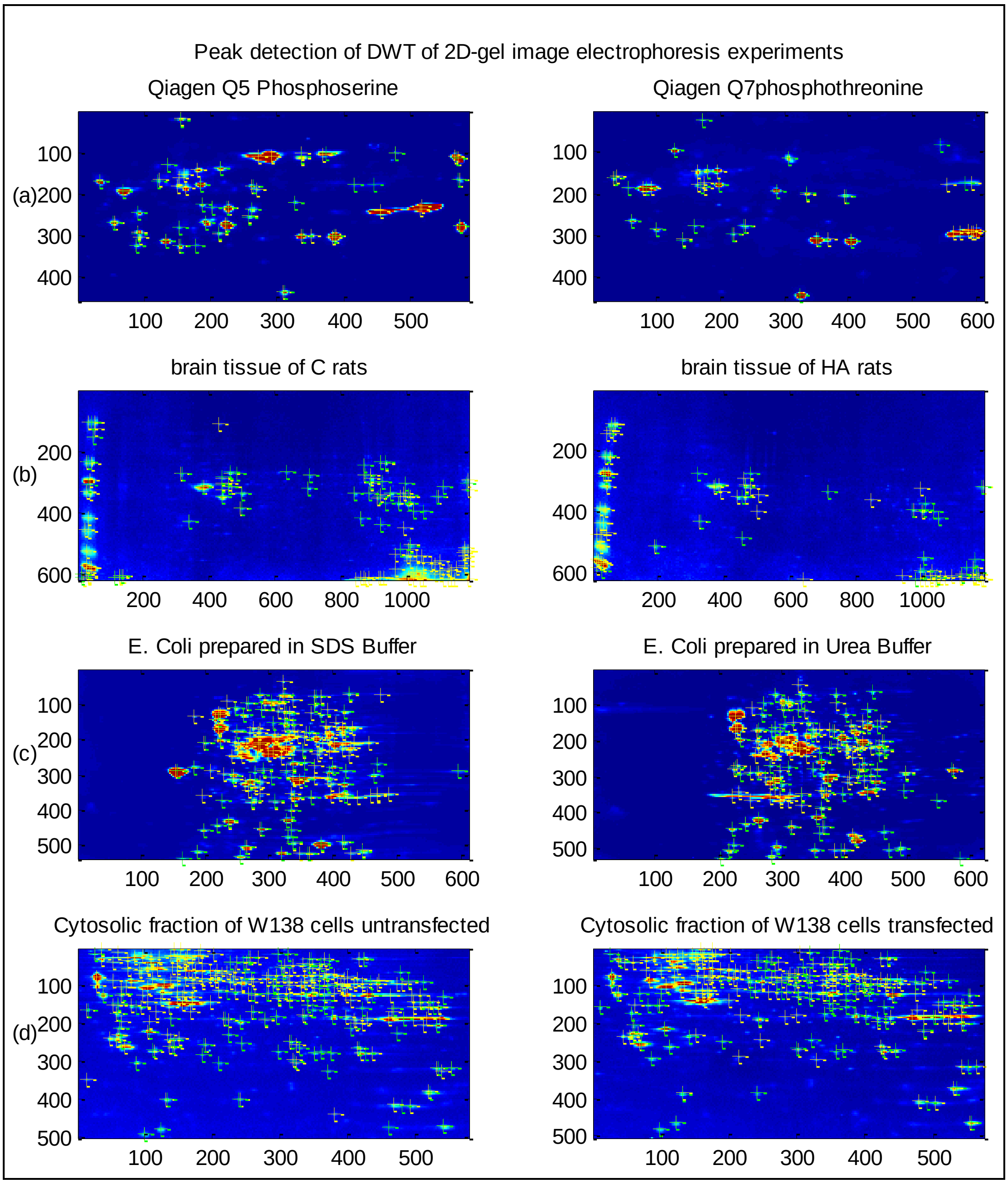

Figure 8. Peak detection of the Discrete Wavelet Transform of the original 2D-gel electrophoresis experiments. The yellow cross symbolizes the local maxima method and the green cross represents the weighted centroid sub-pixel resolution method. Protein differentiation analysis includes: Phosphoserine (left-a), Phosphothreonine (right-a), brain tissue from C-type rats (left-b) with included control, brain tissue from HA-type rats with included contro (right-b), E. Coli in SDS Buffer (left-c), E. Coli in Urea Buffer (right-c), untransfected W138 cells (left-d), transfected W138 cells (right-d).

From the results it is evident that, the proposed technique gives a different and more user friendly performance compared to other traditional techniques. Wavelets are better suited to time-limited data set and reduce errors. Finally image analysis techniques could enhance proteomics workflows.

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BACKGROUND EMR MEASUREMENTS IN ZANTE AND LESVOS ISLANDS, GREECE

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This study's main purpose was to investigate extremely low-frequency magnetic fields and radiofrequency electromagnetic fields as possibly carcinogenic to humans based on the suggestion of the International Agency for Research on Cancer (IARC).

Measurements were taken in a variety of environmental locations, mostly houses and workplaces in urban, suburban and rural areas, outdoor and indoor, in the islands of Zante and Lesvos as well as in dwellings in Attica.

Emphasis of the electromagnetic field measurements was placed on mobile frequency (RF) sources, wireless technologies and DECT telephony. In different location points a total number of 208 measurements were taken in Zante island and 355 measurements in Lesvos. In Zante, measurements were performed using Antenessa and Aaronia spectrum analyzers (HF & NF) which show the exact frequency and the signal strength of the sources including RF and EMF.

All possible sources of background EMR were investigated, namely in the frequency area between 9 KHz – 1.5 GHz. In Lesvos, measurements were taken with NARDA EMR-300 RF survey meter. In Lesvos, a map of the measurement points was created and analyzed by GIS software. The measurements in Attica were also taken with NARDA EMR-300 RF.

On the electrical field the maximum values were below 5V/m, however increased values of up to 3 kV/m were addressed near high voltage power transmission lines. On rural areas measurements of the electric field values were approximately 3–5 times lower than those existed in urban areas. In most cases the magnetic field values were lower than 2μT. In some occasions some of the measurement values up to 6μT were occasionally observed.

In conclusion the results of the study showed that Wi-Fi modems, mobile phone and DECT facilities when in use, expose people to high electromagnetic radiation although the intensity greatly depends on the distance and the functionality of the devices.

1. INTRODUCTION

Due to the exposure to electromagnetic radiation, which comes from the environment well as from the sun, the outer space, even from the earth itself, technological achievements such as radios, radars, televisions, PCs, mobile phones, Wi-Fi, DECT bases, have raised concerns about the health problems that may occur and are associated to the increased use of these devices, involving an increased exposure to EMR.(NRPB 2003; HPA 2004a, 2004b; Valberg et al 2007; Ahlbom et al 2008; SCENIHR 2007, 2009). Also these devices have as non-ionizing radiation exposure like LF-EMR as large amounts of radio frequencies (RF). In every case, the exposure to EMR sources is measured in the surrounding space of the object and the distance from the device and in the case of directional antennas from the proximity to the main beam. The field intensity decreases, often rapidly, with distance (IEEE 2004, 2005a, 2005b; IEC 2005; WHO 2002, 2006a, 2006b, 2011).

1.1 RF

At the beginning of the 20th century there is an increased exposure to RF radiation due to the presence of mobile phones in the market which resulted in steady and rapid growth of DECT base stations. In Europe, the percentage of users reaches up to 80% while more than 2billion people use it worldwide (Scenihr 2007).Despite the increasing development of new technologies that use RF, the knowledge we have about the effect on human exposure, is minimum.

In a typical home, the RF exposure may be caused by outdoor factors such as the radio, the television, and the mobile phone antennas, but also indoor factors such as the operation and the use of mobile phones, DECT base stations, WLAN, or even from a microwave oven. The transmitters of the radio and television have a large coverage area and therefore operate at relatively high power levels up to 1 MW (Dahme 1999). However, the high levels of operation do not cause major exhibition of the population because they are in sparsely populated areas. Power levels inside a building can be from 1 to 100 times lower than those outside the building (Schüz and Mann 2000) and even inside the building the exposure may vary from floor to floor. For example, the exposure on the higher floors was double (and more variable) compared to the lower floors of a building. (Anglesio et al. 2001).

1.2 1.2. Mobile phones

Most mobile phones in Europe use GSM1800, GSM900, although GSM900 are no longer applicable, (Global System for Mobile Communications) or UMTS (Universal Mobile Telecommunications System) which operate in 1900-2200MHz. The radiation we receive from a mobile phone depends on various factors such as the characteristics of the device, particularly the type and the location of the antenna, the distance and the way we keep the mobile, the distance that the antenna of each company is situated, on whether the user is in motion (for example, inside a car) and most importantly, the adaptive power control, which may reduce the emitted power by orders of magnitude (up to a factor of 1,000). In areas where are many phone-users, the mobile phones can work at maximum power for quite long time. Inside the buildings, the power levels of mobile phones are on average higher than outdoor ratios, because of the shielding materials. (Scenihr 2007; Ahlbom 2004).

1.3 DECT

All wireless devices generate radio waves but the exposure from wireless phones and their stations (DECT) is usually lower than to mobile phones.

A typical cordless phone, found in a house, produces about 10 mW of power, considerably less than a mobile phone and this is because the signals have to travel only a few meters compared to the signal of a mobile phone that can even travel for kilometers.

What needs to be examined is the field strength of its base station. The maximum time-averaged power level for a DECT base station is the same while for a mobile phone handset is 250 mW. However, the exposure is less because the cordless phone base station is not held to the head, and the field strength falls rapidly with distance (Scenihr 2007).

1.4 WLAN

A terminal WLAN, for domestic use, has a maximum power of 200 mW but the average power is much less, because it depends on the traffic. Typically, the field intensity is below 0,5 mW/m^2, so the exposure to them is lower than that in the mobile phones. In some cases, however, the exposure to RF fields from WLAN and DECT base stations can overcome GSM and UMTS (Scenihr 2007).

2. MEASUREMENT'S PROCEDURE

2.1 Measurement locations

The measurements of this research were made in dwellings in different regions of Attica, Peloponnisos and in the islands of Zante and Lesvos. By now they have been performed 70 measurements indoors. The aim of this research is to identify the areas of interest and to determine the protocol for the future measurements.

