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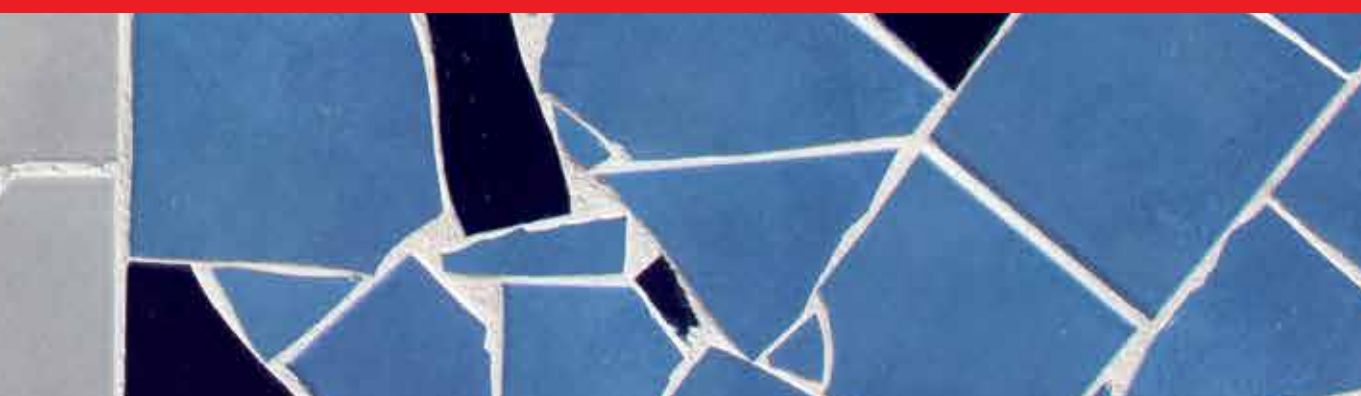
Interdisciplinarity and Creativity in the Knowledge Society

Edited by Valentina Mihaela Pomazan



PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON INTERDISCIPLINARY STUDIES (ICIS 2016) - INTERDISCIPLINARITY AND CREATIVITY IN THE KNOWLEDGE SOCIETY

Edited by **Valentina Mihaela Pomazan**

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Notice

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Meet the editor

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Contents

Proceeedings of the International Conference on Interdisciplinary Studies, ICIS 2016

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Chapter 1

The Principle of Critical Energy as a Transdisciplinary Principle with Interdisciplinary Applications

Valeriu V. Jinescu, Vali-Ifigenia Nicolof, George Jinescu and Simona-Eugenia Manea

Additional information is available at the end of the chapter

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Abstract

The principle of critical energy (PCE) is a transdisciplinary principle that may be used in all chapters of sciences for superposition and/or cumulation of different external actions (mechanical, thermal, magnetic, electrical, chemical, etc.) It may be used for lifetime evaluation of engineering structures, as well as for living organisms, by taking into account the influences due to pollution, due to internal deterioration, due to preloading or residual stresses, etc. In this paper, we explain what PCE is, how it may be practically used and the interdependences between the terms comprised in its general relation. PCE was applied for solving problems of superposition of external actions and internal deteriorations in the following chapters of sciences: mechanical engineering, thermomechanical-chemical loadings, multiple pollution, medical field and viscoelasticity. It was compared with synergy theory and with catastrophe theory.

Keywords: Transdisciplinarity, interdisciplinarity, principle of critical energy, superposition and cumulation of load actions, multiple pollution, application in medical field, viscous and elastic behaviour, synergy

1. Introduction

The principle of critical energy (PCE) is the fourth principle of Energonics [1–3], a field of science that stands for energy in action. It was discovered and formulated in 1984 [4].

The principle of critical energy has allowed so far the finding of solutions to many problems of superposition and/or cumulation of actions or their effects on engineering structures [1–17], or on living organisms that find themselves under stress, abused and/or medically treated [2, 13].

The criterion of truth in scientific research is the experiment. For this reason, down below there have been presented the predictions resulting from the application of the principle of critical energy in comparison to experimental results. In this way, the critical energy principle has been validated by the experimental data reported in the literature by various authors.

The principle of critical energy has been used, for example, to solve the problems of superposition and/or cumulation of the effects of actions definitory for such disciplines/chapters of engineering sciences as mechanical engineering, electrical and electromagnetic engineering, chemical engineering, etc. The question is whether we are dealing in this case with an interdisciplinary or a transdisciplinary issue?

Interdisciplinarity means bringing together elements of two or more academic disciplines in order to solve a specific theoretical or practical problem. The result would not be possible without the 'cooperation' of different academic disciplines, out of which use is made of elements that have been time proven. Creation, in this case, refers to the combination of knowledge already extant in the academic fields under scrutiny.

Transdisciplinarity essentially means concerns that go beyond any discipline ('trans' = beyond) or away from a particular discipline, concerns based on the existing academic disciplines and finally capable of generating new areas of knowledge. The new concepts in the field can be retrieved and applied to other areas or academic disciplines.

Consequently, the PCE features transdisciplinarity but in conjunction with just one more academic discipline it becomes interdisciplinary.

2. The principle of critical energy

The principle of critical energy is stated as follows [2, 4]:

'The critical state in a process or phenomenon is reached when the sum of the specific energy amounts involved, considering the sense of their action, becomes equal to the value of the critical specific energy characterizing that particular process or phenomenon'.

The principle of critical energy allows the calculation of the effect produced upon a physical body by the simultaneous or successive action of several external actions or loads Y_j (where j=1; 2; 3...). The mathematical expression of the principle of critical energy was stated as follows (1):

$$\sum_j \left(\frac{E_j}{E_{j,cr}} \right) \cdot \delta_j = 1, \tag{1}$$

where E_j is the specific energy (expressed in J/kg, J/m^3 or J/m^2) introduced in the material by loading Y_j, while $E_{cr,j}$ is the critical value of the specific energy E_j. If $E_j = E_{j,cr}$ the critical state is reached, namely, fracture, excessive deformation, buckling, and so on:

http://dx.doi.org/10.5772/64914

$$\delta_j = \begin{cases} 1, \text{if the specific energy acts in the direction of the process;} \\ 0, \text{if it has no effect upon the respective process;} \\ -1, \text{if it opposes the evolution of the process.} \end{cases} \quad (2)$$

The expression under the sum in relation (1) represents the participation of the specific energy introduced by the action or load Y_j and is written as:

$$P_j = \left(\frac{E_j}{E_{j,cr}} \right) \cdot \delta_j, \quad (3)$$

thus, the sum in the left part of relation (10) is called the total participation of specific energy:

$$P_T = \sum_j P_j, \quad (4)$$

where P_T is a sum of dimensionless variables calculated with respect to the critical state; this particularity gives a high degree generality of the Eq. (4).

If the loading is caused by normal stress, one writes $P_j = P_j(\sigma)$. But in the case of shear stress, τ, loading $P_i = P_i(\tau)$. For multiaxial loading:

$$P_T = \sum_j P_j(\sigma) + \sum_i P_i(\tau)$$

For real materials whose mechanical characteristic values range inside a dispersion interval, the critical specific energy also ranges inside a dispersion interval. Consequently, the right part of relation (1) can be replaced by the condition $P_{cr}(t) \leq 1$. Relation (1), by taking into account the relations (3) and (4), becomes:

$$P_T = P_{cr}(t), \quad (5)$$

3. Practical use of PCE

The total participation of specific energies is a dimensionless value that expresses the loading level of any physical body by considering its behaviour.

For example, if a load featuring stress Y produces effect X upon a physical body, the interdependence between the two expresses the body behaviour. In general, one resorts to the law of non-linear behaviour, function of power

$$Y = C \cdot X^k, \tag{6}$$

where C and k are constants of the physical body. The specific energy in this case is:

$$E = \int_0^X Y \cdot \mathrm{d}X = \frac{C \cdot X^{k+1}}{k+1}. \tag{7}$$

Expressed as a result of loading Y, relation (8) becomes:

$$E = \frac{Y^{(1/k)+1}}{(k+1) \cdot C^{1/k}}. \tag{8}$$

The specific critical energy corresponds to $Y = Y_{cr}$, so that:

$$E_{cr} = \frac{Y_{cr}^{(1/k)+1}}{(k+1) \cdot C^{1/k}}. \tag{9}$$

From relations (4), (9) and (10) one acquires the expression of the specific energy participation:

$$P(Y) = \left(\frac{Y}{Y_{cr}} \right)^{1/k+1} \cdot \delta_Y, \tag{10}$$

where δ_Y means the same thing as δ_j.

When several loads n act, written as Y_i, where $i = 1; 2; \ldots n$ (Figure 1), the total participation of the specific energies of action is:

$$P_T = \sum_{i=1}^{n} P(Y_i). \tag{11}$$

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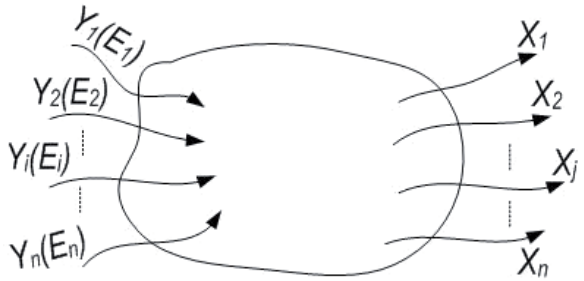

Figure 1. Loading with stresses $Y_i(E_i)$, carrying specific energies E_i, produces upon the physical body effects X_j.

If for all loads Y_i, the behaviour of the material is given by a relation of the form (7), where the values of constants C_i and k_i are different, Eq. (12) becomes:

$$P_T = \sum_{i=1}^{n} \left(\frac{Y_i}{Y_{i,cr}} \right)^{\alpha_i + 1} \cdot \delta_{Yi}, \tag{12}$$

where $\alpha_i = 1/k_i$, and δ_{Yi} stands for δ_j.

The critical participation of specific energies, a time-dependent dimensionless variable, has the general expression [2, 12]:

$$P_{cr}(t) = P_{cr}(0) - D_T(t) - P_{res}, \tag{13}$$

where $P_{cr}(0)$ is the initial value of the critical participation at $t = 0$.

The value of $P_{cr}(0)$ depends on the probability of achieving the critical condition at $t = 0$. Generally, $P_{cr}(0) \in [P_{cr,\min}(0); P_{cr,\max}(0)]$, where $P_{cr,\min}(0) > 0$ and $P_{cr,\max}(0) \leq 1$. The critical participation $P_{cr}(0)$ expresses the value distribution of physical characteristics (e.g. tensile strength, σ_u, yield stress, σ_y, etc.). If one considers as deterministic (fixed; statistical averages) values of the critical physical characteristics $Y_{i,cr}$, then $P_{cr}(0) = 1$.

For the *deterministic values* of the physical characteristics $Y_{i,cr}$ one replaces $P_{cr}(0) = 1$, so that relation (14) becomes:

$$P_{cr}(t) = 1 - D_T(t) - P_{res}. \tag{14}$$

Relation (14) is used to interpret the experimental data, and relation (15) is used to calculate structures with deterministic calculation methods [12].

The total damage $D_T(t)$, a dimensionless value, depends on the duration of exposure, t, and one calculates it by using the general relation [3, 7, 12]:

$$D_T(t) = \sum_k D_k(t), \tag{15}$$

where $D_k(t)$ is the deterioration produced by loading or by cause k: crack $D(a;c)$, pre-loading $D(-t)$, corrosion $D(t_{cs})$, creep $D(t_c)$, hydrogen action $D(H^+)$, neutron action $D(n)$, magnetic action $D(B)$, vibration action $D(\omega)$, radiation flow action $D(\Phi)$, pollutant action $D(c)$, etc.

In the manufacturing of engineering components (by plastic deformation, welding, moulding, forging, etc.) there are induced residual stresses, σ_{res}, that map out the participation [2],

$$P_{res} = \left(\frac{\sigma_{res}}{\sigma_u}\right)^2 \cdot \delta_{res}, \tag{16}$$

where $\delta_{res} = 1$ if the residual stresses act in the direction of the process taking place in the body under load and $\delta_{res} = -1$ if not.

The practical use of the results obtained lie in comparing, for a certain given moment t (Figure 2), the values of $P_T(t)$ and $P_{cr}(t)$. If

$$\begin{aligned} &P_T(t) < P_{cr}(t) - \text{subcritical loading;} \\ &P_T(t) = P_{cr}(t) - \text{critical loading;} \\ &P_T(t) > P_{cr}(t) - \text{overcritical loading.} \end{aligned} \tag{17}$$

After equalizing the expressions of participations (13) and (14),

$$\sum_{i=1}^{n}\left(\frac{Y_i}{Y_{i,cr}}\right)^{\alpha_i+1} \cdot \delta_{Yi} = P_{cr}(0) - D_T(t) - P_{res}, \tag{18}$$

one obtains the time life t_l, or the duration down to the moment when the body under load is destroyed (Figure 2).

In the general case of statistical value distribution of critical characteristics $Y_{i,cr}$ between a minimum $(Y_{i,cr})_{\min}$ value and a maximum $(Y_{i,cr})_{\max}$ one, the initial critical participation is itself a statistical distribution and consequently, it lies probabilistically between the corresponding curves written as $P_{cr,\min}(t)$ and $P_{cr,\max}(t)$.

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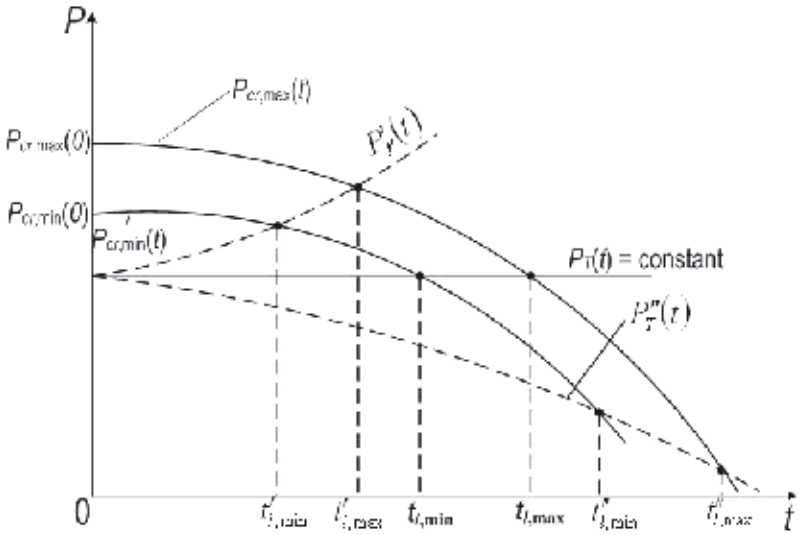


Figure 2. Lifetime with critical characteristics featuring probabilistic variables. $P_{cr,\min}(t)$ corresponds to maximum probability and $P_{cr,\max}(t)$ corresponds to the minimum probability of recovery of a value of the critical characteristic (e.g. the maximum probability of survival and the minimum probability of survival, respectively).

If $P_T(t)$= constant, the lifetime lies between values $t_{l,\min}$ and $t_{l,\max}$, if $P_T(t)=P'(t)$ rises in time, then the lifetime decreases and it lies between $t'_{l,\min}$ and $t'_{l,\max}$. Similarly, if the total participation $P_T(t)=P''(t)$ decreases in time, the lifetime rises and it lies between $t''_{l,\min}$ and $t''_{l,\max}$.

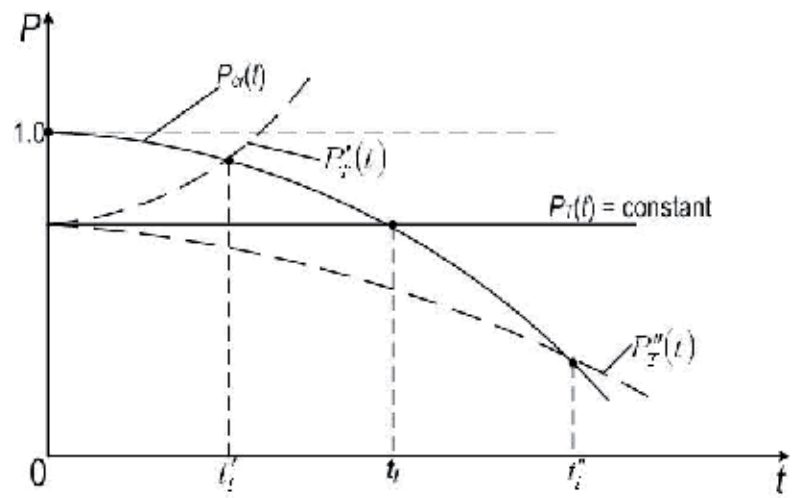


Figure 3. Lifetime when critical characteristics are deterministic variables.