2.2 Measurement procedure

The measurements were performed using NARDA EMR-300 RF as well as Aaronia spectrum analyzer (HF & NF) machines which show the exact frequency and the signal strength of the sources including RF and EMF. NARDA monitors high-frequency radiation in the range from 3kHz to 60GHz. The units of measurement and the measurement types have been selected to allow easy comparison with the most commonly applied limit values. Both of the devices are widely and successfully used in industry, research, schools and workshops RF, mobile phones, transmission towers, WLAN, DECT, Wi-Fi, Bluetooth, monitors, televisions, power lines and so on, as with the EME spy Information (ANTENNESSA). The highest threshold of 5.02 V/m of the equipment used, limited several measurements which led us to the possible use of any other device with no highest limit, in order to measure the exact value in V/m existing in the area. All measurements given by the diagrams of this presentation are mean values. The frequencies of EME for the measured regions are defined in Table 1.

88 - 108 MHz	FM	0.11	V/m
174 - 223 MHz	TV3	0.06	V/m
380 - 400 MHz	Tetrapol	0.10	V/m
470 - 830 MHz	TV4&5	0.13	V/m
890 - 915 MHz	GSM tx	0.05	V/m
935 - 960 MHz	GSM rx	0.05	V/m
1710 - 1785 MHz	DCS tx	0.10	V/m
1805 - 1880 MHz	DCS rx	0.07	V/m
1880 - 1900 MHz	DECT	0.12	V/m
1920 - 1980 MHz	UMTS tx	0.11	V/m
2110 - 2170 MHz	UMTS rx	0.21	V/m
2400 - 2500 MHz	WiFi	0.85	V/m
	Total field	0.93	V/m

Table1. Frequency range

3. METHODOLOGY

The procedure followed was in accordance with the agreed protocol. Measurements conducted with NARDA are expressed in units of electrical and magnetic field strength and power density with two different probes: the first one measures electric fields in V/m while the other magnetic field in A/m. Both measurements were applied for 10 minutes each with a sampling of 8 seconds in the center of the room regardless the existence of wireless devices. All the measurements which were conducted with ANTENNESSA where done from the middle of each room and those that were conducted with the machineries of Aaronia spectrum analyzer (HF and NF) where done in various parts of the residencies, at distances of 0m, 1m, 2m from the devices (televisions, Wi-Fi, mobile phones). In some of the areas of interest, we decided to make targeted sequential measurements by enabling and disabling some devices, such as the microwave oven (MWO), the Wi-Fi and the mobile phones, by making calls to other mobile phones during the measurement. The time of measurements was set at 10 to 15 minutes. The above criteria were considered as standardization compromise during real measurement practice. In addition, all remaining factors were recorded.

4. RESULTS

4.1 High Voltage Power lines

Some of the measurements were made at residences located near high-voltage transmission lines. The following table 2 shows the results of these measurements.

Table 2. EMF Indoor and Outdoor Measurements

Location	**Floor**	***EMF INDOOR MEASUREMENTS***		***EMF OUTDOOR MEASUREMENTS***	
		E.F.(V/m)	**M.F.(μT)**	**E.F.(V/m)**	**M.F.(μT)**
A	1st	2	0,686	8	0,69
	2nd	-	-	117	0,83
	3rd	1,6	0,8	348	0,833
B	1st	4	1,2	159	1,65
	2nd	2	2,7	315	3,2
C	Ground 1	10	3,17	**313**	6
	Ground 2	**16**	1,5	5	1,5
	Ro	**1,5**	1,	3	0,7

	of 1		2	50	
	1st	3,5	1,2	270	3
	2nd	8	2	3000	2,8
	3rd	25	0,7	65	0,35
	4th	1,5	0,35	150	0,15

We observe that the electric field ranges from 1.5 V/m to 10 V/m inside the residencies while outside ranges from 5 V/m to 3 kV/m. Also, the magnetic field inside the houses ranges from 0.35 μT to 3.17 μT while outside fluctuates from 0.15 μT to 6 μT, when the legitimate international permissible limits are 5 kV/m for the electric field and 0.1 μT for the magnetic field (ICNIRP 1998).

4.2 <u>Measurements with Antennessa, Aaronia and Narda</u>

Measurements taken with Antennessa were performed in Peloponnisos and Attica. With Aaronia the results come from Zante and Attica and eventually measurements with Narda were taken in the area of Athens and Lesvos. In all the above locations, the measurements were statistically analyzed and the graphs will be presented in each section below.

Antennessa measurements

The following results originate from the measurements with Antennessa in both Attica and Peloponnisos

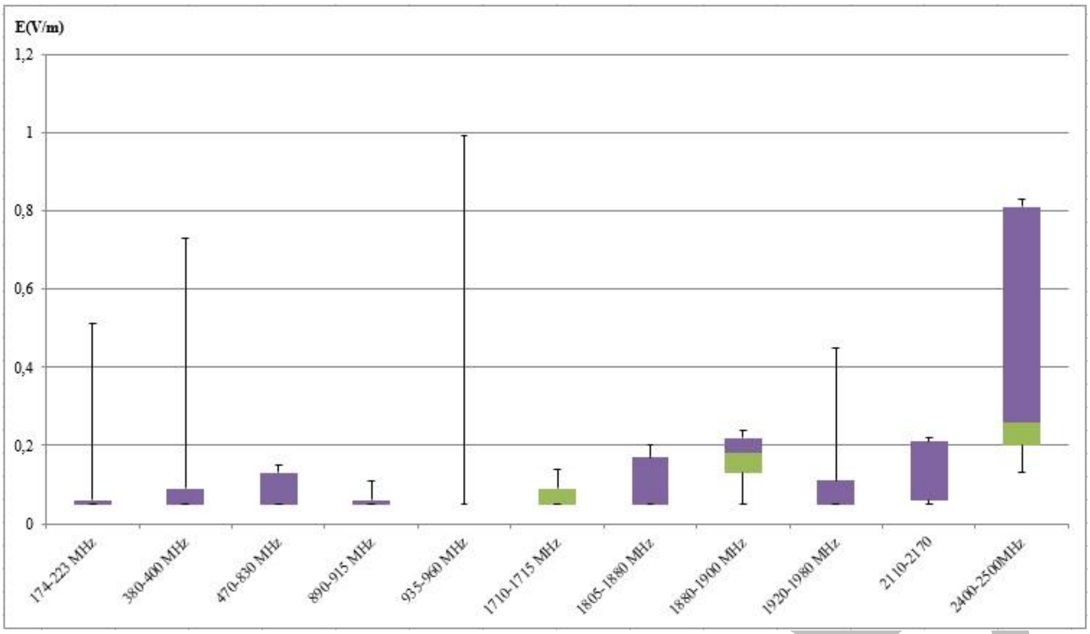

Fig.1 Antennessa measurements in Attica residences

In figure 1 we observe that the average of the values are on the WIFI although the highest values are found in mobile phones in GSM tx region with the highest measured value being 4,47 V/m.

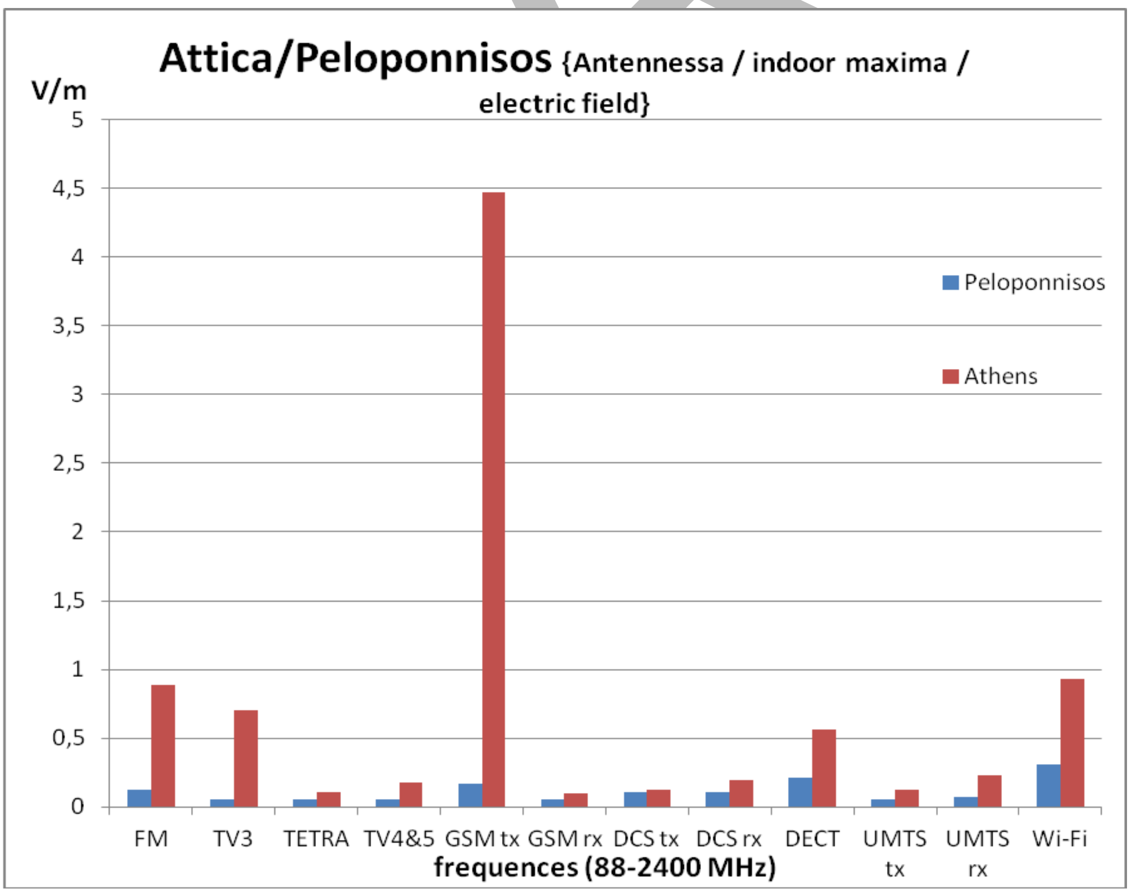

Fig 2. Attica comparatively to Peloponnisos

Comparing Athens to Peloponnisos the later values are much lower, turning to zero in some frequencies. (Fig.2)

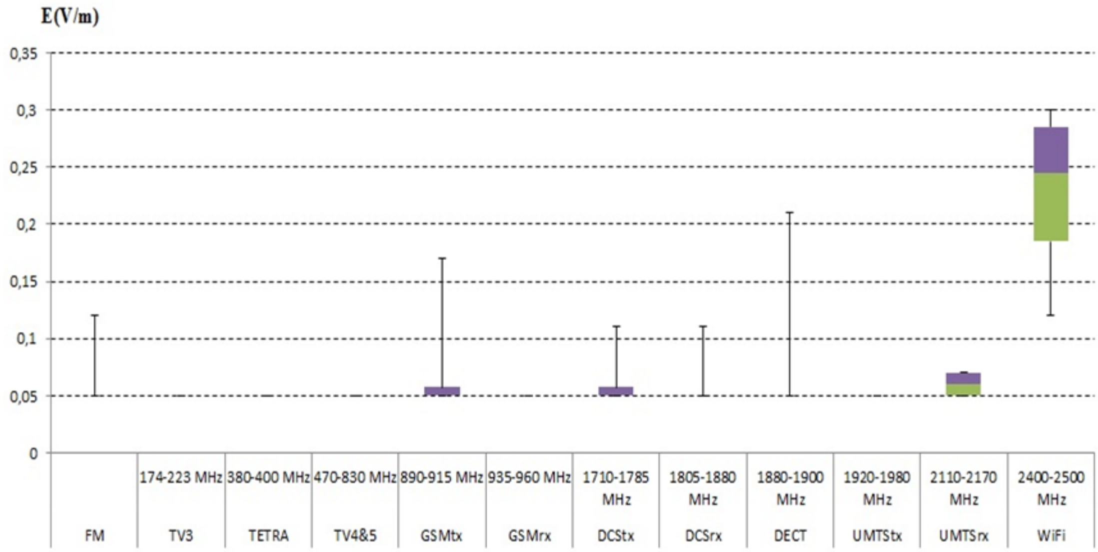

Fig.3 Antennessa measurements in Pelopinissos residences

In figure 3 it is noticed that the WIFI column has the average and the highest values. Although, DECT column has equally the highest value as WIFI.

Aaronia measurements

Electric field

Figures 4a, 4b and 4c shows that generally mobile phones tend to have more nW/m^2 in a distance of 2m rather than 1m or zero. GSM 1800 have the highest values averagely with the highest reaching 200 nW/m^2, followed by UMTS 2100 and GSM 900 with highest peak of 119,14 nW/m^2 and 76,48 nW/m^2 respectively

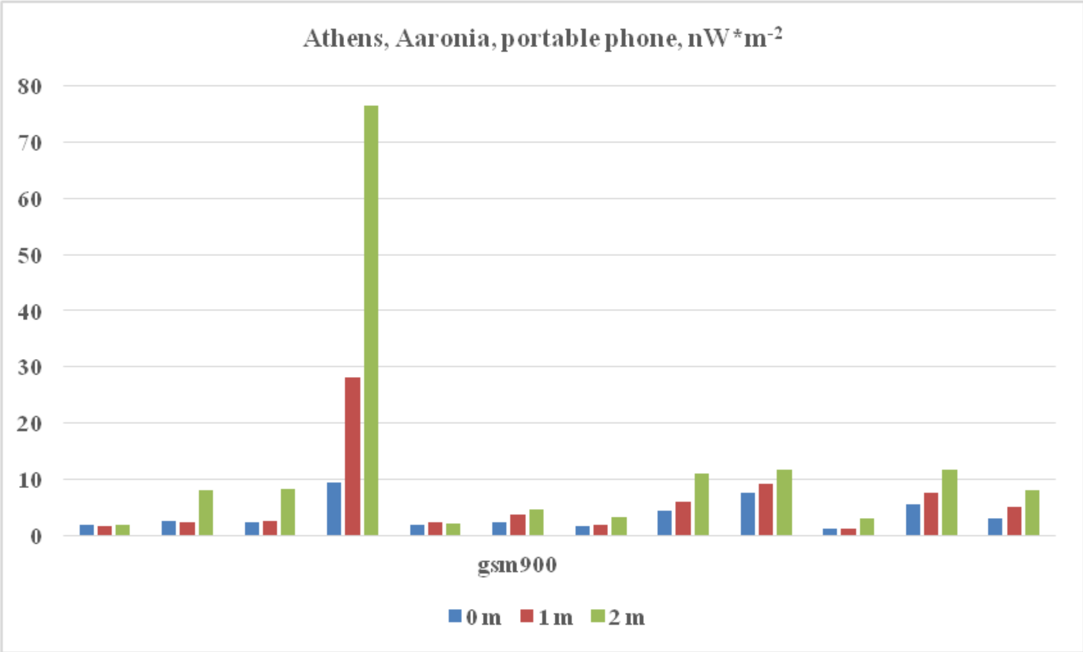

Fig.4a Aaronia measurements in Athens residences

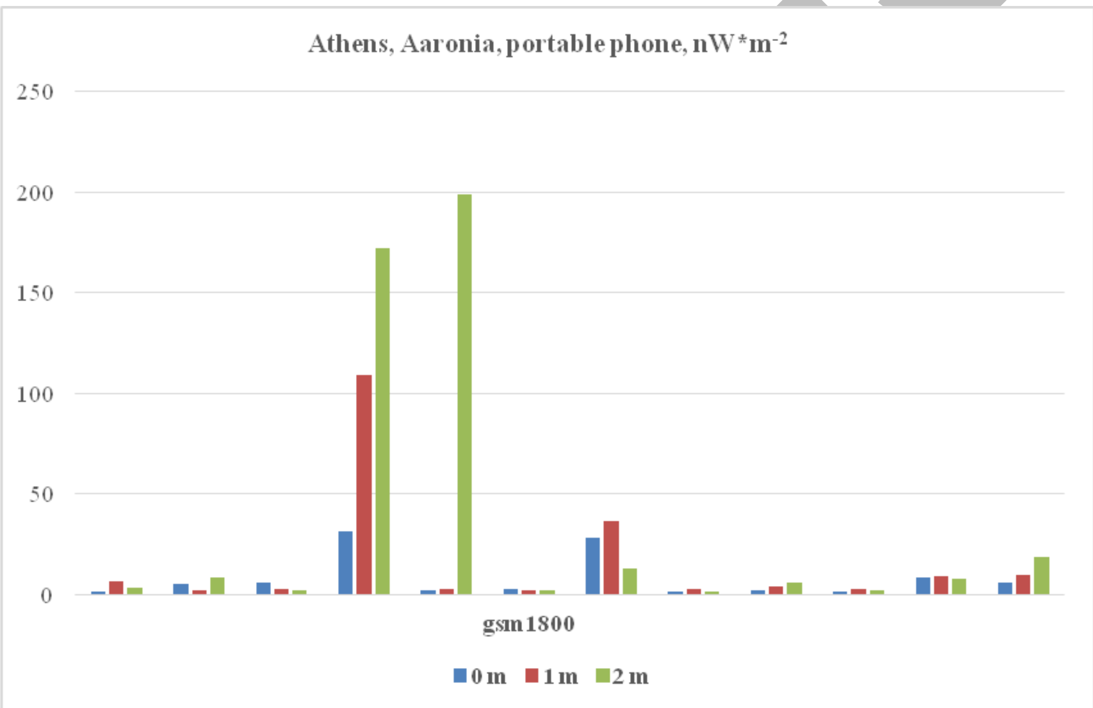

Fig.4b Aaronia measurements in Athens residences

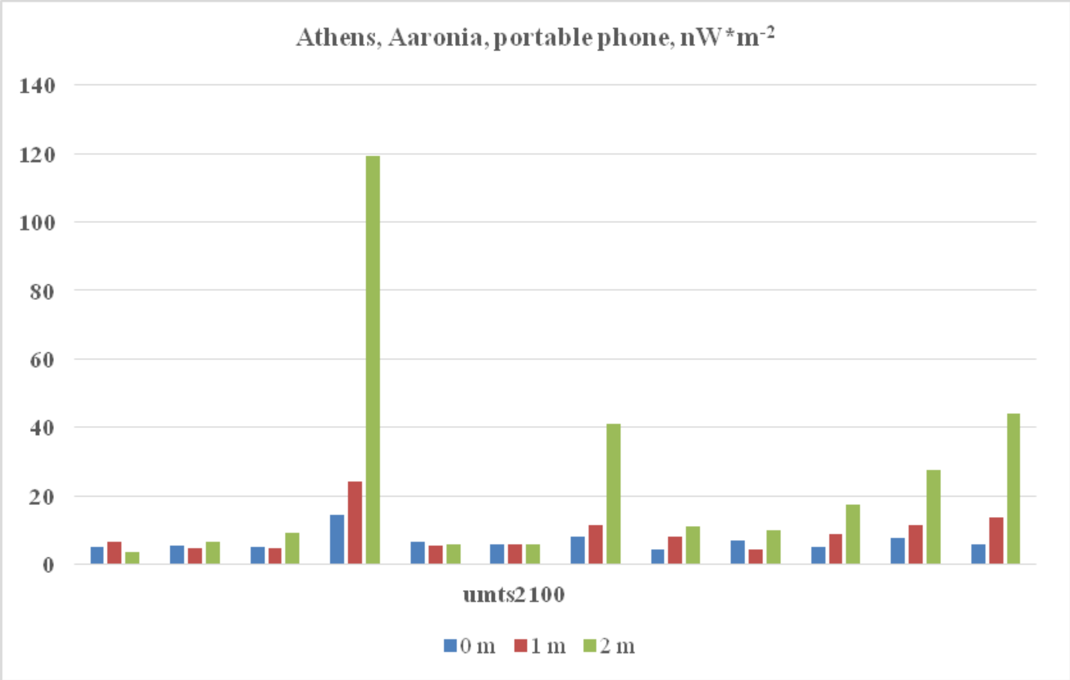

Fig.4c Aaronia measurements in Athens residences

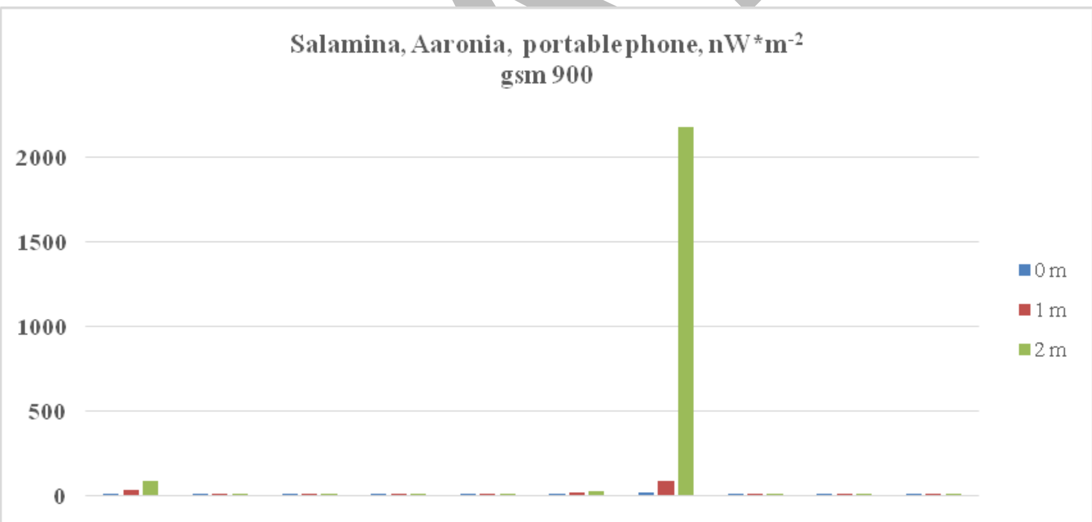

Fig.5a Aaronia measurements in Salamina residences

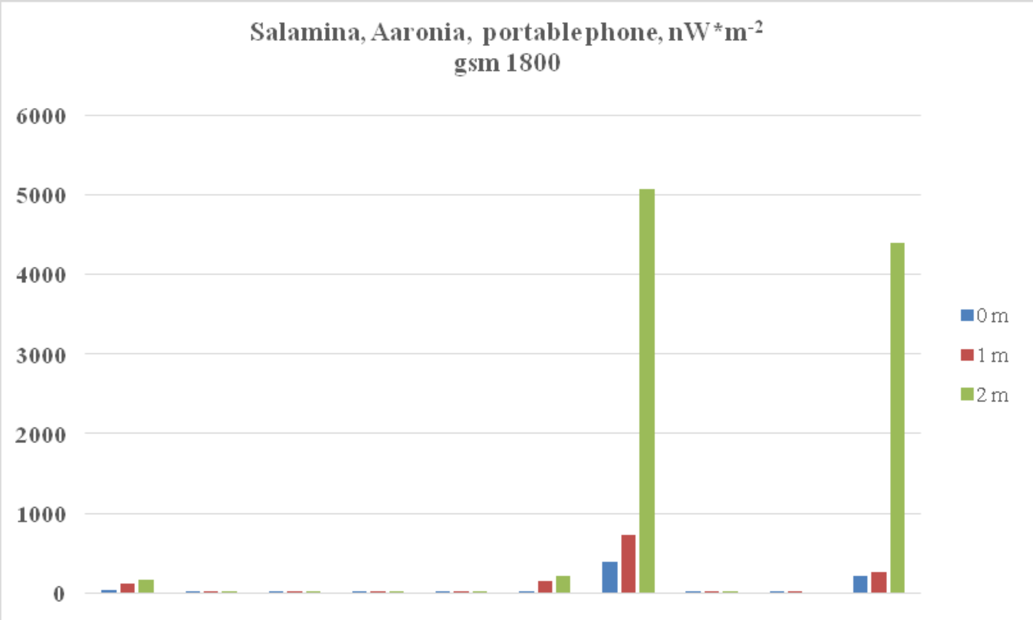

Fig.5b Aaronia measurements in Salamina residences

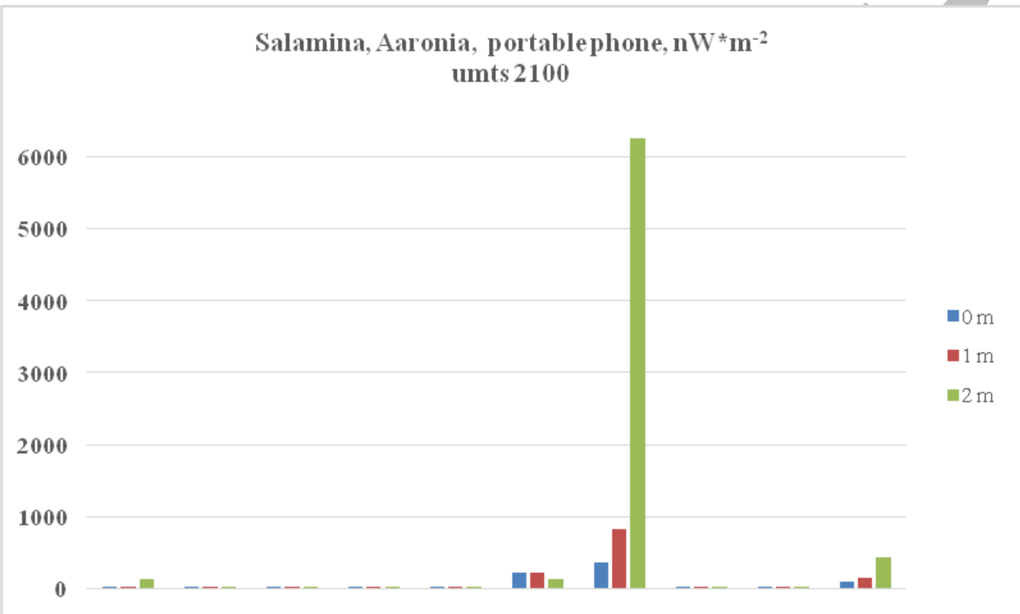

Fig.5c Aaronia measurements in Salamina residences

In figures 5a, 5b, 5c it is observed that the electric field is higher overall. Compared to Athens, Salamina has higher values in umts with the highest value being 6269 nW/m^2, followed by GSM 1800 with highest value of 4393 nW/m^2 and finally 87,28 GSM 900 with the highest value being nW/m^2. It is also observed that the values of the signals are higher in 2m rather than 1 or 0m.