In case critical characteristics $Y_{i,cr}$ feature deterministic values, critical participation $P_{cr}(0)=1$, which yields unique, precise values in the three cases analogous to Figure 2. One obtains lifetimes $t'_l<t_l<t''_l$ (Figure 3).

4. PCE application to solving problems of superposition or/and cumulation of loadings

The principle of critical energy generally refers to the effect of energy cumulation in a physical body, in connection with some phenomenon or process.

Load superposition means the simultaneous load actions upon the physical body. *Load* cumulation means successive load actions in time.

The discrimination between the superposition of effects and their cumulation is essential, especially if the effect of loading depends on the rate of applied load.

4.1. Applications in mechanical engineering

a. One examines the superposition of effects under loading combining tensile stress, σ, bending stress, σ_b and torsion stress τ_t (Figure 4): $\sigma \sim F$; $\sigma_b \sim M_b$ and $\tau_t \sim M_t$.

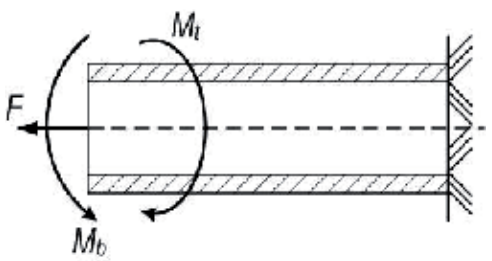


Figure 4. A tubular specimen loaded by axial force, F, bending moment, M_b and torsional moment, M_t.

The total participation is calculated with the general relation (12),

$$P_T = \left(\frac{\sigma}{\sigma_{cr}}\right)^{\alpha_\sigma+1} \cdot \delta_\sigma + \left(\frac{\sigma_b}{\sigma_b}\right)^{\alpha_b+1} \cdot \delta_{\sigma_b} + \left(\frac{\tau_t}{\tau_{t,cr}}\right)^{\alpha_t+1}. \tag{19}$$

Since $\sigma>0$ (traction), $\delta_\sigma=1$. In a stretched fibre, where $\sigma_b>0$, $\delta_{\sigma_b}=1$, the denominators represent the critical values of the stresses corresponding in the numerator. Generally $\alpha_\sigma=\alpha_b=\alpha_t=\alpha$, so that

http://dx.doi.org/10.5772/64914

$$P_{T,\max} = \left(\frac{\sigma}{\sigma_{cr}}\right)^{\alpha+1} + \left(\frac{\sigma_b}{\sigma_{b,cr}}\right)^{\alpha+1} + \left(\frac{\tau}{\tau_{t,cr}}\right)^{\alpha+1}. \quad (20)$$

If the loading state is bound not to exceed the yield stress, then one has to accept that the material features a linear elastic behaviour, in which case $k=1$ and $\alpha=1$; relation (20) becomes

$$P_{T,\max} = \left(\frac{\sigma}{\sigma_Y}\right)^2 + \left(\frac{\sigma_b}{\sigma_{b,Y}}\right)^2 + \left(\frac{\tau}{\tau_{t,Y}}\right)^2, \quad (21)$$

where σ_y, $\sigma_{b,y}$ and $\tau_{t,y}$ is the yield stress under tensile, bending and torsional stress, respectively.

Consider the particular case when loading occurs only under bending and torsional stress ($\sigma=0$). With the aid of the law of equivalence of processes and phenomena [2, 12, 18, 19] one obtained from relation (20), the equivalent bending stress:

$$\sigma_{b,ech} = \left(\sigma_b^{\alpha+1} + K \cdot \tau_t^{\alpha+1}\right)^{\frac{1}{(\alpha+1)}}. \quad (22)$$

$K = \frac{\sigma_{b,cr}^{\alpha+1}}{\tau_{t,cr}^{\alpha+1}}$ is a ratio of some mechanical characteristics of the material. In the linear elastic case, ($\alpha=1$) Eq. (22) becomes the known relation recommended by literature [20],

$$\sigma_{b,ech} = \left(\sigma_b^2 + K \cdot \tau_t^2\right)^{0.5}, \quad (23)$$

where K depends on the theory of strength used, not on the nature and behaviour of the material.

b. For engineering structures with cracks, PCE connects the mechanics of the deformable solids to fracture mechanics.

At present, the strength analysis of structures with cracks is done by using fracture mechanics concepts that are different from those of the mechanics of deformable solids. In the mechanics

of the deformable solids one makes use of such concepts as normal stress, shear stress, strain, etc.

In the mechanics of the deformable solids, the strength condition is expressed by inequality:

$$\sigma_{eq} \leq \sigma_{al}, \tag{24}$$

where σ_{eq} is the equivalent stress at the tip of the crack and σ_{al}, the allowable stress, calculated —generally—with the relationship:

$$\sigma_{al} = \min\left(\frac{\sigma_u}{c_u}; \frac{\sigma_y}{c_y}\right), \tag{25}$$

where σ_u is the ultimate stress; σ_y is the yield stress, while c_u>1 and c_y>1 are safety coefficients.

In fracture mechanics one resorts to the concepts of stress intensity factor, K_i, crack tip opening displacement, δ_i and the integral J_i, where i=I, II, III, corresponds to the three accepted modes of failure (I, opening; II, sliding; III, tearing). The strength condition is expressed:

$$K_i \leq K_{i,al} \quad \text{or} \quad \delta_i \leq \delta_{i,al} \quad \text{or} \; J_i \leq J_{i,al}, \tag{26}$$

where $K_{i,al}$, $\delta_{i,al}$ and $J_{i,al}$ are the allowable values of the variables K_i, δ_i and J_i.

By introducing the concepts of *deterioration or damage*, with the aid of PCE there have been established the following relations of the critical stresses (ultimate stress, yield stress or allowable stress) for the structures with cracks that have characteristic dimensions *a* and *2c:*

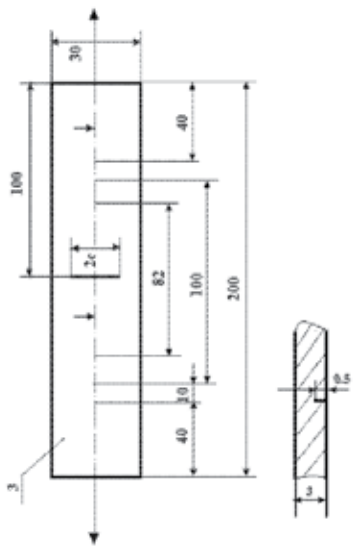
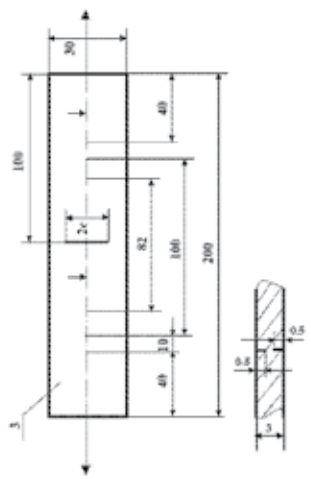
$$\left.\begin{aligned} \sigma_{cr}(a;c) &= \sigma_{cr} \cdot \left[1 - D_\sigma(a;c)\right]^{\frac{1}{\alpha+1}} \\ \tau_{cr}(a;c) &= \tau_{cr} \cdot \left[1 - D_\tau(a;c)\right]^{\frac{1}{\alpha+1}} \end{aligned}\right\}, \tag{27}$$

where σ_{cr} and τ_{cr} are the critical normal and shear stresses of the structure without cracks; $D_\sigma(a;c)$ and $D_\tau(a;c)$ are the deterioration due to the crack (a, c) in the field of normal and shear stresses, respectively.

http://dx.doi.org/10.5772/64914

On the basis of relationships (27) one can experimentally determine the value of the deterioration. For example, Table 1 lists the values of deterioration $D_\sigma(a;c)$ calculated on the basis of the first relation (27), for some steel specimens:

$$D_\sigma\left(a;c\right)=1-\left(\frac{\sigma_{cr}\left(a;c\right)}{\sigma_{cr}}\right)^{\alpha+1}.$$

	Dimensions in mm	2*c*, mm	$\sigma_u(a;c)$, [MPa]	$D(a,c)$
Sample with a crack on one side		10	439.722	0.1045
		20	429.701	0.1652
		30	391.698	0.3704
Sample with cracks on both sides		10	421.756	0.2113
		20	390.027	0.3786
		30	379.444	0.4285

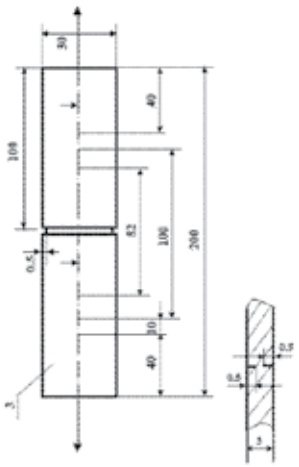
	Dimensions in mm	2*c*, mm	$\sigma_u(a;c)$, [MPa]	$D(a,c)$
Sample with around crack		29	330.447	0.6250

Table 1. The deterioration $D(a,c)$ due to crack of some steel specimens elongational loaded. The ultimate stress of the crackless specimen σ_u=455.934 [MPa]

Analogously, for the critical load of the structure with cracks one established the general relation:

$$Y_{i,cr}(a;c) = Y_{i,cr} \cdot \left[1 - D_{Y_i}(a;c)\right]^{\frac{1}{\alpha+1}}, \tag{28}$$

where $Y_{i,cr}$ is the critical load for the structure without cracks; $D_{Y_i}(a;c)$ is the deterioration due to the crack within the load range (force, bending moment, torque, pressure, etc.).

The strength condition of a structure with cracks, after using PCE,

$$\sigma_{eq} \le \sigma_{al}(a;c), \tag{29}$$

which is similar to the relationship (25) from the mechanics of deformable solids; it differs from Eq. (25) in that the allowable stress depends on the crack characteristic parameters, through the concept of deterioration,

$$\sigma_{al}(a;c) = \frac{\sigma_{cr}(a;c)}{c_\sigma}, \tag{30}$$

http://dx.doi.org/10.5772/64914

where

$$\sigma_{cr}(a;c) = \sigma_u(a;c) = \sigma_u \cdot \left[1 - D_\sigma(a;c)\right]^{\frac{1}{\alpha+1}}. \tag{31}$$

The equivalent stress is calculated in the same way as in relationship (25).

The use of relations (29)–(31) requires the determination of deterioration value $D_\sigma(a;c)$ as it was done in works [7, 15–17, 21–24].

The method of calculating presented may replace the calculation based on the concepts of fracture mechanics (26). The connection with fracture mechanics lies only in the calculation of deterioration based on crack geometry.

4.2. Thermomechanical-chemical application

One examines the superposition of actions under static loads featuring constant stress σ in creep conditions of a body lying in a corrosive environment for time t_{cs}. The total participation of an action featuring stress σ is calculated with relation (12):

$$P_T = \left(\frac{\sigma}{\sigma_{cr}}\right)^{\alpha+1}, \tag{32}$$

where $\delta_\sigma = \delta_{Y_i} = 1$.

The influence of loading beyond creep temperature and corrosion influence intervene in calculating the total deterioration:

$$D_T(t) = D(t_c;T_c) + D(t_{cs}), \tag{33}$$

where $D(t_c;T_c)$ is the deterioration resulting from loading at temperature (creep temperature) over interval t_c, and $D(t_{cs})$ is the damage caused by corrosive action over interval t_{cs} [3, 7].

The critical stress that takes into consideration the deterioration results from the second equation (17), from relations (13) and (32):

$$\sigma_{cr}(D) = \sigma_{cr} \cdot \left[1 - D_T(t) - P_{res}\right]^{\frac{1}{\alpha+1}}, \tag{34}$$

where σ_{cr} is the critical stress of the undamaged material ($D_T(t)=0$) and without residual stresses ($P_{res}=0$).

Other applications of the PCE have been summarized in [1, 2, 12], such as the superposition of mechanical and electrical effects, the superposition of the mechanical loads and magnetic field by shells/buckling, the superposition of effects in thermoelectromagnetism, etc.

4.3. Applications in the field of multiple pollution

The natural environment can be polluted chemically, electromagnetically, thermally, nuclearly, etc. To date, the individual maximum/allowable concentrations of various pollutants affecting the environment and the living organisms have been identified [25–36]. The crucial issue lies in determining when the critical state is reached in case two or several pollutants act simultaneously and/or successively.

Actually, one has to deal with the superposition of pollutant action, or the cumulation of their action and sometimes with the superposition and cumulation of their action. The problem is solved relatively simply by using PCE, according to which the total participation of pollutant action is equal to the sum of their individual participations. By analogy with Eq. (4) we may write:

$$P_T\left(t\right)=\sum_i P_i\left[\left(c_{p,i}\right);t_i\right], \tag{35}$$

where $c_{p,i}$ is the pollutant concentration i acting over time t_i.

For the sake of generality, one allows that the relation between the pollutant and its effect is a power law, similar to law (6), namely:

$$c_{p,i}\left(t\right)=M_{c_{p,i}}\cdot e_{p,i}^{k_{p,i}}\left(t\right) \tag{36}$$

where $M_{c_{p,i}}$ şi $k_{p,i}$ are constants while $e_{p,i}(t)$ is the effect of the pollutant upon the natural environment, living organisms, plants, etc.

By analogy with the general relation (12) one gets the total participation caused by pollutant action:

$$P_T\left(c_p\right)=\sum\left[\frac{c_{p,i}\left(t\right)}{\left(c_{p,i}\right)_{cr}}\right]^{\alpha_{p,i}+1} \tag{37}$$

where $\left(c_{p,i}\right)_{cr}$ is the critical concentration of the pollutant i, while $\alpha_{p,i}=1/k_{p,i}$. The critical or allowable value of the concentration is specific to the biophysical factor that is being calculated (water, air, earth, some plant, some living organism...), as shown in the examples listed in Tables 2 and 3.

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Physical or chemical agent pollutant	UM	Maximum allowable concentration (MCA)			The limit value for protection of ecosystems			Limit value for protection of human health		
		The period of mediation								
		1 h	24 h	1 year	1 h	24 h	1 year	1 h	24 h	1 year
Benzene	$\mu g/m^3$	-	-	5	-	-	-	-	-	5
Carbon monoxide	mg/m^3	-	10	-	-	-	-	-	-	-
Lead	$\mu g/m^3$	-	-	0.5	-	-	-	-	-	-
Arsenic	ng/m^3	-	-	6	-	3.6	-	-	3.6	-
Cadmium	ng/m^3	-	-	5	-	3	-	-	3	-
Nickel	ng/m^3	-	-	20	-	14	-	-	14	-
Benzo (a) pyrene	ng/m^3	-	-	1	-	0.6	-	-	0.6	-

Table 2. Maximum allowable concentration for environment factors in air (extracted with permission from [27])

Global indicators	UM	Waste water discharges in sewer networks	Waste water discharges into natural receivers
A. Physical and chemical indicators			
Maximum temperature of discharge	^0C	40	35
pH of wastewater discharge	pH units	6.5–8.5	6.5–8.5
B. Pollutants discharged maximum allowable concentration (MCA)			
Suspensions	mg/dm^3	350	35.0
Ammonia nitrogen (NH_4^+)	mg/dm^3	30	2.0
Sulphur and hydrogen sulphide(S_2^-)	mg/dm^3	1.0	0.5
Sulphites (SO_3^{2-})	mg/dm^3	2	11.0
Total phosphorus(P)	mg/dm^3	5.0	1.0
Total cyanide(CN)	mg/dm^3	1.0	0.1
Free residual chlorine(Cl_2)	mg/dm^3	0.5	0.2
Lead (Pb^{2+})	mg/dm^3	0.5	0.2
Cadmium(Cd^{2+})	mg/dm^3	0.3	0.2
Hexavalent chromium(Cr^{6+})	mg/dm^3	0.2	0.1
Copper (Cu^{2+})	mg/dm^3	0.2	0.1
Nickel (Ni^{2+})	mg/dm^3	1.0	0.5
Zinc (Zn^{2+})	mg/dm^3	1.0	0.5
Total manganese (Mn)	mg/dm^3	2.0	1.0

Table 3. Maximum allowable concentration for environment factors in water (extracted with permission from [29])

The total participation thus calculated is compared to the critical participation,

$$P_{cr}(t) = 1 - D_T(-t) \tag{38}$$

where $D_T(-t)$ previously produced deterioration $(-t)$ upon the biophysical factor.