Figures 6 and 7, show the electric field in measurements at 0m, 1m and 2m in Athens and Salamina. Measurements were taken in 12 and 10 locations respectively. In Athens at 0m distance the highest value is 677,5 mV/m and the lowest 197,8 mV/m, in 1m distance the highest is 498,9 mV/m and the lowest 66,3 mV/m and finally in 2m distance the highest value is 362,7 mV/m and the lowest 56,3 mV/m. In Salamina, at 0m distance the highest value is 621,6 mV/m while lowest is 216,6 mV/m, in 1m distance the highest is 367,3 mV/m and the lowest 216,8 mV/m and in 2m distance the highest value is 388,6 mV/m and the lowest 58,4 mV/m.

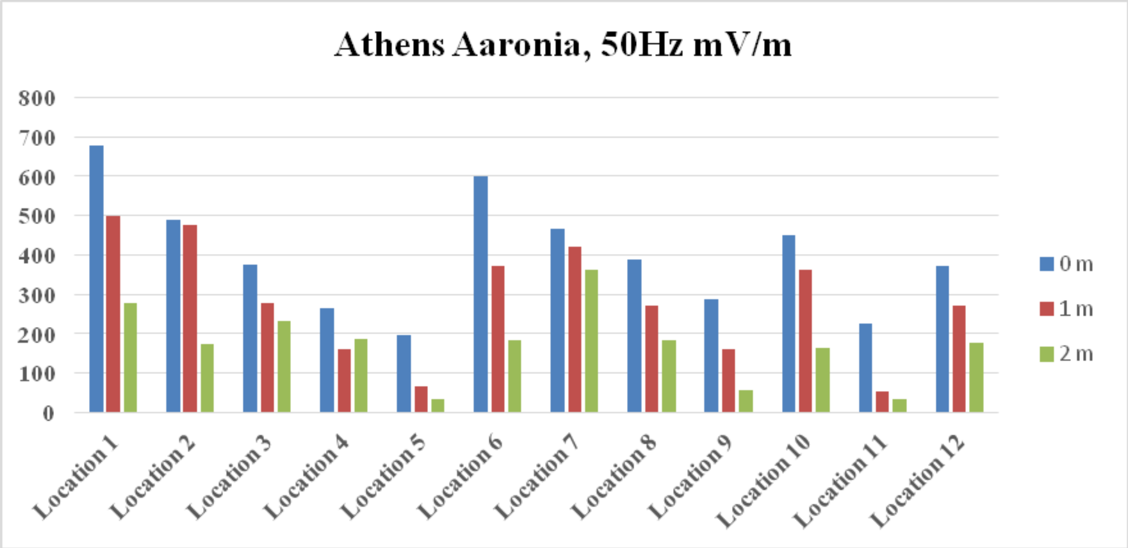

Fig.6 Aaronia measurements, 50Hz mV/m in Athens

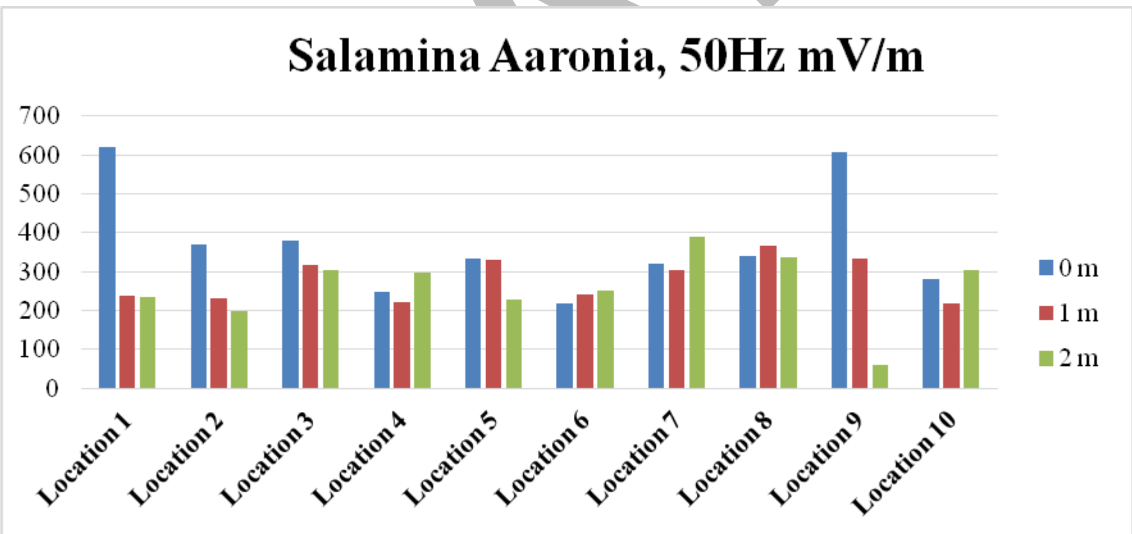

Fig.7 Aaronia measurements, 50Hz mV/m in Salamina

In conclusion, the next figure represents the average and the maximum values of the electric field of the two figures above. Athens has the highest maximum value which is 677,5 mV/m, although Salamina has the highest average values which is 303,7 mV/m.

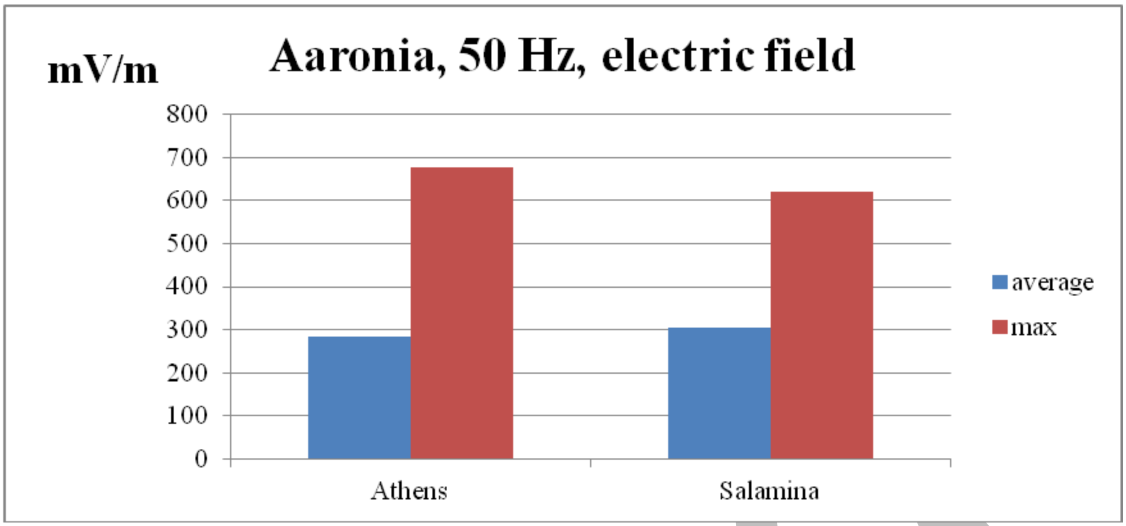

Fig8. Athens and Salamina comparison

Magnetic field

The comparison on the magnetic field is represented in figure 9 with the maximum and average measurements in Athens, Salamina and Zante. The highest maximum value observed belongs to Salamina being 774 nT followed by Athens with a value of 508,88 nT and Zante with a value of 505 nT. On the scale of average measurements the highest value comes from Athens, 237,25 nT, followed by Salamina 168,64 nT and finally Zante with a value of 61,82 nT.

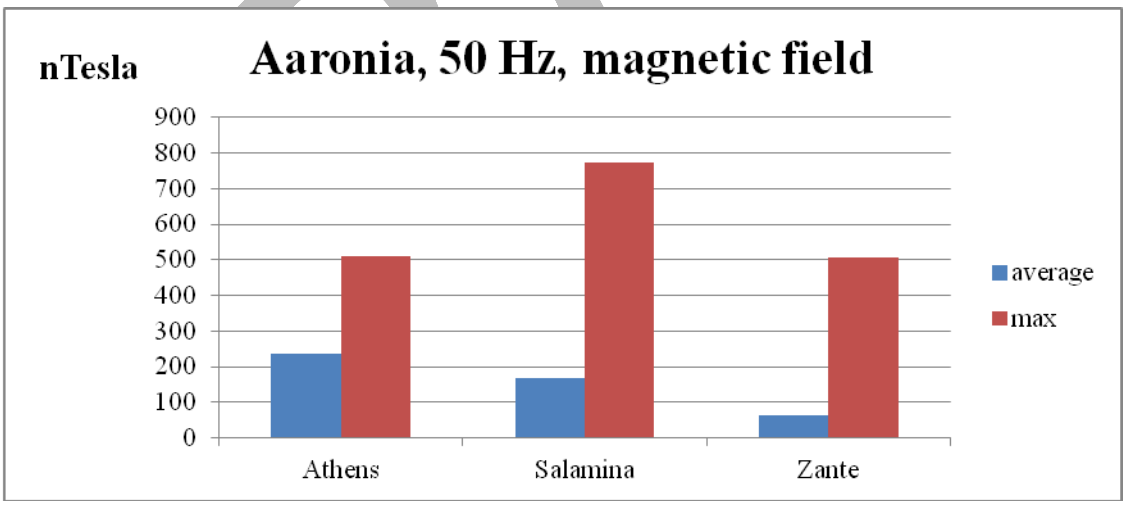

Fig.9 Aaronia measurements comparison

Narda Measurments

Figures 10 and 11 represent the magnetic and electric field in Athens with NARDA. In the magnetic field (figure 10) the 25 percent of the measurements belong in the range of 0,0024 to 0,0033 A/m while the 75 percent of the measurements belong in the range of 0,0033 to 0,0039 A/m.

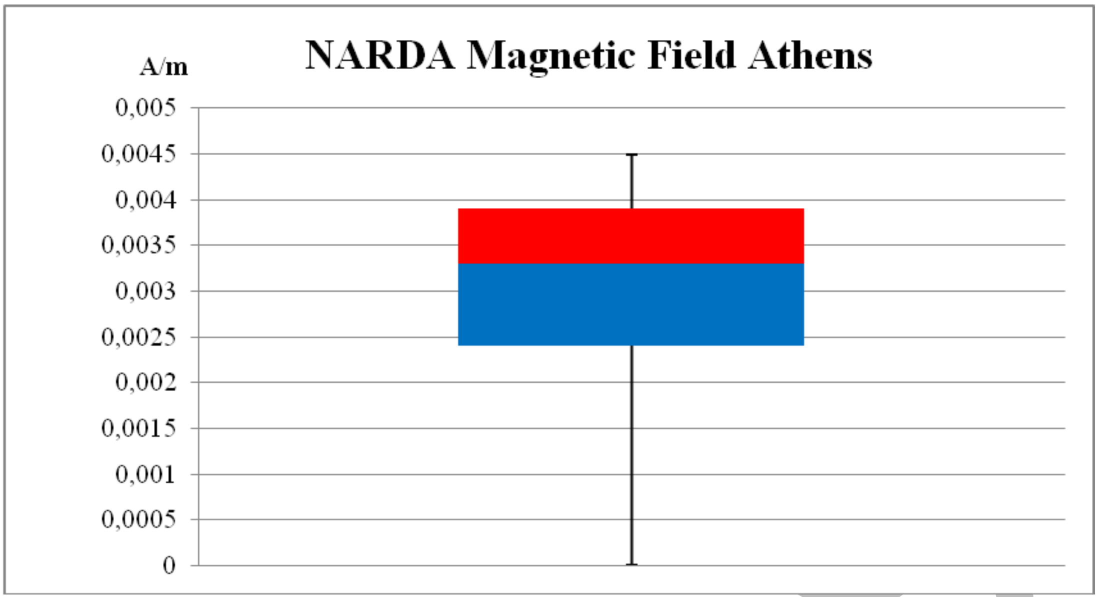

Fig.10 NARDA measurements magnetic field, Athens

In the electric field (figure 11) the 25 percent of the measurements are in the range of 0,04 to 0,1 V/m while the 75 percent is in the range of 0,1 to 0,16 V/m.

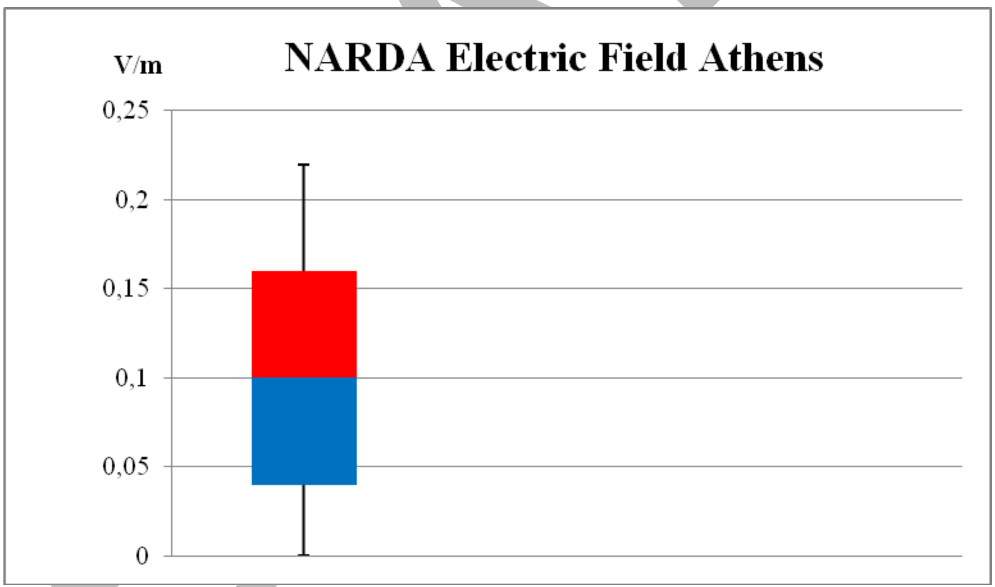

Fig.11 NARDA measurements electric field, Athens

Figure 12 shows the electric field in the island of Lesvos. The 25 percent of the measurements are in the range of 0,14 to 0,2 V/m while the 75 percent of the measurements are in the range of 0,2 to 0,27 V/m

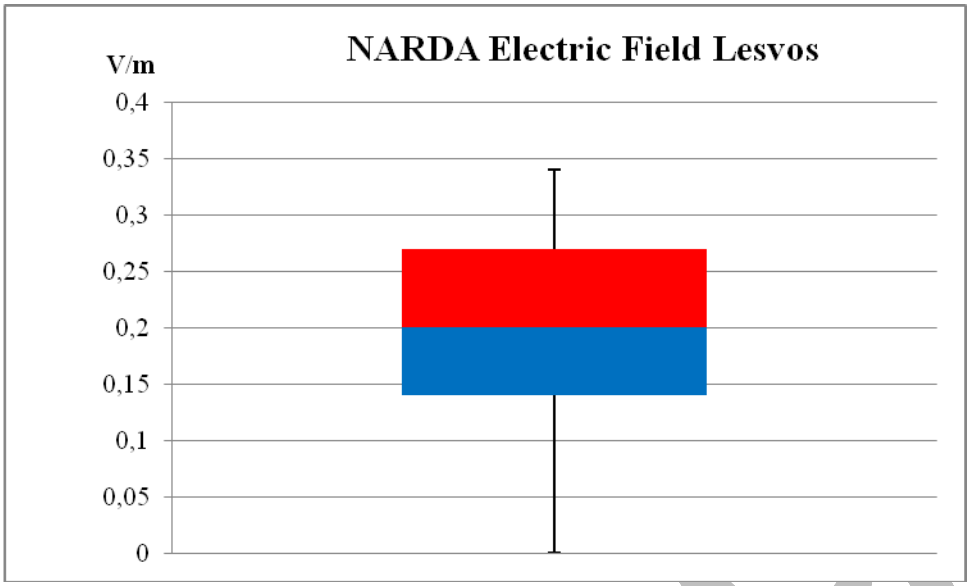

Fig.12 NARDA measurements electric field, Lesvos

In the last figure, figure 12, the results represent the comparison of the maximum and average measurements taken in Athens and Lesvos in the electric field. The highest maximum value exists in Lesvos, 5,6V/m, and also the highest average, 0,23V/m.