If $P_T(c_p) < P_{cr}(t)$ the status of the biophysical factor is subcritical, while if $P_T(c_p) \geq P_{cr}(t)$ —the state is critical or supercritical.

Sometimes the interaction of pollutants from a mixture produces a change in their behaviour, as they mutually enhance their obnoxious effects. One can get a positive synergistic effect, meaning that the effect of the mixture is greater than the sum of the individual effects of the pollutants [14]. Positive synergism does not mean that one can get more out of 'something plus something else', but it means that the behaviour of that 'something' changes in the presence of the 'something else' which makes the whole effect be greater than the sum of the composing effects!

4.4. Application in the medical field

A body or an organism can be subjected to the action of several harmful external factors, such as: radiation flow (ultraviolet, thermal, neutrons, X-ray, etc.), viruses, stresses, etc. The total effects of the cumulative action of a viruses, a radiation, stress and a pollutant upon an organism, or upon a particular cell, may be obtained by calculating the total participation of the specific energies,

$$P_t(t) = \left(\frac{m_v}{m_{v,cr}}\right)^{\alpha_v+1} + \left(\frac{\Phi}{\Phi_{cr}}\right)^{\alpha_\Phi+1} + \left(\frac{S}{S_{cr}}\right)^{\alpha_S+1} + \left(\frac{c}{c_{cr}}\right)^{\alpha_c+1} \tag{39}$$

where m_v and $m_{v,cr}$ is the 'quantity' of a certain virus and its critical values; Φ and Φ_{cr} is the certain radiation flow and its critical value; S and S_{cr} is the stress produced upon the organism and its critical value; c and c_{cr} is the concentration and its critical value of a certain pollutant. The exponents α_v, α_Φ, α_S and α_c have the meaning of α_i from Eq. (12). That means the virus behaviour, the radiation flow behaviour, the stress behaviour and the pollutant behaviour are nonlinear and are described by general law (6).

If they are more external action for each category the total participation is:

$$P_T(t) = \sum_i \left(\frac{m_{v,i}}{(m_{v,i})_{cr}}\right)^{\alpha_{v_i}+1} + \sum_j \left(\frac{\Phi_j}{\Phi_{j,cr}}\right)^{\alpha_{\Phi_j}+1} + \sum_k \left(\frac{S_k}{S_{k,cr}}\right)^{\alpha_{S_k}+1} + \sum_l \left(\frac{c_l}{c_{l,cr}}\right)^{\alpha_{c_l}+1} \tag{40}$$

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If $P_t(t)<1$ or $P_T(t)<1$ the critical state is not attained, whereas if $P_t \geq 1$ of $P_T(t) \geq 1$ the critical state is reached or exceeded (the organism dies).

The critical participation contains deterioration of the living body and the weakness due to lack of vitamins, oligoelements, etc. W_n, such as:

$$P_{cr}(t) = 1 - D(t) - \sum_n W_n \tag{41}$$

If $P_T(t)<P_{cr}(t)$, the critical state is not attained.

In order to help the organism to survive, or to get beyond the state of temporary illness, one administrates a quantity of medication m, whose critical value is m_{cr}. The medication participations opposes the weakness, such as,

$$P_{cr}(t) = 1 - D(t) - \sum_n W_n + \left(\frac{m}{m_{cr}}\right)^{\alpha_m + 1} \tag{42}$$

can be higher the unity.

If more useful medication will be administered,

$$P_{cr}(t) = 1 - D(t) - \sum_n W_n + \sum_p \left(\frac{m_p}{m_{p,cr}}\right)^{\alpha_{m,p} + 1} \tag{43}$$

4.5. Viscoelastic and elastoviscos behaviours

The unitary properties of matter at the microscopic scale are viscosity (μ) and elasticity (E). Viscosity as a property is associated to purely viscous fluids, while the elastic property is associated with purely elastic bodies.

Actually, matter is viscoelastic if viscosity prevails and it is elastoviscos if elasticity prevails. For a real physical body, which features the two properties in different ratios, based on PCE one can write that the total participation of specific energies is:

$$P(\mu) + P(E) = 1 \tag{44}$$

where $P(\mu)$ is the contribution of the viscous component, whereas $P(E)$ is the contribution of the elastic component.

If $P(\mu)=0$, the body is perfectly elastic ($P_T = P(E)$), whereas if $P(E)=0$, the body is perfectly viscous ($P_T = P(\mu)$).

If: $P(\mu)<P(E)$ —the body is elastoviscos;

$P(\mu)>P(E)$ —the body is viscoelastic.

The *purely elastic nonlinear* behaviour is mapped on the form of the general law (6),

$$\sigma = M_{\sigma} \cdot \varepsilon^{k} \tag{45}$$

where σ is the normal stress, ε —strain, while M_{σ} and k —constants of the elastic solid.

The *purely viscous nonlinear* behaviour is given by Oswald—de Waele's law

$$\tau = K \cdot \dot{\gamma}^{\nu} \tag{46}$$

where τ is the shear stress, $\dot{\gamma}$ is the shear strain, K and ν are the constants of the viscous fluid.

The participation of the specific energy corresponding to the elastic component is:

$$P\left(E\right) = \left(\frac{\sigma}{\sigma_{cr}}\right)^{\alpha+1} \tag{47}$$

where $\alpha = 1/k$.

The participation of the specific energy corresponding to the viscous component is:

$$P\left(\mu\right) = \left(\frac{\tau}{\tau_{cr}}\right)^{\beta+1}, \tag{48}$$

where $\beta = 1/\nu$.

Out of relations (43), (46) and (47), one gets:

$$\left(\frac{\sigma}{\sigma_{cr}}\right)^{\alpha+1} + \left(\frac{\tau}{\tau_{cr}}\right)^{\beta+1} = 1 \tag{49}$$

The graphical representation of the relationship (48) in Figure 5 separates the zone of elasto-viscos bodies from the zone of viscoelastic bodies.

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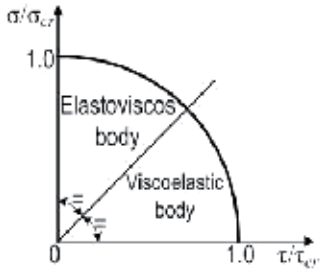

Figure 5. Graphic representation of relation (48).

4.6. The principle of critical energy, synergy and catastrophe theory

The principle of critical energy combines the essentials of synergetics and catastrophe theory. This statement is easy to account for:

- The total effect, P_T,, according to PCE is obtained as the sum of the partial effects P_i, produced by the actions of Y_i. Thus, the total effect results from the *cooperation* of several actions that are external and/or internal to the body analysed. But one of the basic principles of synergetics[1]
- According to the principle of critical energy, a phenomenon is triggered when the accumulated specific energy likely to jumpstart it reaches its critical value. This cumulation can be slow, fast or sudden. On the other hand, the transformation achieved by reaching the critical specific energy is often sudden, it is a leap. Such a leap can be catastrophic or dramatic.

Such a sudden transformation has been called catastrophe [38]. It underlies the theory of catastrophe [39]. Here are some examples of leap-type transformations which are the object of the theory of catastrophes and also lie at the core of some particular cases of PCE application: buckling bars, ice melting, water boiling, earthquakes, the camel back likely to withstand n loadings, but fails—as well known—under load $n + 1$, a cell that suddenly changes its reproduction rate, doubles and redoubles, etc. Some phenomena are triggered when the friction forces are overcome, like the rustling of a plant, or the noise of an earthquake.

The cumulation of the state of stress (frustration, desolation), coupled with alienation (alienation, lack of communication) may lead at a certain moment, in prisons, to rebellion. There is a sudden violent switch from quiet to disturbance, to disorder.

Bar buckling, for example, was first analysed by Euler [40] that is so long before the emergence of the catastrophe theory, a theory capable to bring some clarity on structural instability,

1 Synergetics studies: the common actions of the micro-components of an open system meant to attain a certain goal. With this aim in view, the system may exchange energy and mass; the macroscopic structures that appear in the sudden transition between the two states of the system, due to their cooperation.

For instance, when a **critical value** of a physcial parametre has been exceeded, the microscopic components of the system may suddenly start working in the same direction. The effect obtained at a macroscoppic level is a state of the system that is qualitatively different from the previous state. [37] is precisely the cooperation principle (the principle of effects superposition through self-organizing at a microscopic scale).

characterized by abrupt changes when the critical value of loading is reached. The problem of structural stability (including bar buckling) was extensively analysed on the basis of the principle of critical energy in [41].

5. Conclusions

The critical energy principle, a principle of Energonics, turned out to have a high degree of generality and it is—in essence—transdisciplinary. Its application in a number of tangible cases of superposition and/or cumulation of actions upon a physical body, assigns it to the interdisciplinary area.

The reason why PCE can be used in all cases of actions upon physical or biophysical bodies comes from its being based on the concept of specific energy and the fact that it introduced the sign of external action in relation to a process or some phenomenon.

Nevertheless, the essential element that makes PCE likely to be used in the superposition or cumulation of actions of various types, but mostly, of different nature comes from the fact that PCE introduced the concept of specific energy participation, a dimensionless value dependent on material behaviour.

On the other hand, the definition of the concept of critical participation in connection with the structural deterioration caused by cracks, aging, overload, etc., allowed the calculation of their strength or the computation of their lifetime without resorting to the concepts of fracture mechanics.

The few practical examples of solving problems of action superposition, both in physical bodies as well as in living organisms, subjected to various external actions (mechanical, chemical and electromagnetic loading, some pollutant actions, of some medicine, etc.) confirms the transdisciplinary of the principle of critical energy, its great degree of generality.

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Chapter 2

Some Issues on Possible Connections between Creativity in Science and Technology and Old Cultural Frameworks

Dan Serbanescu

Additional information is available at the end of the chapter

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Abstract

The paper presents some results related to the approaches used to identify possible connections between aspects of creativity in science and technology and old cultural topics and paradigms. The analysis is performed for some specific cases for nuclear physics and nuclear energy issues considered of interest in the Romanian environment. Five cases were analyzed. The evaluation method is based on some previous results proposed by the author in order to illustrate the identified, in a systematic manner, connections between creativity in science and technology and old cultural framework. By using the proposed method, a set of connections was identified for the chosen cases. The approach was tested for some specific cases, but it is expected that it may be applied to other examples as well.

Keywords: Belief, knowledge process phase, creative solutions in science, old cultural frameworks

1. Introduction

The goal of this paper is to present some results related to possible connections identified between aspects of creativity in science and technology and old cultural topics and paradigms. The analysis is performed for some specific cases for nuclear physics and nuclear energy issues considered of interest in the Romanian environment. Five cases were analyzed:

- **Case A:**Procopiu magneton and Proca equations and pi meson
- **Case B:** Purica research methods in nuclear experimental physics
- **Case C:** Hulubei researches in nuclear physics and creation of an institute and a "school" of thought

- **Case D:** Romanian nuclear program
- **Case E:** An example of an individual experience of training and working in diverse cultural environments in nuclear energy

The evaluation method is based on some important results available in literature on the aspects analyzed in this paper, as follows:

- Knowledge is acquired in a series of steps, by switching [1–7] from one set of paradigms [8] to another.
- Not only the models (knowledge gained) is described by topological approaches [9–11], but the objects themselves that are considered to be modeled ("real world," "nature," etc.) are defined by topological spaces. The relationship between the models and "real world" is isomorphic.

The change from one step to another in the knowledge management process (KMP) and the creation of a new set of paradigms are driven by the need to find solutions to strong "conflicts" between facts and theories. Those solutions are generated by a process that can be described as being similar to a "syphoning process" between science/technology and culture. Culture is used in the sense of condensed societal set of beliefs acting for all aspects in science and art/culture, which may be called "mythology." In other words, deep old embedded in the social conscience (old knowledge as reflected in folklore for instance, but not only in it) are the real sources for building the new set of paradigms to solve critical/crisis type of problems in a science.

2. Method

The method used to identify possible connections between aspects of creativity in science and technology and old cultural topics and paradigms was previously communicated [1–7]. It is based on the following basic assumptions:

1. Knowledge is acquired in a series of steps, by switching from one set of paradigms to another. The paradigm notion is in the sense defined in the literature [8]. The process of moving from one phase to another is described in detail in previous papers [1–7] and it is illustrated for some important aspects in the Annex.

2. It is considered that not only the models (knowledge gained) is described by topological approaches, as previously defined in the literature [9–11], but that the objects themselves may be considered to be modeled ("real world," "nature," etc.) are defined by topological spaces and that the relationship between the models and "real world" is isomorphic [12-14].

3. The driving force of changing from one phase to another in the knowledge process is the need to find solutions to strong "conflicts" between facts and theories, in a creative manner, by using solutions to the conflicts from other areas than the science itself. Those

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solutions are generated by a process that can be described as being similar to a "syphoning process" bringing solutions from the "mythological" space to the scientific one. The present paper details the mechanism presented above for some case studies.

2.1. Description of the cases is presented below

2.1.1. Case A represented in Figure 1

- Case A is related to the moment of defining the magneton Procopiu-magnetic momentum of the electron and to the development of the Proca equations.
- The magneton was a synthesis between the Planck theory and the atomic (Bohr) model, while the Proca equations were part of nuclear field researches for a spin −1 and mass *m* particle (that proved to be later on meson pi). The Proca equations implied the need to make a synthesis between the Schrödinger equation and theory of relativity.
- In both cases there was a conflict between the two theories and there is a need to find a solution in compliance with both. The dilemma in the approach to try to solve two conflicting theories was solved by searching a solution using a third way—integrating the two.

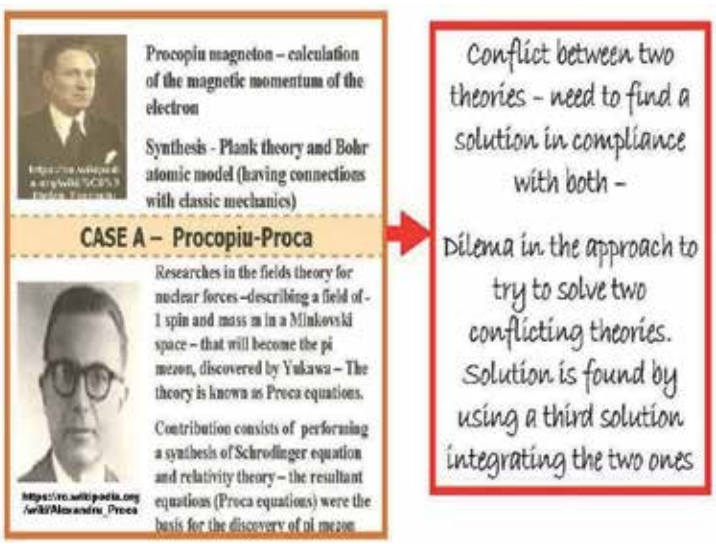

Figure 1. Case A

2.1.2. Case B represented in Figure 2

- Case B is related to development of experimental research methods in nuclear physics and reactor theory by using various types of logics.

- The dilemmas in choosing the investigation and the specific results interpretation of nuclear and quantum physics by considering the limits of the binary logic lead to specific solutions on the methods proposed.