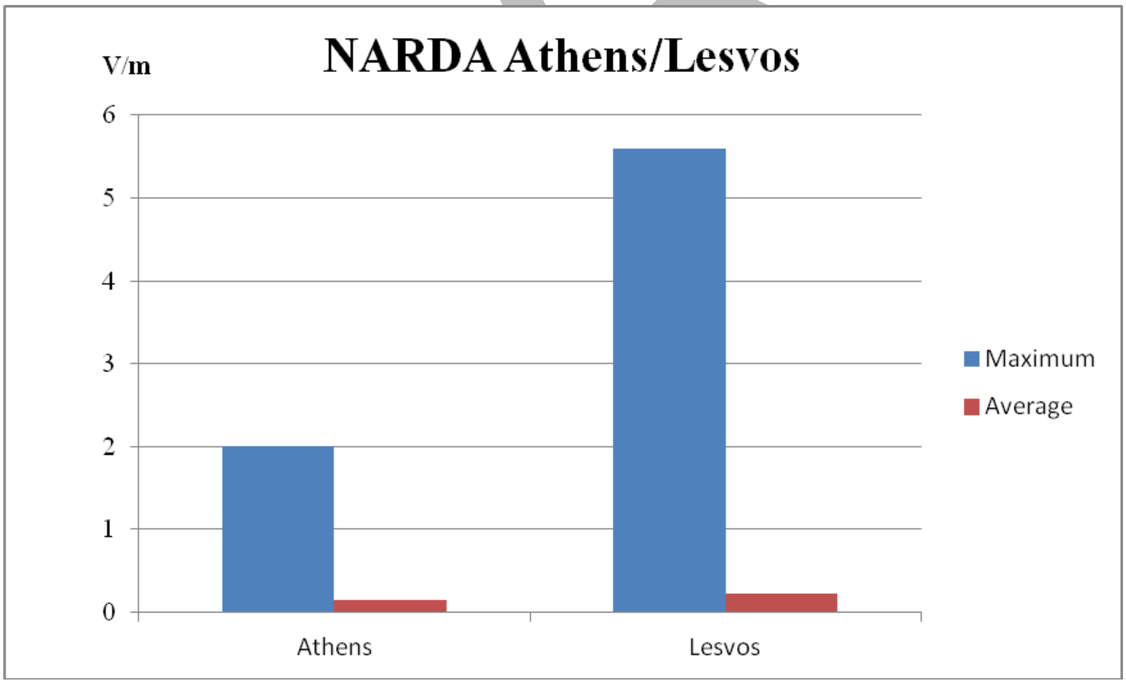

Fig.13 NARDA measurements electric field compared

5. Discussion

The indications of the Electric Field Strength in the above cases with the mobile phones, Wi-Fi and DECT have been, in majority, much lower than 61 V/m, which is the reference guidelines for general public set by ICNIRP (ICNIRP 1998) and which, also, depend on the distance. Compared to Salamina, Athens has generally lower maximum values in the electric and magnetic field although

Athens has greater average values. It was also observed that the island of Lesbos, in the electric field, has values greater than the ones in Athens. However, care should be taken because some published studies (Wang et al. 2006; Dimbylow and Bolch 2007) showed that in the frequency ranges of body resonance (100 MHz) and from 1 to 4 GHz for bodies shorter than 1.3 m in height (corresponding approximately to children aged 8 years or younger) at the recommended reference level the induced SARs could be up to 40% higher than the current basic restriction under worst-case conditions. In the case of houses located near high-voltage transmission lines the results are alarming because almost all the measurements exceed the international limits set by ICNIRP, which are 5 kV/m for the electric field and 0.1 μT for the magnetic field. Studies have shown that exposure to such radiation may be responsible for childhood leukemia (Hardell 2008; Petridou et al 1977).

In conclusion the results of the above study show that Athens has lower levels of radiation originated from WiFi and dect compared with Lesvos or Zante.

Acknowledgements

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Specification of the industry's necessities in nowadays – the role of Tempus activities to the connection of the industry with the education

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Abstract

In the frame of the UNITE Tempus project, the main intention is to connect the necessities of the industry with the higher educational system in Belarus. Aiming to achieve this, is taking in mind the existing systems in the European countries taking part at the project, like Greece, Belgium, Spain, Portugal. Until now, there have been implemented some activities of the project, which contribute to the formation of the first view of the textile industry's necessities. It is about the following reports:

"Identification and analysis of good practices of cooperation between HEI and industry", "Good practices for Liaison offices", "Needs analysis for liaison services in Belarus". In the present paper are analyzed all the data derived from the before-mentioned reports in order to be channeled to the activities of the project which follow.

Keywords: textile industry, European projects, education, liaison offices

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1. Introduction

In the frame of the UNITE project the main intention is to connect the necessities of the industry with the higher educational system in Belarus. Aiming to achieve this, is taking in mind the existing systems in the European countries taking part at the project, like Greece, Belgium, Spain, Portugal. Until now, there have been implemented some activities of the project which contribute to the formation of the first view of the textile industry's necessities. It is about the following reports (in brief):

- "Identification and analysis of good practices of cooperation between Higher Education Institutes and Industry",
- "Good practices for Liaison offices",
- "Needs analysis for liaison services in Belarus".

In the present paper are analyzed all the data derived from the before-mentioned reports which created in the frame of Tempus project.

2. Identification and analysis of good practices of cooperation between Higher Education Institutes and Industry (study 1)

Good practice report, including case studies of cooperation between Academia and Industry. The case studies are focus on experiences on the textile sector cooperation. The report includes a number of seven case studies and a synthesis of the results including main challenges, impacts and recommendations. The involved institutions to this report are:

- Technological Education Institute of Piraeus, Greece
- University of Beira, Valencia
- Polytechnic University of Valencia,
- AITEX, Spain - AITEX is a non-profit association established in 1985, composed by textile and related companies, whose main objective is to improve the textilde companies competitiveness,
- CITEVE, Portugal - Technological Centre for the Portuguese Textile and Clothing Industry
- Kauno Technical University, Lithuania
- University of Ghent, Belgium

Some useful information derived from their studies, are presented below:

2.1 <u>Good practice by TEIPIR</u>

In the implementation of the related with this activity, structures, programs, actions in the Institutions of Higher Education observed from different point of views and approaches there is a variation in the success and the achievement of the objectives.

Through these different approaches, however a series of "good practices" can be traced, which can be analyzed and exploited (when it is possible or where adjustments are applicable) in the synergy of Higher Education Institutions & Industry. The "good practices" identified concern both Incentive Programs, Business activities, innovative applications, actions of entrepreneurship, Liaison Offices etc discussed below. The result is identified in realizing stable and long-term partnerships between education and production (at local, regional or national level).

The stability and duration of these partnerships have enabled substantial involvement of stakeholders and people outside of institutions and provided substantial incentives for their participation in program activities. At the same time, it was a factor of activation for local communities (in an extent) as to be interested and be involved, while this helped significantly the diffusion and dissemination of programs and results. At the level of cooperation and networking, a good practice in relation to cooperation and joint activities within the institutions themselves but also with others.

The development and monitoring mechanisms for the progress of the programs and the achievement of objectives in relation to the qualitative characteristics can be identified as a good practice (for example questionnaires surveying business attitudes of students / students before and after monitoring entrepreneurship courses), which served as an effective tool of monitoring the achievement of quality targets and feedback of strategy for the stakeholders. Of particular concern in this case, is far beyond, the manner used to attract the stakeholders and involve them and the way the different disciplines, both in terms of knowledge and attitudes are used. Supporting students, graduates, new & old entrepreneurs, creating spin off companies was of particular importance and increased efficiency. Finally, as good practice we can consider the involvement of more teachers, business-mentors and others in the process of drafting business plans. A broader and more effective transfer of knowledge and experience took place, with wider contribution and acceptance of both the academic programs and the industry.

In conclusion, there are a lot of deliverables produced all these years with a large geographical and sectorial impact along with enabling market potential for SME and inducing benefits such as job creation, triggered investment, trained people etc.

Universities, all over the world, exist to fulfill three main goals: educate future leaders of their communities, promote the advance of knowledge in every academic field (research), propose an offer of continuous education to practitioners. We can see these three purposes in the statements of the Mission of our institutions as well as, in the introductory chapters, in Universitary Laws in every country. Since the decade of 1990 there has been in Europe (EU) a reinforcement of the role that research must play in universities and research is becoming an increasingly important task for university teachers. This is true in every academic field and also in Industrial Engineering and in Operations Management as a branch of it. The university-industry relationships is is important in many academic fields but especially in Industrial

Engineering and so in Operations Management. The issue is to build a strong rather than a faint relevance of university research results and industry, something which is not always effectively done. Another issue is the knowledge management operation deriving from all the different structures/programs/actions which in some cases overlay each other and do not encourage scale economies.

In conclusion, there are a lot of lessons to be learned from all the analyzed structures/programs/actions and there is a variety of key factors of success. Most of the analyzed structures/programs/actions either already exist in other European countries or can be created in the future as long as there are adjusted to the specific circumstances.

2.2 U.B.I. – INPROPLAN

The practice of textile and clothing design should be based on culture, should be able to establish bridges between tradition and reality of the world around us, should be able to understand that organizations exist because they have a market, so you should always be attentive to their evolutions, must accept that products and services must have a function and a suitable price, those that the market absorbs, which should be guaranteed by the proper use of technology and available resources in companies.

The success of organizations resides in people and in the right combination they are able to make between the three functions, innovation, design and marketing. The responsibility then lies with the top management in order to have the courage to create the functions of marketing and design in organizing their businesses and providing them with responsibilities for objectives. These functions must have limits as the budget allocated to the aims set and cohabitation with proper engineering and, as is common, not protectionism. The innovation key is the ability to demonstrate that managers enable and encourage that the people have ideas, develop and implement them. Should not forget that any element of an organization may have a brilliant idea (innovative) even that he had been encouraged to have many.