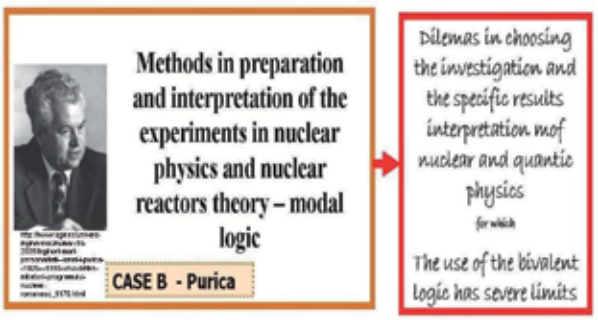

Figure 2. Case B

2.1.3. Case C represented in Figure 3

- Case C is related to the foundation of a research nuclear institute and a founding personality. There were three founding principles:
  - Combine theoretical nuclear and atomic physics with the nuclear technology/engineering
  - Assure continuous interface and update with the state of the art of researches at international levels
  - Inter- and transdisciplinary researches

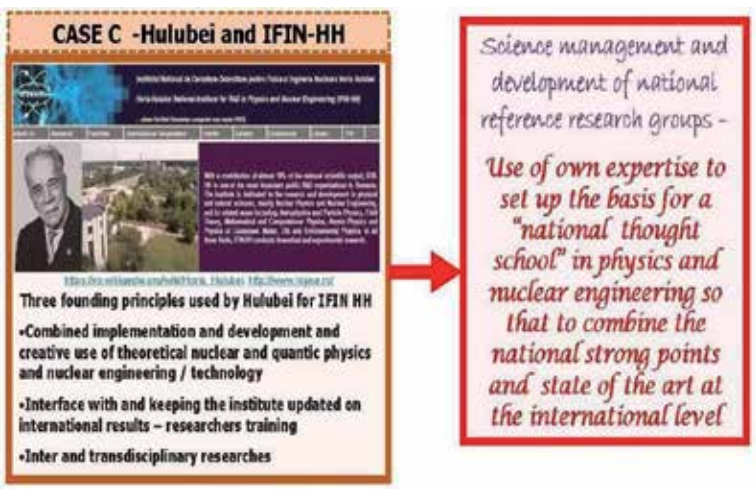

Figure 3. Case C

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The main issue to solve was to assure science management and development of national reference research groups. The approach to solve the task was to use our own expertise to set up the basis for a "national school of thought" in physics and nuclear engineering so that the national strong points and state of the art at the international level can be combined.

2.1.4. Case D represented in Figure 4

- Case D goal was to create research and engineering institutes, manufacturing facilities, including the know-how, general management of the program, and the interface with external partners and national/ international organizations.
- The main issue to solve was to develop a nuclear program management, as management of national critical infrastructure.

The main challenge of the case is to maintain a set of objectives for society segments with diverse political and economic objectives.

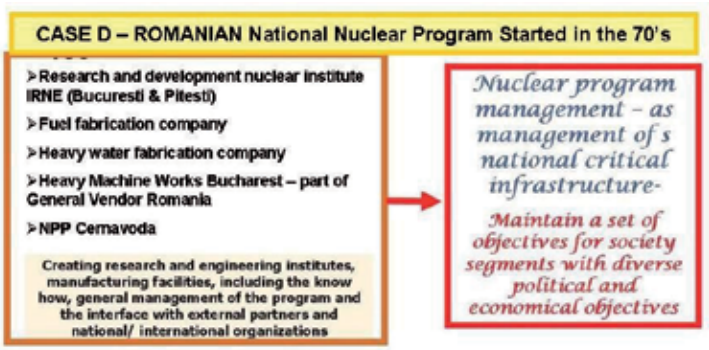

Figure 4. Case D

2.1.5. Case E represented in Figure 5

- Case E is represented by an individual (of an exponent of the generation "baby-boom" in nuclear) experience of education and training in diverse environments
- The specific issues needing to be evaluated were related to the features of this experience:
  - Experience gained during education period in diverse approaches
  - Experience enhanced during PhD studies
  - Training for working place at a new nuclear plant
  - Participation in commissioning and operation-related activities of a new plant built under license from a Western country in an importing country
  - Analyses and studies for new generation reactors in various countries and type of organizations

- Diversity of the experience is a very interesting challenge with specific insight on the driving forces for continuous improvement in such cases.

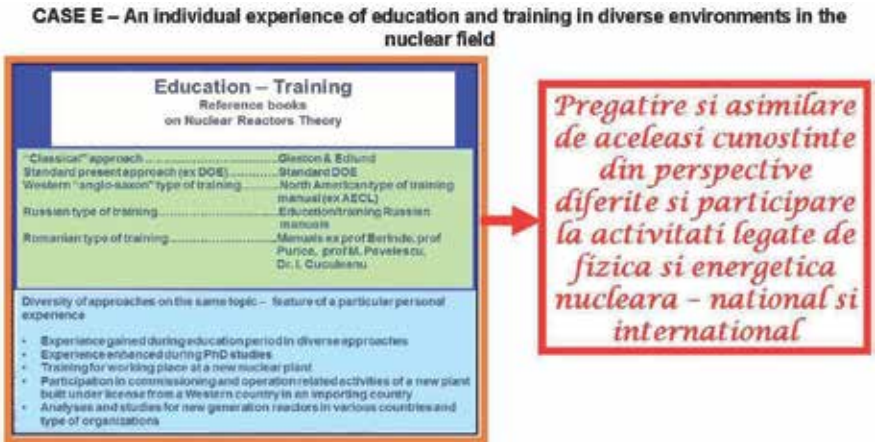

Figure 5. Case E

A set of typical phases as defined by the method proposed [1–7] are defined for all the chosen cases. For all the cases there are some common features related to:

- the fact that the search for a third type of solution while having two strongly conflicting ways to go forward, and
- the fact that the decisions on the creative solutions to be chosen are based on strong beliefs coming (in a "syphoning process" from other knowledge areas, as for instance) from the "mythological" old cultural frameworks.

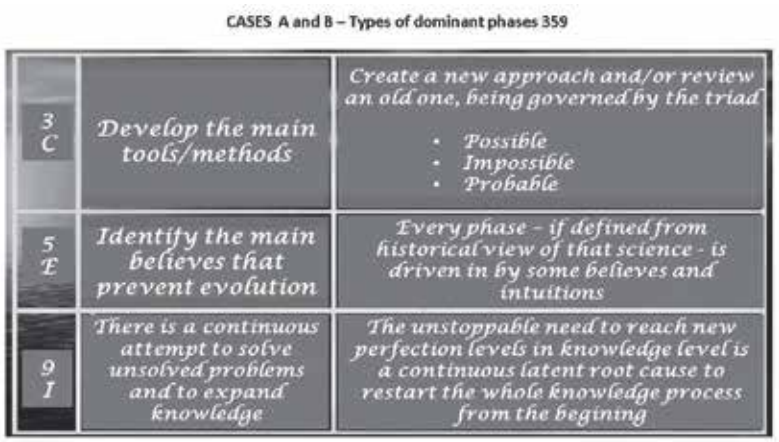

Figure 6. Case A and B typical phases in KMP

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For cases A and B, phases 3-A, 5-E, and 9-I are defined as being dominant. Therefore, the main characteristics (described on the second column in Figure 6) and the impact of the phase features on the potential creative solutions (as per the third column of the same figure) are describing the expected type of solutions on the dilemmas encountered in this case.

For case C and for cases D and E (considered together as having similar features), phases 3-A, 5-E, 6-F, and 8-H (for case C) and 3-A, 5-E, 6-F, and 8-I (for cases D and E) are defined as being dominant. Therefore, there are similar type of conclusions to case A, in the sense that the main characteristics (described on the second column in Figures 7 and 8) and the impact of the phase features on the potential creative solutions (as per the third column of the same figure) are describing the expected type of solutions on the dilemmas encountered in this case.

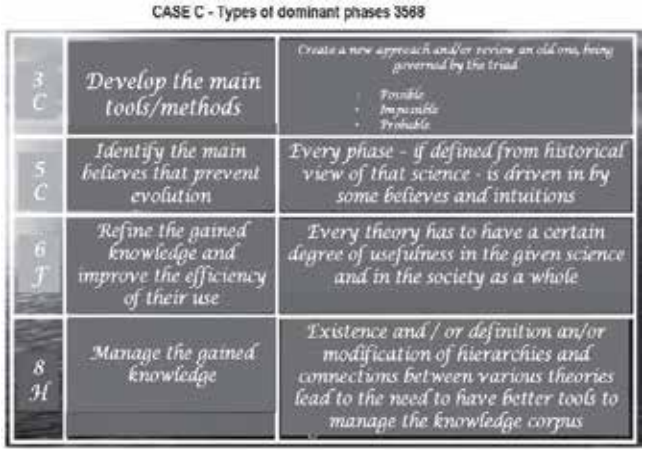

Figure 7. Case C typical phases in KMP

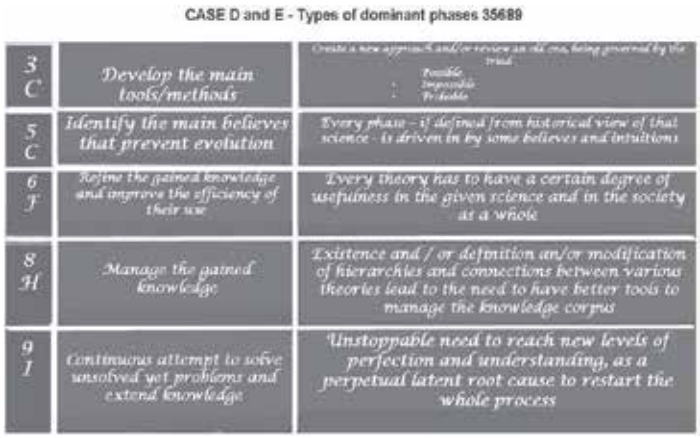

Figure 8. Case D and E Typical phases in KMP

3. Results

The main goal of applying the method [1–7] is to define the main features of the search for creating new theories and/or scientific methods in crucial times/phases. The search is based on the idea, formulated by this method, that the real creative solutions for crisis situations have strong connections with the old cultural frameworks, called in this paper "mythological" areas of knowledge, which may be considered as being specific to our cultural heritage.

As a result of the evaluations, the following results are obtained:

3.1. Results for case A

In this case a type of dominant feature (coded as MS1-A) was identified. This type of dominant "syphoning feature" is called "Trinity, triads, fractals—Pre-, non-, and Christian heritage." Examples are represented in Figure 9.

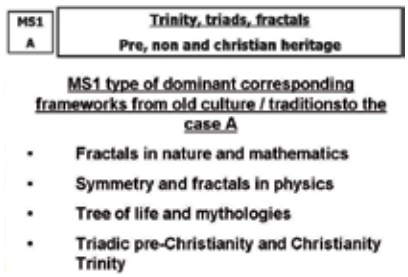

Figure 9. MS1 for Case A

3.2. Results for case B

In this case a type of dominant feature (coded as MS2-B) was identified. This type of dominant "syphoning feature" is called "The gate-The pillar." This feature has the following characteristics (Figure 10):

- It illustrates the separation of the sacred and profane/impure spaces, i.e., the separation of solid, confirmed, recognized knowledge from the new, unconfirmed, and uncertain, and
- It defines the strategies and tactics in the KMP.

3.3. Results for case C

In this case, two types of dominant feature (coded as MS3-C and MS4-C) were identified (Figures 11 and 12). These types of dominant "syphoning features" are called "The world-cosmos" and acquired knowledge on it a set of fractals" and, respectively, "Hora, The spiral." These features define:

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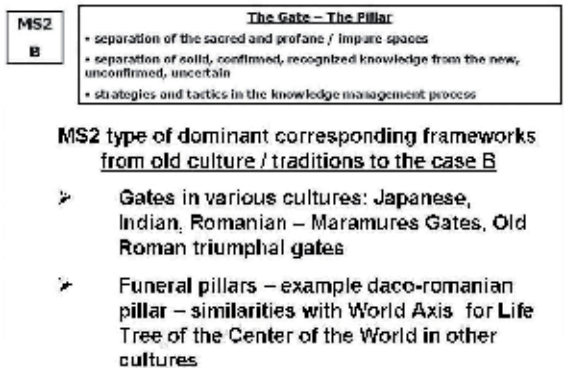

Figure 10. MS 2 Case B

- the tendency to reach the solutions guided by the perfect forms (solar and cosmic symbols), as expression of the force and perfection of feelings, living, and knowledge, and
- the role of collectivity in life and KMP, changes and transformations of the world, and of the corpus of knowledge on it.

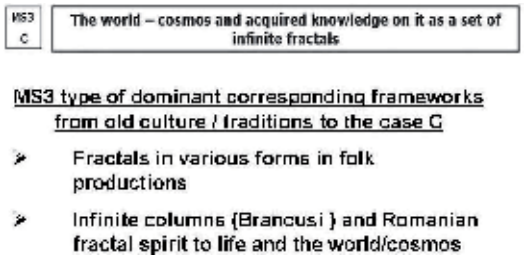

Figure 11. MS4 C Case C

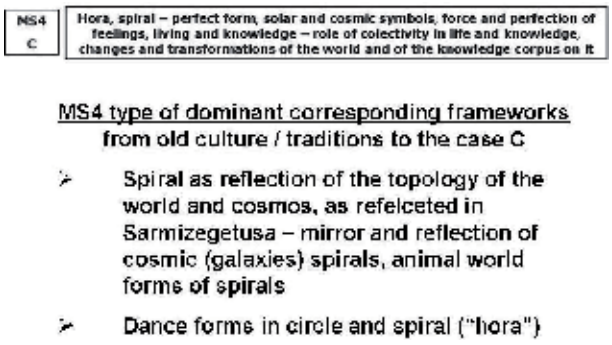

Figure 12. MS4 C Case C

3.4. Results for cases D and E

In those cases there is one type of dominant feature (coded as MS5-D,E) identified (Figure 13). This type of dominant "syphoning feature" is called "Oikonomia – οικονομία" The features of this type of symbolic topological similitude is described by the ability to perform management of community-related issues and its environment, using the lessons learnt and patterns as a guidance for solutions to dilemmas specific to cases D and E. Lessons derived from the natural energy and traditional household, the solutions of traditional household (the ecology "avant la lettre"), and the type of solutions adopted for the knowledge/risk analyses in natural, complex, self-regulating, and reproducing systems (Complex Apoietic Systems, CAS [1–5,12, 13]) may be used, too.

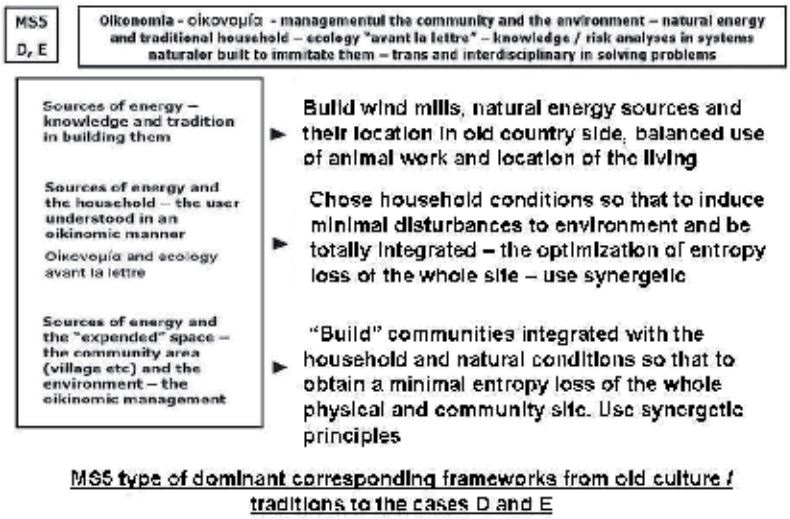

Figure 13. MS5 D and E

4. Conclusions

Based on the particular results for the cases mentioned above, a set of possible and most probable connections between the issues that had to be solved in science and the "old knowledge" was identified.

The approach was tested for some specific cases with very interesting results and it is expected to be applicable to other examples as well. However, it is expected to acquire more in-depth review of the methodology and investigation of more diverse examples during the future work. At this moment of research, it can be noted the well-suited applicability for the evaluated cases and the proposed method proves to be of interest to be considered for other more general examples.

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Appendices

Annex

The method described in previous papers [1–5,12,13] assumes that the world of scientific studied objects and the models on them are described by topological spaces. Knowledge is acquired in phases. There is a double triad describing the objects to be studied and the methods used to study them (as illustrated in Figure 14).

As a result of the process, scientific theories are built and in various phases generate different topological structures. Each phase is characterized by some dominating features, created by some deep believes. From the point of view of the type of dominating believes (which generate paradoxes and hence become a driving force of knowledge transition from one phase to another), there are three categories of possible situations. This specific feature may be used to refine the general knowledge states depending on the phase in which the knowledge process as a whole is at that moment in time. The change from one phase to another is driven by the mismatch between the truth switch and the belief (paradox creating) switch as represented schematically in Figure 15.

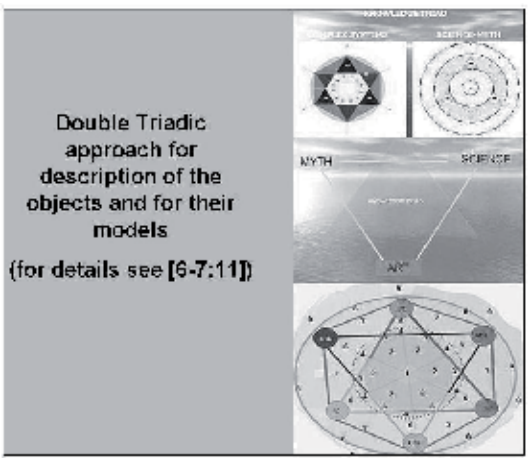

Figure 14. Triadic knowledge approach

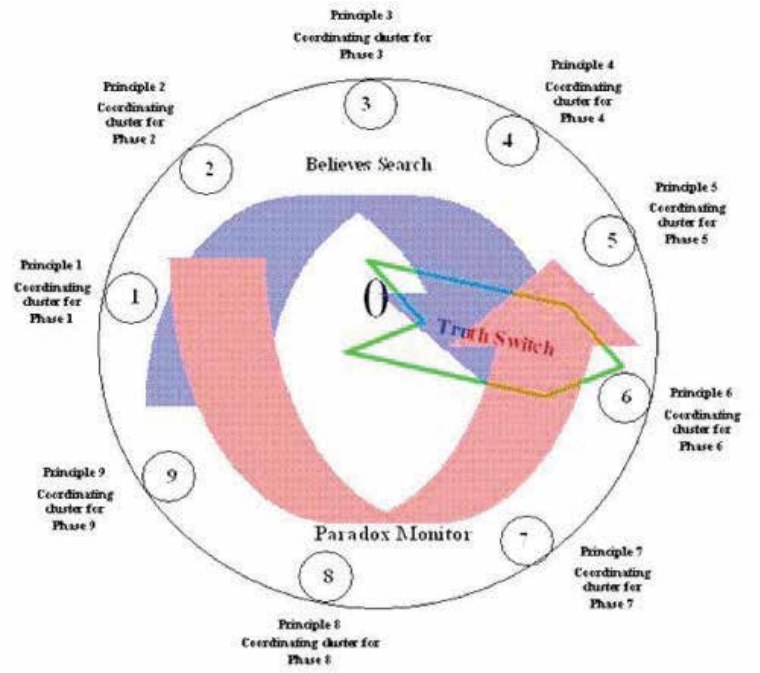

Figure 15. Belief switch

The transition from one phase to another and the building of the topological spaces are described in detail in the literature as defined by the author [1–5,12,13] and represented in a illustrative manner in Figure 16.

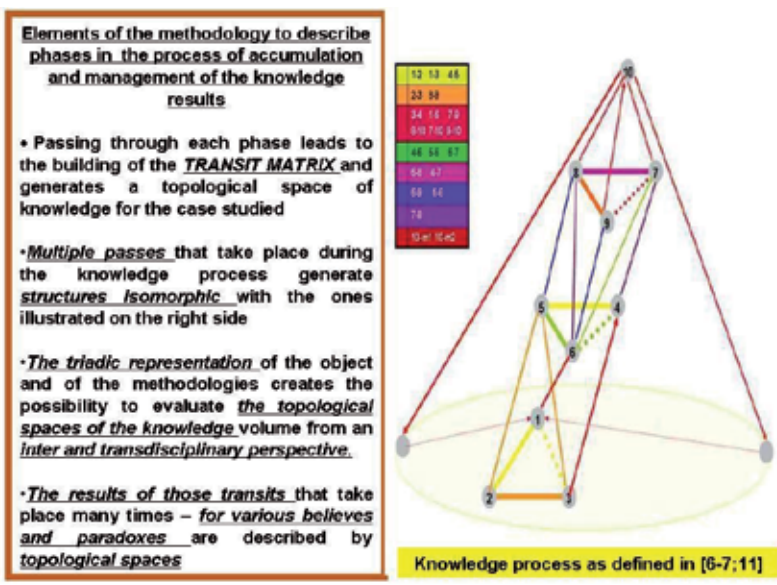

Figure 16. Knowledge matrix

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The resulting topological spaces, describing the knowledge space at a given phase, may be similar to the representation from Figure 17 (in which a typical science dominated KMP is represented).

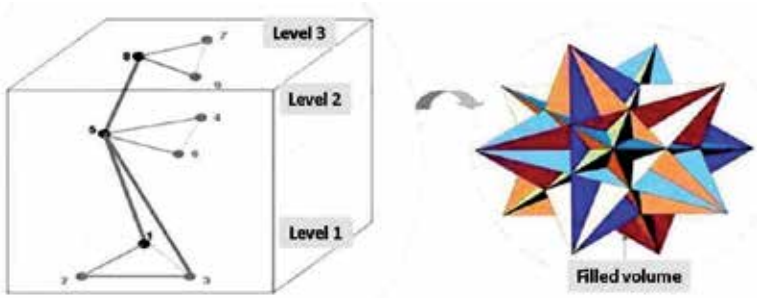

Figure 17. Knowledge process

Depending on the type of dominance, i.e., if there is a dominance of one side of acquiring the knowledge (science, myth, or art) or two or three sides, the author proposed to complement the approach of classification of civilizations based on the energy it may harness (as defined by Kardashev and described in more detail with other further developments [1–5,12,13]). It was proposed to classify the civilizations based on the type of process that describes the KMP (as represented in Figure 18). From this point of view, the type III might be an example of the present multidisciplinary approach specific to many contemporary scientific issues.

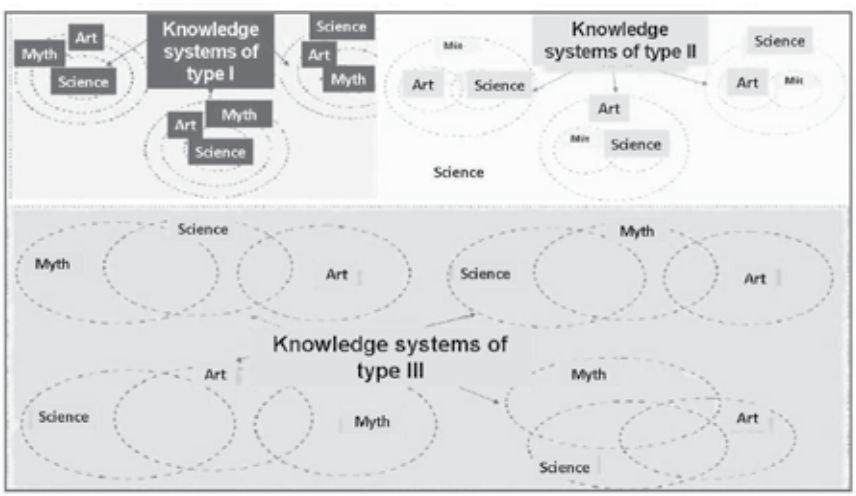

Figure 18. Knowledge and civilizations types

Another aspect of the results obtained with this approach to evaluate KMP proposed for consideration is that the knowledge is the target of a knowledge acquisition after passing through various phases is to define a "continuum" reflecting the "continuum" of the studied world/objects/reality.

The reality is, as Figures 16 and 17 illustrate, that knowledge is a discontinuous space about a discontinuous space of studied objects. It would be helpful for the KMP to understand the importance of answering questions such as the following:

- How to describe and formalize aspects of total knowledge (of everything) versus partial knowledge (of something).
- How to define an *x*-adic object that is studied with *y*-adic methods and rules and generate *z*-adic results/spaces which are being judged with *w*-adic logical tools.

Other sets of conclusions and applications are related to the practical use of the method. One application described in [1,2] is related to the nuclear physics and nuclear energy technology. Nuclear energy as a technology has an evolution characterized by the technology curve [3–5] as illustrated in Figure 19. The topological spaces representing the change of nuclear science and technology during the years are represented in Figure 20. The use of this method allows better understanding of main challenges encountered by the technology during the years and may make prognosis on some future features [4–7].

The last possible example of using the method is related to the possibility to study in a more systematic manner some amazing similarities from topological spaces point of view illustrated in Figures 21 and 22.

The similarities may be understood to some degree by the use of the method as presented in previous papers [5–7].

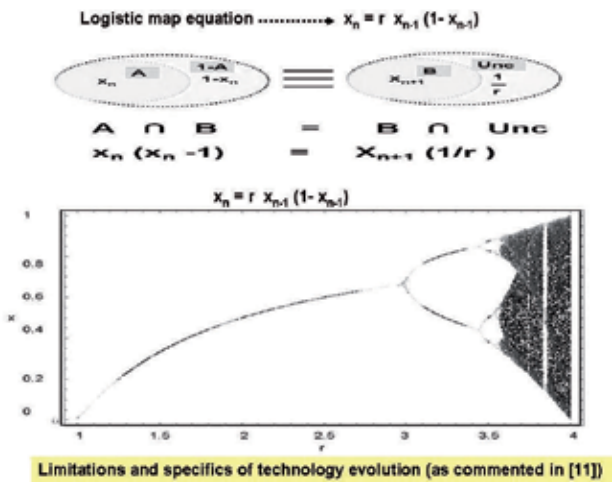

Figure 19. Knowledge and technology

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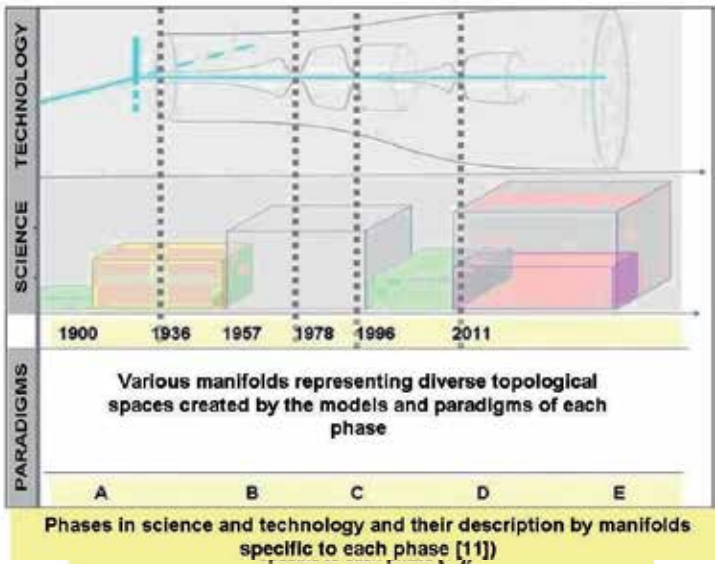

Figure 20. Nuclear knowledge and technology

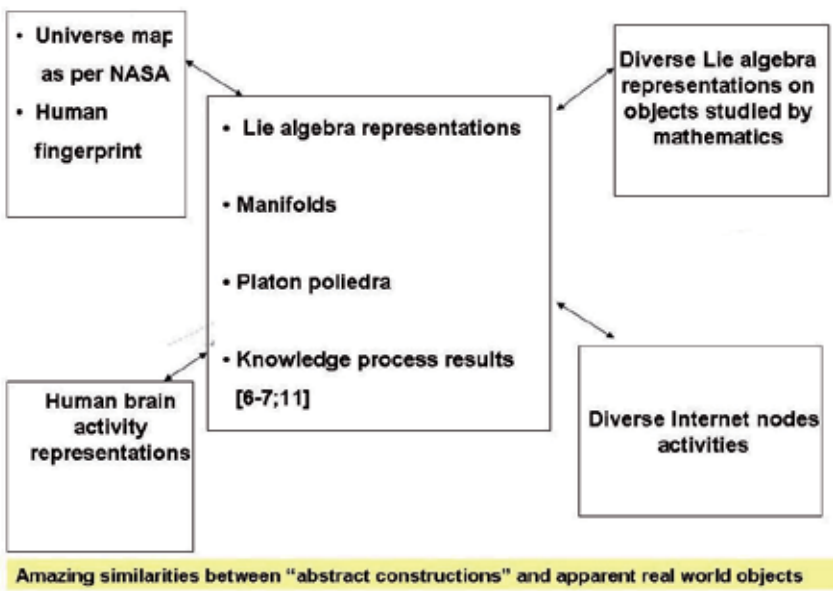

Figure 21. Topology and knowledge results

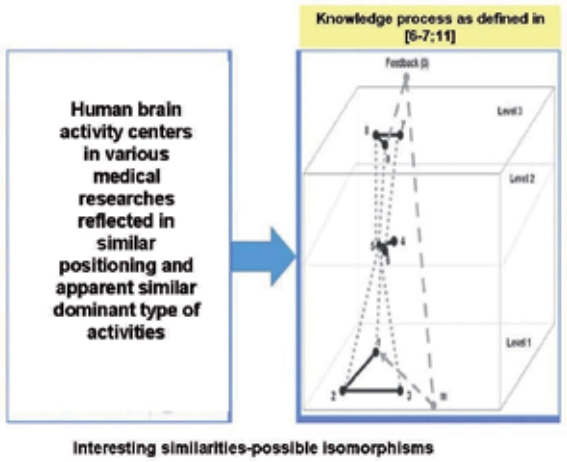

Figure 22. Knowledge topology and brain

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Chapter 3

Some Considerations on the Lessons Learnt from the Cavalcade of Changes in Physics' Models

Dan Serbanescu and Lucian Victor Spiridon

Additional information is available at the end of the chapter

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Abstract

This paper presents an attempt to explain and to make predictions on the change process in the physics' models. One important goal of the search for such an attempt is to develop an approach that is able to have a certain degree of predictability of at least the direction in which the models will change, assuming that in general it is possible to have an answer to the question, whether this change process has a certain rhythmicity and follows some patterns, or it is a totally chaotic one. The paradigmatic approach of Kuhn on changes in science was one of the starting points for this search, and the use of topological aspects to describe models in physics was a starting point of the search for the approach. By using notions of categories and of syzygies from mathematics, a new approach is proposed to evaluate the direction of changes in science and technology, with an example from the nuclear physics and technology.

Keywords: Belief, knowledge process phase, creative solutions in science, old cultural frameworks

1. Introduction

The goal of this paper is to present a new approach on the evaluation of the change process of models in science. The goal of the approach is to be able to increase the existing degree of predictability of the evolution of the models, as given by existing methods [1-6].

It was found out in some examples of its application [7] that the proposed approach indicates better the direction in which the models will change and if this change process has a certain rhythmicity and follows some patterns, or it is a totally chaotic one.

The authors started from the paradigmatic approach of Kuhn on changes in science [1], the use of topological specs to describe models in physics [5,6], and previous similar developments [7,10,12-15].

In this paper the principles of the approach and some results are presented. The novelty of the applied principles is that they are based on a generic description of the science phases (as detailed in previous papers [8,9]) and on the use of the notions of categories and syzygies, as defined in mathematics. The example illustrated in the paper is from the nuclear physics and technology.

As it was shown before in some sample cases (Aristotelian, Newtonian, quantum physics, and relativity theory) [8,9], the change of syzygies is performed by switching from one approach/ science to another by the time the paradox solving process leads to minimum set of syzygies for the given approach. It is also shown on a case considering various energy sources that the syzygy approach in a context of topological description is applicable equally to the object to be studied and its model, which are considered to be in an isomorphism [7].