This pursuit of excellence needs an evolution on the part of entrepreneurs, to believe and to be receptive, by the State, in order to create conditions for the further training of personnel and their insertion in the labor market, by the Business Associations in order to continue to promote the circulation of information and partnership between companies and / or agencies and by schools, towards updating and adapting the training to change, at the level of technological courses and degrees in initial training and corporate " masters " in recycling and enhance knowledge of companies. Also, the approach between companies and schools, based on contracts for applied research and development, it is essential to support a new development model.

New methods of organization emerge due to the need for businesses to adapt to profound changes in the market and technology. The effects of globalization require mastery of organizational and production techniques capable of causing the differentiation in terms of quality, flexibility, responsiveness and customer service, rather than the strategy based on the price factor.

There are methodologies, policies and management philosophies that when combined are capable of adapting to wool sector, and from this perspective, with your application perfectly delineated and specified to every organization, the change can be translated into success.

Alongside, the organizational processes are important research of segments of vertical markets, distribution strategies with global logistics systems.

The Inprolan project contributed, in a decisive way, to greatly improve the quality of products manufactured in the Portuguese Wool Industry and learned best practices and procedures. It seems reasonable that this initiative could easily be applied in other countries / regions, if one takes account of their particularities.

2.3 CITEVE- E-learning Programme for Skills Development in Textile Defects Analysis (SKILLTEX)

Skilltex project's final product is an e-learning training course about textile defects/faults that is be available in 6 languages, allowing to overcome the language barriers related to the uniformization of textile defects analysis across Europe. It is important to note that the course is accessible to any person, irrespective of the geographical distance. This eLearning course was created based on the textile workers needed competencies according to Professional Profiles defined in each country involved in the project. Furthermore, after having the final product it was tested and validated by 40 textile workers in each country involved in the project.

As impacts, the project is expected to:

- Increase the active workers skills, citing lifelong learning as a major training tool;
- Contribute to the problems resolution between the varied agents of the productive process;
- Promote product improvement and increase the competitiveness of companies;
- Support qualifications and personal development;
- Make training more attractive through nontraditional resources and the use of ICT.

Through a dedicated training programme, it was anticipated that the Skilltex Project would:

- Assist with the enhancement of training for all textile and clothing workers and their ability to identify and rectify faults in the industry
- Contribute to a decreasing level of defects through knowledge enrichment and contribute to quality assurance procedures within the textile industry.
- Improve skills development and knowledge transfer in universities and technological schools through dedicate training packages;
- Assist machinery and product manufacturers understand the complexity of machine setup and work closely to achieve the desired outcome by promoting a better understanding of textile faults in machinery.

The learning contents arising from the project are very relevant and are a good way to support enterprises and operators to avoid mistakes and defects during the production process.

Nevertheless the quick changing environment in the production process does not give the possibility to workers of the textile industry to get time to do training or to access SKILLTEX and understand the base of a concrete problem. During the application in real situations we found out also some difficulties interacting with computers mainly when it comes to textile operators with low ICT knowledge.

2.4 UPV 'DIVERSIFICATEX'.

The main phases of the project were:

- Phase 1: Firm classification according to their technological capabilities, existing processes and machinery available.
- Phase 2: Inventory of existing technologies and their productive capabilities.
- Phase 3: State-of-the-art technology of non-conventional textiles.
- Phase 4: Construction of a virtual Technology-Product matrix, which permits the rapid appreciation of the necessary technologies required by every product.
- Phase 5: Grouping the productive solutions.
- Phase 6: Deep technical commercial diagnose divided in two stages. The first one analyzing the present commercial structure and the second one focused on the prospective markets.
- Phase 7: Design of the necessary tools for the SMEs to expand commercially.
- Phase 8: Starting-up of the virtual platform 'DIVERSIFICATEX'.
- Phase 9: Dissemination of the project to the participating firms and the others in the sector.

The target of this project was to provide with strategic thinking techniques to Valencian textiles SMEs. These firms always need to adapt themselves to the sector requirements in order to grow as businesses as their technology and infrastructure do. This study has permitted the creation of a virtual platform to analyze the present situation of the companies in the region and to introduce their textile products in new potential markets. Textile technology available in each company had to be taken into account.

The project has supplied the firms with a mechanism to assist them in making strategic decisions towards diversification. Moreover, it offers the traditional textile firms the possibilities to manufacture and market more technical textiles. The information provided about new markets with higher value-added products helped the SMEs to find new market opportunities for their potential technical products.

The strategy of product diversification to higher value-added markets helped the Valencian SMEs to boost business cooperation towards innovation and commitment to internationalization.

Other possible future research could be found in the extrapolation of the tool to other specific areas of the textile industry.

As the most notable experience, we consider the determination of the production capabilities of the textile sector in a particular area or region. This analysis allows knowing the competitive advantages that the firms in the region possess, resulting in synergy among them. This way, the SMEs can work on joint projects to develop new products in need of technological facilities which cannot be found in one only firm. The most important lesson learned is that companies have to combine their technological capabilities to develop new products for a more exigent and demanding market.

2.5 AITEX

The action stems from the urgent requirement for textile manufacturers to confront the changes that the textile market has been undergoing in recent years. It is clear that if a manufacturer is to survive, he must offer consumers innovative products with a high added-value factor and that requires research into new products using currently-available technologies. The search for new markets for their products or making the step towards the diversification of their existing product range to face up to the added concerns of new players entering the textile marketplace.

The aims of the project were to provide the partners with the means to incorporate innovation into their products and processes and to diversify their activities by means of a coherent strategic option involving every facet of the company's activities. This would include studying resources, life cycles and market maturity, risk assessment, influences and trends, and analysis of the market and competitors, which would be based on qualitative and quantitative studies at a level permitting a product innovation plan to be drawn up.

The project had two well-defined facets; one the one hand a specific element which would offer companies consultancy in order to be able to carry out the customised innovation and diversification plan: this was extremely important owing to the fact that manufacturers' needs for consultancy and guidance is growing every year. The other facet was more generic and clearly oriented towards the detection of innovation in the textile industry as well as the identification and classification of possible applications. The innovative aspect of this element was the idea that through this action, the project partners would be able to produce articles aimed at new markets and the search for new applications and markets for their existing product lines could be carried out without the need for major investment in manufacturing processes.

AITEX was project leader and from among its principal functions, the following can be highlighted:

- The specific element was run individually for each partner and was designed to help them introduce themselves into new markets or design new products with a greater added value factor. This required case-by-case assessment which was used to analyse the processes, products, target market, distribution networks, etc. the results were used to create personalised innovation plans to orient manufacturers and advise them on the best options available depending on the idiosyncrasies of each company and their products. The assessment was well-received by the partners and continues to be a strategy followed by companies in the sector.
- The generic element was of vital importance in the creation of a study which expresses the theoretical and practical knowledge relating to the evolution of textile innovation in general and technical textiles in particular. AITEX was the conduit through which this knowledge, so vital to the sector, could be transmitted to manufacturers, allowing them to benefit from the experience gained.

Due to the diversity of the fields of applications in conventional and technical textiles, each partner worked with a group of experts within its specialised field and focused on an analysis, study and evaluation of the options available.

The final aim of the project was to gain a personalised assessment in the search for a technological strategy in technical textiles, clothing and decorative fabrics for each partner, by analysing the technological capabilities it possessed at the time and the general strategies which could be applied and to draw up a Product Innovation Plan using the strategies selected.

Obviously, the socioeconomic impact was self-evident for the project partners. The execution and transfer of the results obtained by the project represent an exceptional opportunity for the Valencian textile industry and by extension, for the whole of Valencia. The project objectives were in harmony with the Valencian Business Competitiveness Plan as it ensured increased capabilities within the textile industry and as a consequence, its sustained socio-economic resurgence, leading to increased employment.

The result was a restructuring of the sector. Companies in the developed world must take on board the necessary changes, if they are to maintain their competitive edge, and adapt to the changing aspect of international markets where Asian manufacturers and those located in developing nations and economies are taking full advantage of their competitive position.

In general terms, eminently manufacturing-based sectors such as textile in developed countries cannot compete on price due to the higher social and environmental costs they must bear.

In our case, companies at whom the present project was aimed are located within the Region of Valencia, particularly the counties of l'Alcoià-Comtat and Vall d'Albaida, in the centre of the region, an area characterised by the strong presence of the textile industry within the local economy.

From a socio-economic point of view, textiles are key to development in the Valencian region. Activity within the sector is highly centralised, with the highest employment rates registered in L'Alcoia-El Comtat and Vall d'Albaida, particularly in the towns of Alcoy, Ontinyent, Cocentaina, Banyeres, Albaida, Bocairent, Muro de Alcoi and surrounding towns. Textile activity is also fundamental for other surrounding areas such as Crevillente, Canals, etc. and smaller towns like Cheste and Villafranca, which are in other counties of the three Valencian Provinces.

While every subsector is represented in the Valencian textile industry, the region is most noted for its production of home textiles such as upholstery, bedding, tablewear and rugs and in other areas of the value chain including spinning, weaving, finishing and garment manufacture; three quarters of Spanish home textile production comes out of Valencia.

Textile and garment-making industries represented at the time, 9.3% of industrial employment in Valencia – more than 38,000 people, although companies with more than 200 employees only represented less than 1% of the total workforce.

Faced with the new reality, our textile manufacturers must continue to learn new strategies for diversification, invest in their human resources through training programmes, increase their technical capabilities, R+D+I and reinvestment in manufacturing equipment and other measures to create more competitive products with higher added value, better design and higher quality.

The project was of vital importance to increasing competence and innovation in the Valencian textile industry.

Thanks to the development of this project, AITEX concluded with its own methodology in which to help textile companies during the definition and implementation of its made-to-measure innovation plans to for their business lines diversification. This methodology is easily applicable in other countries and adaptable to several typologies of companies.

This methodology is being used from the finalisation of these projects in a success way and it has been added to AITEX catalogue services. In this aspect, every year innovation plans are carried out with contracts with companies which conduct to the implementation of new productive processes and/or to the development of new products focus on the application of technical textiles.

With these actions, AITEX contribute to the technicisation and modernisation of the textile sector and increase their technical ceiling, in order to manage new business opportunities which represent these new markets.

2.6 AITEX Leonardo da Vinci Project "European Textile Learning Tools" (D.Mikucioniene)

The project was operated with seven partners and has been delivered through six work packages with aims:

- WP1 – To undertake research into ICT tools available in textiles to support vocational learning and development for technical level learning in partner countries.
- WP2 – To develop a new learning module in carpet production.
- WP3 – To develop a new learning module in hosiery.
- WP4 – To produce a research report into how learning materials can be delivered via the Internet.
- WP5 – Map the Interactive CD to the relevant textiles qualifications in the partner countries.
- WP6 – Dissemination Strategy.