2. Method

2.1. General aspects

The knowledge topics and the manner they are reflected in the physics models are an old topic of the natural sciences and philosophy. Nevertheless, and may be because of that, actually there is an impressive series of approaches trying to explain and evaluate those aspects. Those approaches are practically part of the main content of the history of science and philosophy. In this context the proposed approach has the following elements of novelty:

i. Interdisciplinary character

a. A set of basic principles is defined, starting from notions from mathematics, as for instance, the concepts of **category** and **syzygy**, in a hierarchically developed model. The results are compared with other explanations offered by using other approaches from physics and philosophy (details in [7]). The results may be a basis for answering questions like: "*If and to what degree the changes in models are predictable?"* and *"Is it possible to define rules describing the model change process?"*

b. The analysis performed using the proposed approach is also correlated with the apparent need to screen existing applicable methods used in mathematics, physics, and/or philosophy to obtain answers to the questions formulated at the point (a) above.

c. The whole model change process may explain their generation and scenarios of possible evolution. The examples considered previously [7] illustrate those ideas. For instance, an example is considered of the interpretation of the models for various levels in physics (from subquantum to cosmic).

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ii. The use of some specific cases [8,9] to illustrate the manner to implement the concepts of paradigm and crisis in science [1] by identifying the mechanism/driving forces of the model change process that leads to the situation that some models are adopted from all the other competitive solutions.

iii. The models were considered as topological spaces [2–4]. The basis of the approach to consider the models in physics as topological spaces that study physical systems/objects being topological spaces themselves was presented in [5] in 2008, and they are in agreement with some more recent results obtained from mathematics tools in 2013.

iv. On the other hand, the proposed approach has a strong competitor in a series of totally opposite approaches that consider that the systems existence, their generation, and their destruction, as well as the models describing this process, is a totally chaotic movement.

2.2. Description of main features of the proposed approach

The approach concentrates on finding rules based on which predictions (and not only postdictions) may be made on model change dynamics in physics.

2.2.1. The following components of the approach have to be defined

- The object (for the study) is defined, i.e., the limits and assumptions for the systems are identified
- The main principles/conjectures of the approach are formulated
- The mechanism to be used to verify and validate results is defined

2.2.2. For all the components mentioned above the following guiding rules to describe them will be used

- The use of the notion of category is focused on the search to identify the basic features of the model for which the application of notions of syzygies is possible, as defined by diverse perspectives—mathematics, physics, and philosophy.
- The solutions that are searched from a perspective of paradoxes reached by the use of "mathematics syzygies" may lead to another cycle of using "physics syzygies" and then to one of "philosophy syzygies." Reaching the state of paradoxes for a certain set of syzygies is limited according to the principles of dynamic asymptotic equilibrium in the system description process.
- However, the final state possible to be reached is unknown and therefore from this perspective (of being able to have "final" knowledge) is chaotic.

It is considered that the models generate a topological knowledge structure $K^{(i)}$, that is based on a certain (dominating) theory (Th $K^{(i)}$). The topological structure that results as a knowledge model and the rules of emergence of the physical system itself are described by an isomorphic relationship.

2.2.3. The three principles of the approach mentioned above are as follows [8–10]

Principle 1: The topological structure $K^{(i)}$ is described by the notion of category that is considered to:

a. Reflect a hierarchical structure of "matrioshka" type, that may be described as a more generalized type of cybernetic system, in which the the objects under study and their models are "black boxes" for every level of emergence and, respectively, modeling of the objects/models.

b. The descriptions of Figure 1 are applicable:

- Objects Obj1, Obj2, Obj3
- Morphisms f1, f2, f1* f2, si
- Three identity morphisms (not illustrated in the figure) 1X, 1Y, and 1Z

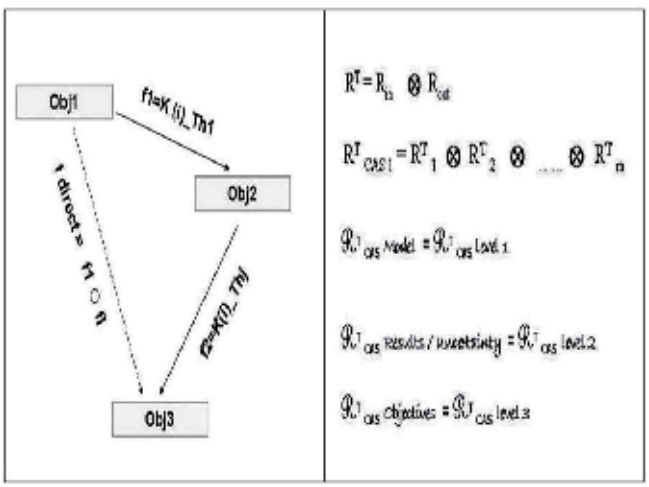

Figure 1. F Description of the category concept

c. C (in the chosen cases) consists of:

- class Ob(C) with elements called objects
- class Hom (C) with elements called morphisms/maps.

d. to be able to define set of minimal conditions describing each phase, that are called syzygies of that set of knowledge relationships that define an algebraic structure.

e. consider that the process of model change consists of having phases of the knowledge process that lead to a certain $K^{(i)}$, i.e., a set described by the rules generated by syzygies, that may be also called paradigms. These paradigms carry with them a set of deviations from the real system/object that are intrinsic to the modeling process and their limits are defined by the set of syzygies.

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Principle 2: The knowledge process (KP) takes place (we will underline that the words "progress" or "evolve" are actually hard to prove and not obvious at all) in iterations made for the categories defined for

- Each object and the whole set as defined by initial assumptions and boundary limits
- At each level of modeling

Up to the point of reaching a critical state due to the number and type of paradoxes embedded in the model [8,9]:

a. In this manner a syzygy set is continuously optimized from diverse approaches—mathematics, physics, philosophy, etc., and based on those optimized sets it is possible to reach (as per the theorem of Hilbert for syzygies in mathematics) a final minimal set of syzygies for a given model. Then by applying the same process from another science perspective this will be repeated.

b. The process of reaching a final optimized state for an approach (with a given set of rules from a certain science) is predictable and it does have a final point. However, the final state of the model as described by the obtained set of syzygies from a given science does not reflect at all the real status of the studied object and therefore new iterations using methods from other sciences to find syzygies are initiated.

c. The KP "imported" approach from another science (mathematics or philosophy for the case of physical objects—as illustrated by the cavalcade of quantum mechanics models of the last decades) lead to a process as described at point (b) above.

d. An example of such a case is the case of NES [7]. It is composed of the following energy levels, defined as energy sources dominating each emergence level:

- Subquantic **SQ**
- Quantic **Q**
- Electromagnetic **EM**
- Molecular **MO**
- Molecular and life **MOL**
- Conscient planetary life **CPL**
- Stellar and universe without life **SUNA**
- Stellar and universe with life **SUA**
- Stellar and universe with conscience **CSU**

Principle 3: The KP is asymptotically stable and complete. Nevertheless, the final structure that results for the KP on a given object cannot be known in its phenomenological detailed characteristics, nor predicted. But the most probable status is that the existence of such a final state can be predicted [8,9].

2.2.4. Description of some specific syzygies

To include more details on the approach presented before and the characteristics of the KP ($K^{(i)}$) a set of syzygies is illustrated for the case of NES, as follows [7]:

- Exergy (Ex) for an NES (defined as the maximum work possible for a process that brings the system to equilibrium with a heat reservoir) as a measure of the process of energy conversion. This generator has the following characteristics:
  - It conserves only when all the processes of the system/environment are reversible
  - It is destroyed when the process is irreversible
- Entropy (Thermodynamic) (EnTh) as a measure of disorder.
- Information Entropy (EnI) as a measure of the limits of knowledge itself.
- Synergy (Sy) as a measure of a set of NES that appear from the existence and interaction all its systems and components, leading to a new set of more characteristics for NES as a whole than for NES components altogether.
- Emergence (Em) from one level to another (for example, from SQ to CSU) as a process in which the entities, patterns, and regularities/irregularities are generated by interactions between smaller (or from lower level) entities, which do not have themselves those properties.
- Nonlinearity (even for simple systems) and/or complexity (NlnCx) for a NES as a source of chaotic behavior of structures of complex systems (SAC).
- The features of a SAC considering fractals (Fr) are defined starting from the characteristics of such systems. In the NES example and its KP structures of $K^{(i)}$ type, as topological structures of the knowledge gained for a given system at a given level, the fractal behaviors is characteristic for describing all levels and each component in a given level.

An illustration of these characteristics is shown in Figure 2.

In Figure 2, the transition matrix may be considered an isomorphic relationship for the aspects considered above. This matrix is actually a function of the considered categories [4]—defined in the KP structure of type $\boldsymbol{K}^{(i)}$ for each source of energy and phase in which the sources may be at a certain stage of changes, as a development of the approaches from [1–6, 11].

Every phase of a NES and every emergent phase are composed of (Figure 3):

- The basic part and the feedback for the structure $COFB_k$,
- The layer of connection from one level to another $CLNL_i$
- The layer of connection to the base level $CLMP_j$
- The main layer of the structure ML_j

where $k = 0, 1, 2, 3$; $i = 1, 2, 3$, *si* $j = 1,\ldots 9$.

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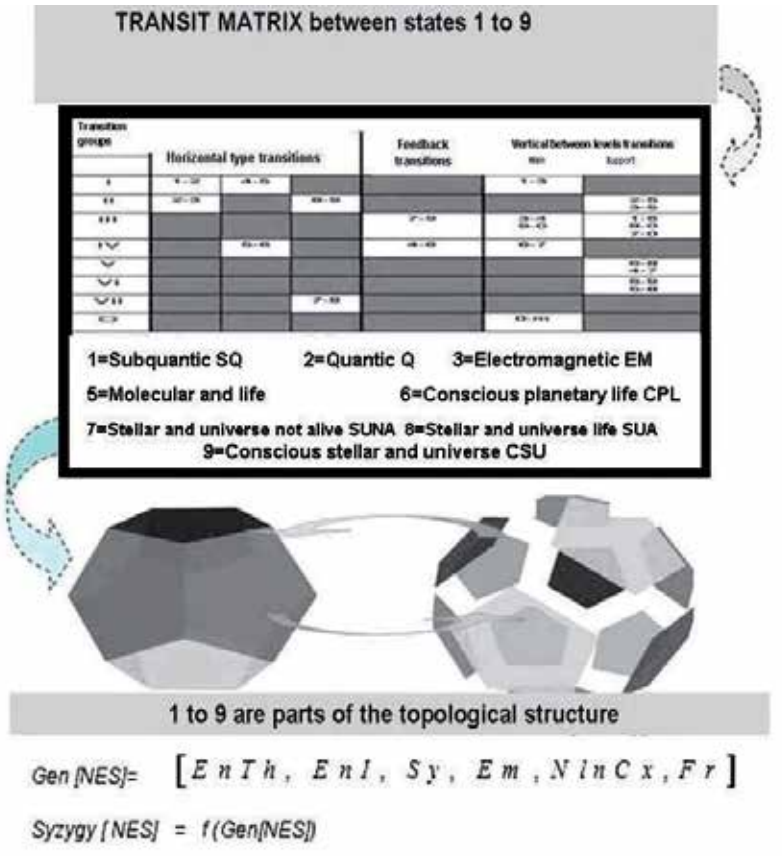

Figure 2. Transition matrix for energy sources and levels of NES example [11]

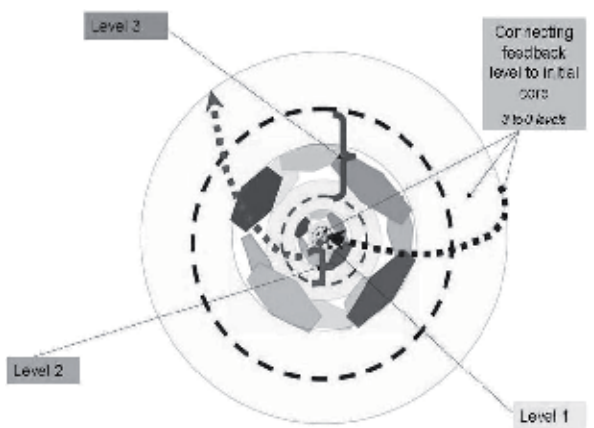

Figure 3. Layers and structure of the KP of K(i) type for the NES example [11]

It can be noted that a given structure of KP for a NES type system has a fractal characteristic.

3.3. Results and conclusions

The approach allows to give some answers to questions on directions of evolution of the models for objects described in physics. The example illustrated is indicating the fractal nature of emergence and changing from one level to another in the process of building a KP structure of $K^{(i)}$ type.

For a NES, this process is repeated in iterations producing versions (R_0,…R_n) generating manifolds of results of MR_i and $MStrR_i$ types (Figure 3).

This process of model generation has the following main characteristics:

- It is quantifiable and predictable for a phase and a given component.
- The type of the final state and the details on the final state (assuming that a real structure of NES type, for instance, exists and it is isomorphic with the final set of models) for a given structure $K^{(i)}$ leads to a state for which its phenomenological characteristics cannot be predicted, and from this perspective this KP state describes a system of knowledge of chaotic type—ChR (Figure 4).

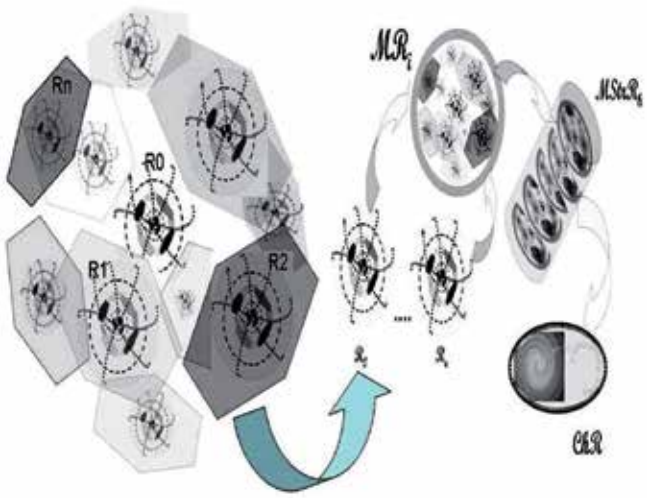

Figure 4. Illustration of emergence for various phases and energy sources [11]

A reformulation of the last statement can be made in the sense that the lessons learnt on NES systems models in this moment (by using the proposed approach) is that

- The process of emergence from one level—one source of energy to another—has a finite character from the number of phases described by syzygy type of characteristics.

- This finite change of states can be predicted and is finite, with a trend to reach an asymptotic level of KP structures.
- However, the detailed phenomenology of the final state is not predictable as the change by the KP topological spaces has a chaotic character from this perspective.

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Chapter 4

A Virtual Routing Solution for IP Networks

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Additional information is available at the end of the chapter

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Abstract

The core of our paper is represented by the development of the HypeRSimRIP application that can be used for various networking purposes, such as designing a network or setting routing processes. Likewise, the application implements didactical functions useful for teaching networking-related concepts and experimental capabilities that enable its users to recreate famous experiments.

Keywords: Hypervisor, network, simulator, RIP

1. Introduction

The concept of virtual has different connotations, depending on the domain in which it is used: philosophy [1], current speech [2], creation of artificial ambients of virtual reality type [3], etc. Most of the time, the term usually refers to applications and services from the Internet. *The virtual experiment* represents an alternative, or better said a complementary, resource in the study of phenomena and processes.

The basis of the concept of *hardware virtualization* (also known as platform virtualization) consists in the use of software in order to simulate the existence of a hardware component. This allows the use of multiple independent Information and Communications Technology (ICT) systems within a single physical computational system. The term 'virtualization', in this sense, was used even in the 1960's mainframes, and it represented as a method of partitioning the resources of a mainframe to all its diverse applications [4].

A *virtual machine* (VM) is a software application that completely simulates all the functions of all hardware components of an informatics system (particularly, a computer). If on a real hardware system (further named as host) are installed multiple virtual machines, each one of them will function as an independent computational system, complete with its own processor,

its own RAM memory, its own Hard Disk Drive (HDD), etc. The operating system that allows the creation and continued simulation of more virtual machines is called a *Hypervisor* or a virtual machine manager.