Work programme have been designed to optimise partner expertise whilst maintaining the involvement of all partners. The aim of this research was to undertake research into ICT tools to support vocational learning in the target areas and to develop an interactive textile training tool with Internet support.

This interactive learning tool supports knitwear and hosiery across Europe and offers the underpinning knowledge to help technicians in the industry across Europe to achieve qualifications at the UK equivalent of NVQ3. The tool helps provide evidence towards achieving the appropriate qualification. The health and Safety and risk management were integrated into the training tool also.

This project aimed to map textile technicians' qualifications across the partner countries. This project surveyed learning materials (in English, French, Czech, Lithuanian languages) for teaching/training purposes for technicians/craft workers available in the European Textile sector – Textile companies (especially SME's).

The challenges in the partner countries are different because textile manufacturing is a developing market. Educational Institutions have traditionally delivered full/part time study with academic awards for successful students. Vocational qualifications are not currently available for textile workers and the concept of delivering training and vocational qualifications in the workplace is a new concept.

The internet based learning materials that are being developed in the project were aimed at level 3 or equivalent learners who are working in or wish to work in the textile industry.

The courses were mostly delivered by traditional methods through courses of study either in a full time or part time mode. The learning material is available on CD ROM or on the internet.

This project improved the links between industry and education

This project was directly targeted equal opportunities for women and men, with a view to combating discrimination in training provision. All materials produced by the project are designed to act against stereotyping, prejudice and discrimination.

The project made an original contribution to the European Strategies for vocational training by developing new materials, which help workers in the textile sector adjust to technological changes whilst also promoting Equal Opportunities.

The innovation contributed by this project is that it applies the use of new technologies supporting the development needs of technicians/craft workers in the European textile sector. This project also contributed innovation by supporting a network involving the European Representative Body for textiles, sectorial training bodies, employers and trade Union representation.

The results of had short and long term impact on users such as training providers, Universities and sectorial bodies.The partners had fruitful experience of working together.

2.7 UGENT

UGent also has the possibility of organising courses on demand in the framework of lifelong learning. The institute for Lifelong learning IVPV has been created to this end (http://www.ivpv.ugent.be/en/index.htm). These courses are fully driven and funded by industry. The courses are of post academic level. Students who pass the exams receive a certificate, no diploma. Course programmes vary each year according to industry needs. Other forms of lifelong learning are workshops, seminars etc. They are often organised within the framework of research projects and/or in cooperation with other unviersities/institutes from Belgium and abroad.

UGent has participated in more than 20 local, regional and international educational projects, of which many with industry participation. Such projects target development of innovative teaching tools, training the trainer, high level advanced training of academic staff.

One of the professors of the department of textiles (L. Van Langenhove) has spent 5 years in industry.

It can be concluded that dialogue with industry is strongly entangled with the whole process of developing and organizing education in textiles.

2.8 Conclusions of the first study

Nowadays it fundamental to be prepared to operate in a in a worldwide market which demands a high level of specialization. The company´s R&D departments play a very important role in this process by serving as a knowledge platform, which support the transformation of new resources into new business opportunities and end up conquering some highly valued niche markets.

In today's particular harsh environment, companies are driven by a rapidly changing market demand. To face up this situation, they are obligated to a constant update and innovation. The generation of partnerships with high education institutions and, in the best cases, with government support, configures the best solution to enhance company's competitiveness.

It is proven that in a more dynamic environment the preponderant factors for the company´s success is precisely the ability to renovate, developing new skills, and integrating/reconfiguring internal resources. All these key issues were tackled by the case studies provided by the contributors.

The reported examples comprise a wide variety of forms of cooperation between companies and high education institutions. All those different kinds of contributions seek to solve particular problems felt by the participating companies or aim at developing new innovative solutions to support the qualifying and training of their personnel.

Simultaneously, they also evidence the involvement of a vast number of other institutions, namely, socio-professional organizations and unions, gathered in a conjoint effort to increase the competiveness of their enterprises.

Despite of being a complex process, the described examples of relationship between companies-university demonstrated some possible strategies to overcome the existing weaknesses of the textile and apparel industry, particularly, from the more conventional and with intensive manpower textile industry.

Globally and when considered in their particular field of intervention, the presented examples can be seen as guidelines for the improvement of the Belarus textile and apparel industry. They objectify a series of tools to overcome some eventual lacks such as:

- Outdated strategies highly influenced by mass production principles and by a short term vision;
- Technological fragilities in the development of new products or processes;
- Difficulties to deal and absorb emergent know-how;
- Negligence with the up-to-date training and qualification of their personnel;
- Generalized lack of cooperation: internal or external; horizontal or vertical.

Obviously, the reported models have to be adjusted in conformity with the Belarus socio-economic reality. Notwithstanding, they are to be seen as good practices, already developed and tested in other countries which, contribute to strengthen their local textile and apparel mills at different levels, namely:

- Strategic use of technology and information so as to attain competitive advantages;
- Use of innovative human resources policies to achieve the employees best qualification;
- Better understanding of the relation suppliers-companies;
- A constant search to improve quality in all their dimensions;
- Some indications that might lead to cost reductions;
- Development of proprietary knowledge and expertise in their fields of operation;
- Minimize investment risks grounded upon the direct involvement of workers;
- Possibility to have in their ranks top skilled professionals;
- Generation of spin-offs and start-up companies;
- Development of patented products or processes.

Based upon the above considerations a consolidated Companies-University partnership has all the potential to trigger and promote some cultural, organizational and operational changes that encouraged by information and knowledge exchange, contribute decisively to the competitiveness and survival of companies in a globalized, market.

3. Good practices for Liaison offices - Conclusions about good practices of Liaison Offices in the analyzed universities (study 2)

There is a number of common services that can be found in all the partner universities. These are: Centre for Innovation, Research and Technology Transfer.

The Centre for Innovation, Research and Technology Transfer is the higher education institutions research and technology transfer knowledge office. The functions of this liaison office department is to favour the I+D+i cooperation between university and higher education institute research departments and the sector firms focused on scientific and technical collaboration. Their mission is to provide support in terms of information, advisory services, signed agreements and administration for the generation of activities and scientific and technical collaboration at a higher education level. By boosting these activities, a more dynamic participation between the scientific community and enterprises is achieved in favour of evolution.

3.1 Employment Service

The Employment Service promotes and manages the practical work and final thesis projects in companies and institutions. This service is the national and international promoter and manager of all initiatives as for employment at the higher education institutions. Moreover, also helps students with national and international internships, training for employment and any activity related to work offers and employment promotion.

3.2 International Exchange Programmes Office

The International Exchange Programmes Office coordinates the participation of the higher education institutions in exchange programmes, worldwide. This office is in charge of mobility programmes for students as well as for teaching and administrative staff.

3.3 Entrepreneurship and Development of Enterprises Unit

The Entrepreneur Unit is a groundbreaking initiative from higher education institutions that focuses on helping the universities and technical universities to implement entrepreneurial ideas with the technological or innovative basis

The collaboration between higher education centers - universities and industrial units – companies, which offer entrepreneurship possibilities and consequently employability can be both a teaching effort and the organized transfer of experience and reflection.

Due to the fact that entrepreneurship is not taught ex cathedra, it is necessary to create the necessary structures and make these operate so that the aforementioned principles will be achieved. The creation, operation and further development of Liaison Offices (the necessary structures just mentioned) is crucial for the accomplishment of many goals from Higher Education Centres and Universities to further formation. For a resounding success, Liaison Offices play a vital part by linking the University with society and market through their activities and ‘the good practice” they implement.

4. 4Needs analysis study for liaison services in Belarus (study 3)

Educational institutions and industrial enterprises cooperate in the following areas:

- conducting of joint research and development (R&D);
- conducting of industrial internship and thesis projects;
- specialists of the enterprises improvement qualification;
- development of material and technical basis of the university;
- career-guidance work.

In each of the universities participated to the project, its own system of interaction, based on the existing departments, was developed. To identify the existing problems, related with the cooperation and needs analysis in collaboration, four groups of respondents were surveyed:

- teaching staff of the departments carrying out training
- teaching staff of the departments carrying out training of specialists for the textile industry enterprises and plants producing chemical fibers and threads;
- graduates of corresponding specialties;
- experienced specialists of textile and chemical enterprises;
- young professionals of the enterprises (graduates of the last 5 years).

Problems which were solved within questioning:

- to assess the actual system of the industrial interaction between enterprises and educational institutions;
- to define the degree of compliance of training programs to requirements of modern manufacture;
- to define the compliance of theoretical and practical experience of graduates to the requirements of labor market;
- to assess the role of interaction of educational institutions and the enterprises in the formation of young professional competence;
- to identify the most practical areas of continuous professional training of the specialists of enterprises;
- to assess the participation of structural divisions of the universities in the process of interaction with industry;
- to analyze the practicability of unified interaction departments establishing at universities participating in the project and to determine the need for adjustments to the list of functions of structural divisions of the university.

The carried-out analysis allowed to reveal the most vital issues taking place in the course of interaction of universities and the industrial enterprises of textile, light and chemical industries. The greatest concern of all groups of the respondents causes the organization of internship, in particular, availability of information and possibility of acquisition of practical experience. Among the important directions of interaction also joint carrying out research and development and improvement of qualification, both teachers of universities, and specialists of the enterprises is noted. On the basis of the analysis suggestions for improvement of the system of interaction will be issued. They will be presented at the first meeting of UNITE Council.

At all universities participating in the project, there are structural divisions which are carrying out functions which are connected with interaction with the industrial enterprises. The circle of resolved issues practically coincides. However the organizational structure of the universities is different taking into account number of students, variety and specifics of the directions of specialists training, the settled traditions, etc. Change of the created structure can't but consider the specified features of each of universities. A number of offers on corrections of functions of structural divisions taking into account the problems established during questionnaire is formulated. Besides, one of the directions of structural transformations is not reorganization of existing departments, and creation of additional structure (for example, Section on interaction at Educational and methodical council of the university) which will consist of the staff of the departments which are carrying out functions, connected with the interaction. Creation of such structure will create additional possibility of coordination of the solution of appropriate questions at university and will promote increase of efficiency of functioning of system of interaction.

5. Conclusions

The benefits gained from the before-mentioned reports have already been utilized as the project is still running. The first one it consists a very good source of information for the academic community and the textile companies. The second one contributed to the know-how transfer to the universities of Belarus, which is one of the main intentions of the whole project. And the third report is a useful tool to modulate the liaison offices and their services at the three Universities at Belarus.

References

[1] Reports, which consist deliverables of the Tempus project “544390-TEMPUS-1-2013-1-GR TEMPUS-JPHES”