At first, hypervisors can be classified into two distinct types: hypervisors of type 1 and hypervisors of type 2. Those of type 1 represent a hypervisor that runs directly on the host. Those of type 2 run within an operating system, which in turn runs on the host [5]. Hypervisors of type 1 are therefore more efficient, but because of this, their monetary cost increases considerably. Thus, in order to experience virtualization, it is often preferred to use a type 2 hypervisor, before entering in the possession of a type 1 hypervisor.

VMware vSphere (known also under the name of ESXi) [6] represents a type 1 hypervisor for servers. ESXi runs directly on the server (the host) and allows the creation and utilization of multiple virtual servers. VMware Workstation [7] is a type 2 hypervisor; it allows the user to create and run in parallel, multiple instances of virtual machines with operating systems compatible to x86 or x86-64 architectures on the same physical host.

Depending on the level of virtualization, hypervisors can be classified [7] as having:

- Full virtualization—the simulation of all the hardware components is almost complete, thus allowing an unaltered run of the operating system of the virtual machine.
- Partial virtualization—just a part of the hardware components will be simulated, thus applications need some changes for a proper use inside the virtual machine.
- Paravirtualization—the hardware medium is not simulated at all; the programs 'virtual machines' are executed in their own separated domain.

Desktop (work area) virtualization represents the concept of separation between the logical desktop and the physical machine. A form of desktop virtualization is represented by virtual desktop interface (VDI) that represents a more advanced form of hardware virtualization. Instead of having to interact with a host directly with a mouse, a keyboard and/or a monitor, the user can interact with the host via another machine—another desktop computer, or a smartphone, etc. This can be accomplished through a LAN network connection or a wireless LAN network connection or even the Internet. In this situation, the host becomes a server computer capable of running several virtual machines at the same time for multiple users. As a first example, the TeamViewer application, developed by TeamViewer GmbH [8], allows remote access and control of a desktop and file transfer between the two devices (a host PC (personal computer) and another device such as a PC or a smartphone). As a second example, more advanced than a connection to a single desktop (TeamViewer's situation), HP and IBM companies offer a VDI hybrid, with a series of virtualization software, in order to improve the computational limitations of a client [9].

Session virtualization allows multiple users to connect and authenticate simultaneously to a more powerful computer via a network. Each user has a personal desktop and a personal folder in which he can store his data [10]. With the multi-seat configuration, session virtualization can be achieved by connecting more input/output devices to a single personal computer.

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Another form of virtualization consists in the movement of all the desktops to a cloud, thus creating hosted virtual desktops (HVDs) in which the desktops are stored and maintained by a hosting specialized business. Here, the benefits include a drastic decrease of the investment funds (in informatics equipment), which is replaced by a monthly 'rent' towards the hosting business [11].

In the second section of this paper, the application HypeRSimRIP ('hypervisor de Rețele cu simulator RIP' [Ro]—network hypervisor with integrated RIP simulator [Eng.]) is presented. This application is a type 2 hypervisor with full virtualization, which was developed by the authors in order to allow the construction, management and observation of a virtual system of Internet Protocol (IP) networks. The HypeRSimRIP application is useful in realizing virtual experiments dedicated to the study of IP networks. Moreover, the subject is of huge interest, considering that the world has embraced the Internet of Everything (IoE) concept—the connection of the Internet to all humans, processes, data and objects. The theoretical aspects, specific to IP networks, like the Open Systems Interconnection model (OSI) and TCP/IP models, the TCP/IP protocol suite, IPv4 addressing (sub-netting and variable length sub-net mask (VLSM) methods), the routing process, the RIPv1, RIPv2 and RIPng protocols are considered known, and they will not be presented in this paper. For further references, please consider [12–17].

In the third and final section of this paper, the functionality of the HypeRSimRIP application is described, alongside with some utilization examples. The application allows the simulation of notable experiments from the IP network domain. The results obtained by HypeRSimRIP are similar to the theoretical results obtained in the literature.

2. The HypeRSimRIP application

The interaction between the user and the HypeRSimRIP application takes place through a graphical user interface (GUI). HypeRSimRIP was developed by the authors in Visual Studio 2012, using the C# programming language, in the Microsoft's.Net Framework (version 4.5) programming platform.

2.1. Design of the main window

The main window of the program is composed of four main areas (see Figure 1):

- The first area (further named as the graphical zone) represents the area in which the network topology can be created, viewed and modified.
- The second area includes all the current routing information of all the routers.
- The third area (further named as the console) includes a history of text messages made for the user: help messages, tutorial messages, announcements about any change in the network topology, reports about sent data packages, etc. The font size of the second and third areas can be adjusted by using the mouse scroll whilst pressing the Ctrl key.

- The forth area includes a diagram that will plot the network usage from the last 60 sec of the simulation (the complete network usage is saved in a text file, at the end of the simulation). This area is detachable from the main window via a double click on it.

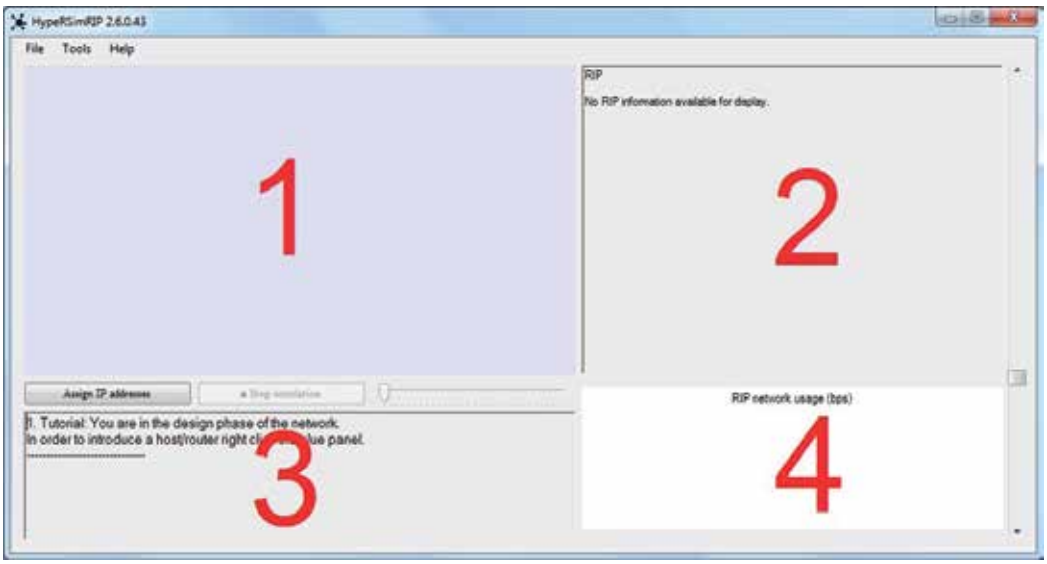

Figure 1. The main window divided into its four main areas.

The main window can be resized upwards of the minimum size of 1000 px (width) × 500 px (height). During the resize process, the following can be observed: the size of graphical zone remains unmodified (500 px × 300 px) for objective reasons (the devices have fixed representation sizes) and only the other areas modify their sizes.

The right-sided scrollbar of the main window (see Figure 1) allows changing the sizes of the routing information area and the network usage diagram area: The ratio determined by the scroll thumb in this scrollbar is equal to the ratio between the heights of the areas in question.

2.1.1. The graphical zone

The graphical zone represents one of the most complex parts of this application.

Its functionality changes depending on the stage in which the application currently is in. Two main stages distinguish themselves:

- The network design stage.
- The RIP protocol simulation stage.

In both stages, the mouse position is continuously monitored, more precisely: the coordinates of the cursor when left click is pressed, its position in the proceeding moments and the coordinates when left click is released. These three events are necessary for a single left click

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because the user may want to drag some object from this area. By pressing right click, a contextual menu will appear; its elements will differ depending not only on the stage in which the application is in, but also on the type of the object that was right clicked. More clarification on this subject will be presented in the following sub-sections.

2.1.2. The network design stage

At the beginning of the application, in the network design stage, a right click on the graphical zone will give two device insertion options: host or router.

Programmatically, by choosing one of these options, an object of class type `Device` will be created in a list from the class `Topology`, which will have as coordinates, the upper-left position of the previous contextual menu. These devices will be represented on the graphical zone through discs of different dimensions and colours depending on their respective states. Next to the discs, a unique name will be shown for quick visual identification (see Figure 2).

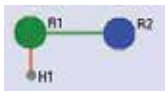

Figure 2. Device representation example: R1 is a selected router; R2 is an online router; H1 is an offline host; the segment [R1,R2] is a connection; the segment [R1,H1] is a deactivated connection.

Once a device has been inserted, the user can select this device or move it around, for repositioning, by dragging it with the mouse.

In order to detect if a device was selected, the application runs the following algorithm:

Step 1. All the devices `d` from the devices list from the `Topology` class are retrieved and checked one by one as in the following algorithm:

a. The radius of the disc representation of the device `d` is calculated depending on its type —5 px for hosts and 15 px for routers.

b. If the Euclidean distance between the coordinates of the device and the position of the left click is smaller than the calculated radius, then the device was selected. **STOP**

Step 2. If this step is reached, then no device has been selected. **STOP**

The same algorithm (with minor changes) is used for the right-click event, in order to determine the contents of contextual menu. The changes consist in:

- If the click was made at less than `Max (radius of host, radius of router)` from a device centre, the opening of the contextual menu will be cancelled because it is not desired to allow the user to insert overlapping devices.
- If the click was not made over any device, it is checked if the right click was made over a connection (as it will be seen in Section 2.3).

In the situation in which the left-click mouse button was clicked over a device, but it was not yet released, mouse movements are monitored as follows:

Step 3. If the Euclidean distance between `P_initial` (the initial point of click) and `P_current` (the current cursor location) is smaller than 6 px, it is considered that the user's hand just trembled when the button was pressed, thus no action will be taken.

Step 4. If the distance increases over 6 px, this means that the user actually wants to move the selected device. This movement will be done continuously until the left click is released (the 6 px protection from step 1 is deactivated). During this movement, two scenarios may occur:

- If the device starts to overlap with another (unwanted behaviour), both the devices are highlighted with yellow. When the overlap stops, they will revert to their original colours. If during the overlap scenario the left click button is released – which represents an illegal movement – the position of the displaced object will be re-established. Note that it will be re-established, not to the position of left click (`P_initial`) but to the original device position.
- If the object approaches or leaves the limits of the graphical zone, the object will be highlighted in red, and at the left-click release event, it will be deleted. Of course, if the object is placed back inside the margins of the graphical zone, without releasing the left-click button, its colour will be reverted to its original, and it will not be deleted at the button release event.

Step 5. If at the left-click button release event, the distance between `P_initial` and `P_current` has never exceeded 6 px, this means the user wanted to select the object, thus it will be highlighted as such (with green).

The management of these warning colours is done through the existence of multiple Boolean-type variables throughout the Device class. They determine the current status of a device. The order of colouring is given by the following method:

```
private void setNormalColor()
  {
   if (flag_deletion)
  {
    colour = Settings.getColor_Device_Dispose();
  }
 else if (flag_overlapp)
  {
    colour = Settings.getColor_Device_Overlap();
  }
 else if (flag_tracert)
  {
    colour = Settings.getColor_Device_Traced();
  }
 else if (flag_selected)
  {
    colour = Settings.getColor_Device_Selected();
  }
 else if (flag_online)
```

```
 {
   colour = Settings.getColor_Device_Online();
 }
else
 {
   colour = Settings.getColor_Device_Offline();
 }
}
```

The following order is distinguished: deletion colour, overlap colour, trace colour, selection colour and online/offline status colour.

The selection of two devices during the network design stage will create/delete a connection between the devices, and during the second stage, it will start a 'trace route' type command from the first device to the second (as it will be shown in Section 2.5).

2.2. Efficient interactive training

This version of the HypeRSimRIP application contains a new functionality of interactive training that allows the user to quickly learn how to use the program.

The training consists of a series of tutorial-type messages transmitted to the user via the console in some special identified moments (see Table 1). These messages are shown only once, each one of them having annexed a Boolean variable, which states if the message was previously shown, in which case the triggering event will be ignored.

Triggering event	Message
Start of the program	Tutorial: You are in the design phase of the network. In order to introduce a host/router, right click the blue panel.
Two devices inserted (with at least one being a router)	Tutorial: To create a connection, select two devices (green colour for selected devices).
Selection of a device	Tutorial: To deselect a device, click an empty place of the blue panel.
Creation of a connection	Tutorial: To delete a connection, select again its own two devices. In order to move to the next phase, press the button 'Assign IP addresses'.
Five devices inserted	Tutorial: You can delete a device by dragging it to the margins of the panel (red colour).
Device approaches graphical zone margins	
Overlap of two devices	Tutorial: It is forbidden to overlap devices. Devices in peril of overlapping will have yellow colour.

Triggering event	Message
The network simulation stage	Tutorial: In the beginning, a device is offline (grey colour, an online device is blue). Also, a device will run by default RIPv2 broadcast. To change these settings, right click the device.
Device activation	Tutorial: Use the play and pause button to play/pause the simulation.
Automatic start of a device	
Simulation starts with at least two online devices	To test if there is a route between two online devices, select them. (Attention: There may or may not be a route depending on the order of the selection).
Activation of a second device during simulation	
'Help' in the design stage	Help: You are in the design phase of the network. In order to introduce a host/router, right click the blue panel. To create a connection, select two devices (green colour for selected devices). To deselect a device, click an empty place of the blue panel. To delete a connection, select again its own two devices. In order to move to the next phase, press the button 'Assign IP addresses'. You can delete a device by dragging it to the margins of the panel (red colour). It is forbidden to overlap devices. Devices in peril of overlapping will have yellow colour.
'Help' in the simulation stage	Help: In the beginning, a device is offline (grey colour, an online device is blue). Also, a device will run by default RIPv2 broadcast. To change these settings, right click the device. Use the play and pause button to play/pause the simulation. To test if there is a route between two online devices, select them. (Attention: There may or may not be a route depending on the order of the selection). It is forbidden to overlap devices. Devices in peril of overlapping will have yellow colour.

Table 1. Messages and their triggering events

All these messages can be re-shown by choosing the option Help from the Help menu. Note that this action will print in the console only the help messages characteristic to the current stage of the simulation.

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2.3. Programming elements

2.3.1. New devices

The HypeRSimRIP program currently includes two types of devices: routers and hosts. Programmatically, they represent instances of the same class—Device. They are differentiated just by their local variable:

```
private string type;
```

that can have the value of '`router`' or '`host`'. This was done having in mind the possibility of introducing in the application of new network-related devices such as switches, hubs, etc. Thus, the possibility of an application update that will include a new device type will not necessitate the complete rewriting of all the code, but instead it will just require some minor add-ons, after the model of the existent devices—hosts and routers.

2.3.2. The problem of selecting a connection

In the HypeRSimRIP program, it is necessary to select a connection between two devices, in order to see its properties or in order to activate/deactivate it. A connection between two devices is represented in the graphical zone by a 2 px wide line between the devices in question, which are in turn represented by discs of radiuses between 5 px and 15 px (see Figure 3).

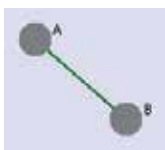

Figure 3. Connection example between the routers A and B.

Two devices (i.e. discs) cannot overlap, thus the length between two centres is at least 5 px + 5 px = 10 px (i.e. 5 px represents the minimum radius). Moreover, as it was previously seen, a selection cannot occur at less than 15 px of a device (i.e. 15 px represents the maximum device radius), in order to disallow the user the possibility of inserting overlapping devices.

In this problem, we not only know the coordinates of the device centres A and B, but also the coordinates of the selection point e.

In mathematics, to test if the point e is on the segment $[AB]$, it is first tested if A,e,B are collinear and if so, the second test verifies if e is between the segment end points.

In informatics, the problem that appears is that the plane (graphical zone) is discrete (it only has a finite set of points), the size of one point being of 1 px. Thus, it is almost impossible to select a point exactly on the $[AB]$ segment. To correct this problem, instead of verifying if the point e is on the segment, it must be checked if the point is near the segment, at maximum 5 px distance from the segment, which is 'somewhere' between points A and B and at least 20

px distance from these two points (5 px, because a selection inside the disc—the minimum length being 5 px—would represent the selection of the device and not of the connection, and another 15 px to compensate with the unselectable area around the device, as previously mentioned). By being 'somewhere' between points A and B, it is understood that the angles $\sphericalangle eAB$ and $\sphericalangle eBA$ must be acute angles (see Figure 4).

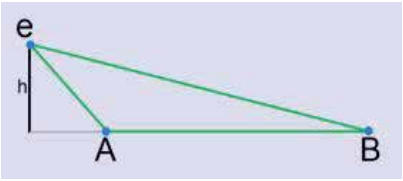

Figure 4. If $\sphericalangle eAB$ is obtuse, then clearly the selection was outside of the [AB] segment.

It can be easily proved that $\sphericalangle$AeB must be obtuse, by using the cosine theorem and the restrictions given by the problem. In a similar fashion, it can be proved that $\sphericalangle$AeB is obtuse, if and only if

$$AB^2 > Ae^2 + eB^2 \tag{1}$$

In order to calculate the distance h between e and the segment $[AB]$, by only knowing the coordinates of the A,e,B points, with simple surface formulae, it can be obtained that

$$h = \frac{\left| \begin{vmatrix} A.X & A.Y & 1 \\ B.X & B.Y & 1 \\ e.X & e.Y & 1 \end{vmatrix} \right|}{AB} \tag{2}$$

which gives the following evaluation statement:

```
Math.Abs(surface(e, A, B)) <= PointDistance(A, B)*5
```
(3)

where the surface method is defined by the Sarrus formula for the calculation of 3 × 3 determinants. Note that the division from the formula was not done in the code because when working with int-type variables (integer numbers), there are some precision issues in the event of division with remainder.

Thus, we obtain the following selection management algorithm:

http://dx.doi.org/10.5772/65415

Step 1. If the selection was made inside the disc of a device, the device will be selected.

Step 2. Else, if the selection was made at maximum 15 px around a device, the selection process will be cancelled.

Step 3. Else, if conditions (1) and (3) are satisfied, then it is considered that the connection between devices A and B was selected.

2.3.3. Device buffers, temporal acceleration and multi-threading

Each device has a series of buffers, which, during one second of the simulator, receive data packages coming from the directly connected devices. These data packages are processed at the end of the said second. These buffers, although existent even in real devices, have had their processing time increased from possibly several milliseconds to one full second, in order to allow a more clear observation of the changes that occur in the routing tables. As a consequence, although in reality, the routing tables of the routers of a mediocre size network reach converge in several milliseconds, here the convergence is slower. This duration can be modified quite quickly because all this temporal discussion really depends just on the interpretation of the trigger duration of an internal time counter. In the HypeRSimRIP program, it has already implemented a facility of time acceleration so that a second in reality can mean that only one second in the simulator has passed (the convergence being slow) or can be up to 30 sec in the simulator. This limit can be increased even higher, but keeping in mind the fact that we can simulate multiple accelerated devices on a single computer, the ratio 1:30 is to be considered as already large enough.

In terms of programming, these buffers are a series of list of objects that have a clear creation timestamp. These objects can be of the following types:

- RIPv1 Responses – instances of the class `ResponseV1`;
- RIPv2 Responses – instances of the class `ResponseV2`;
- RIP Requests – instances of the class `RequestFormat`.

At the end of each second, after the data packages transmissions, the simulator's second pass function will call the second pass function of every device, every time on another thread (hence multi-threading programming).

The second pass function of every device starts by processing every above-mentioned object, depending on their respective creation timestamp, as follows:

- If the creation time was 2 sec prior to the current time, then the object will be eliminated without processing, due to the fact that it is considered that the package was not processed on time and was therefore lost. This exception, following hundreds of simulations, has failed in occurring, but for safety reasons, it is still considered as a possibility.
- If the creation time was one second prior, then the object will be processed and afterwards, it will be eliminated from the buffer.
- If the creation time is the current time, then the object will be ignored, therefore it will be processed in the upcoming second.

- If the creation time is from a future point than the current time, the object will be ignored, and the user will be announced about this exception. Again, similar to the first exception, it has failed to occur yet.

Because each device processes its buffers on another thread, the main program will not wait for it to finish processing, as well all the other devices will not wait for each other. Thus, the execution order is non-deterministic, as in real life.

For didactical purposes, for a clearer observation of the simulation, the multi-threading facility can be disabled from the Settings windows of the program (see Figure 5).

2.4. Experimental facilities

The HypeRSimRIP program has a series of experimental facilities that allow modifications of some standard parameters of the RIP protocol. These include

- The possibility to change the value of infinity.
- The possibility to change the randomization interval of the automatic updates trigger period.

These changes can be done during the network design stage from the Settings window (see Figure 5).

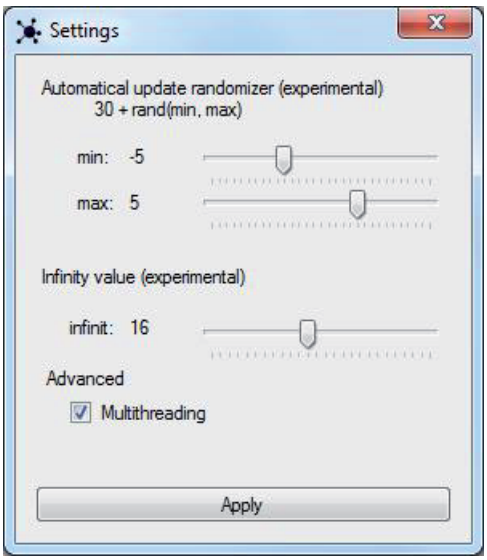

Figure 5. Settings window—Default-Start values.

For the infinite value change facility, the most suggestive examples are those with chain-linked routers. By default, the application comes with two such predefined examples: one with 20 chain-linked routers and another with 30 chain-linked routers.

For the facility in which you can change the randomization interval of the automatic updates trigger, the user can repeat rather interesting experiments, such as the one done by Floyd and Jacobson [17], which was the one that initially highlighted the need of a stochastic period. For this facility, an optimal experiment consists in the predefined network topology of 10 routers that generate a full graph. These experiments will be presented in detail in Section 3 of this paper.

2.5. Route highlight facility

The route highlight facility, characteristic to the HypeRSimRIP program, represents a highly useful tool int for the analysis of routing information. Its didactic scope is unmatched.

2.5.1. Usage

Once a network topology was designed in the program (see Figure 6), the IPv4 addresses were assigned (see Table 2) and the devices were activated (see Figure 7), all the devices start to transmit RIP datagrams and thus start to complete their individual routing tables.

Properties router 1st floor (00:00:00)
Name: 1st floor
Device type: router
Availability: offline
Local network
IPv4 network address: 192.168.0.64/28
IPv4 gateway address: 192.168.0.65/28
IPv4 broadcast address: 192.168.0.79/28
MAC gateway address: 70:11:16:91:AA:D9
Broadcast domain (BD) identifier: 5 external networks
External network towards central router
IPv4 network address: 192.168.0.80/28
IPv4 broadcast address: 192.168.0.95/28
IPv4 interface address: 192.168.0.82/28
Broadcast domain (BD) identifier: 6
RIP version: 2 broadcast

Table 2. Assigned parameters example—file automatically generated by the application

By selecting two online devices, the program will start to determine the route between them by using the routing data generated by each device at that given moment (see Figure 8). Note the fact that the utilized highlight algorithm is progressive, thus the topology or the routing information have time to change during the route tracing (see Figure 9).

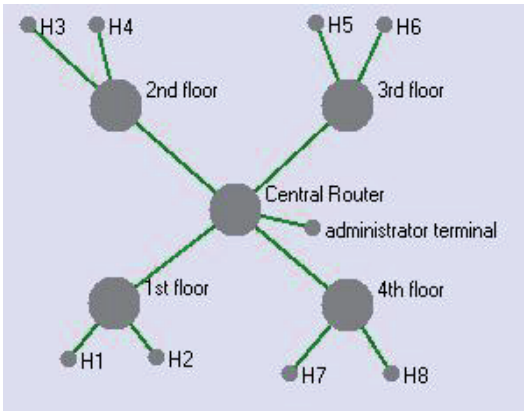

Figure 6. Network topology example.

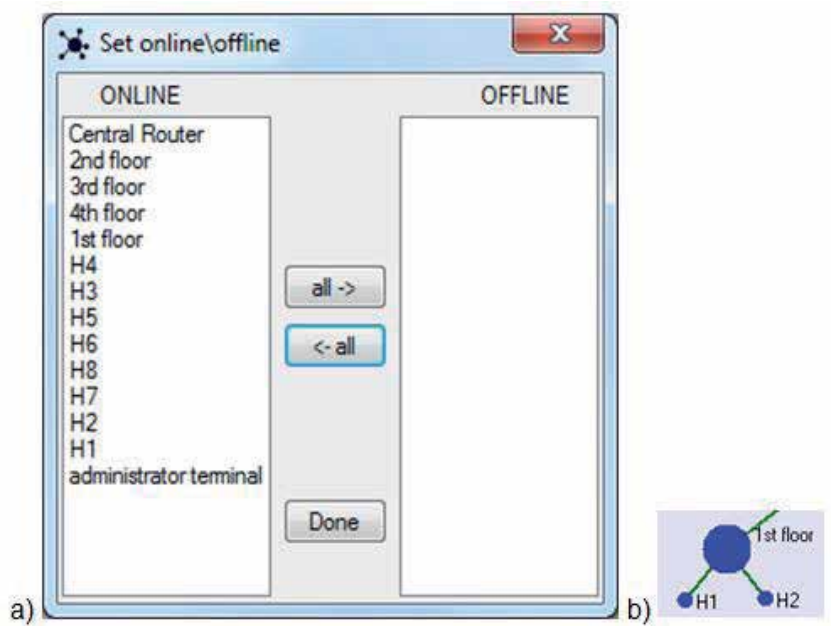

Figure 7. (a) Window that allows rapid multiple device activation/deactivation. (b) Online devices.

2.5.2. Programming

The programming of this tool relies on two main elements:

- The function

```
pinging(Device d1, Device d2): void
```

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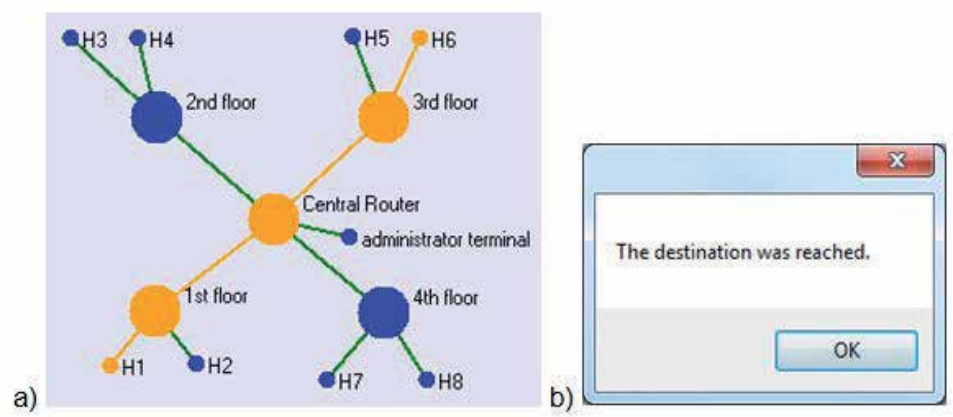

Figure 8. (a) The route from H1 to H6 is highlighted. (b) Destination reached alert message.

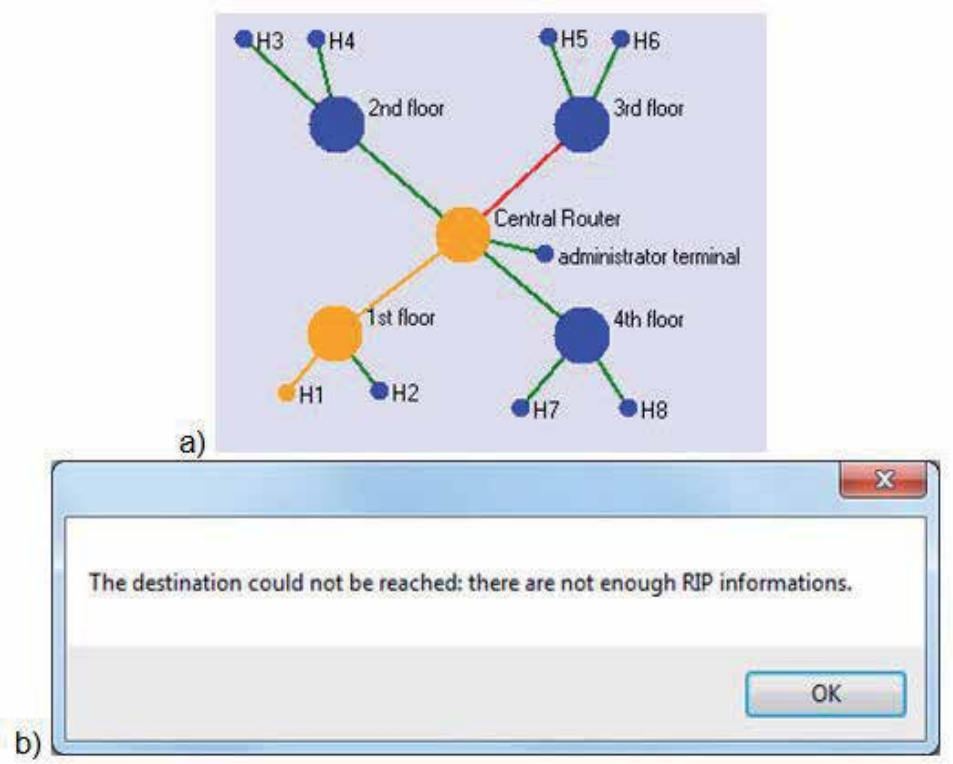

Figure 9. (a) In the event of the deactivation of the connection between the central router and the third floor, the route from H1 to H6 got blocked at the central router. (b) The message given by the program for this situation.

- The timer

```
timer_ping
```

The function `pinging` is called, once the program detects the selection of two devices (indifferent of the types: host-host, host-router, router-host or router-router). `d1` represents the first selected device and `d2` the latter, the order being of upmost importance because the transmission is unidirectional.

In the algorithm, two global variables `current_ping` and `end_ping` are initialized with the devices `d1` and `d2,` respectively. They represent the device in which the ping transmission has currently arrived and respectively the final destination of the ping transmission.

Furthermore, verification is in need to check if the sender is online; this is done in order to avoid having an offline device that is sending pings. If the result is positive, `current_ping` is highlighted and the `timer_ping` counter is started.

This functionality, as observed, has a distinct time counter, separated than that of the simulation time counter, in order to further simulate reality; in real life, there is not any dependence correlation between the two temporal measurements (the ping datagrams are different than the RIP datagrams). Didactically, the analysis of some well-defined situations, in which, for example, the update timers are frozen, is thus possible.

The `timer_ping` chronometer is set to 500 ms and after the `timer_ping.Start();` command the `'tick'` function

```
timer_ping_Tick(object sender, EventArgs e):void
```

will be periodically activated (every 500 ms).

At the beginning of this event management function, because of the complexity of the calculations, the timer is stopped and it will be restarted for the next step, after a new part of the route is highlighted.

The general form of a route is H-R-R-R-...-R-H, H-R-R-R-R-...-R, -R-R-R-...-R-H or R-R-R-...-R, where H means host and R means router. Thus, the following algorithm is:

Step 1. If `current_ping` is offline, then **STOP** – the device must have encountered a failure (i.e. went offline) during the tracing process.

Step 2. If `current_ping` is a host, then the existence of a connection between the current host and a router is checked. If the answer is negative, then the host must be isolated **STOP**. If the found connection is deactivated **STOP**. Otherwise, the found connection with its router is highlighted. If this router is in fact `end_ping`, the destination must have been thus reached, otherwise `timer_ping` is restarted.

The meaning of this step is that in order to discover another device, a host must first contact directly its connected router.

Step 3. In this moment of the algorithm, `current_ping` must be a router, but there still is a need to discover the nature of `end_ping` (host or router). If `end_ping` is a host, a local variable `ender_ping` is initialized with its directly connected router. If there is no such thing, then the final receiver is an isolated host **STOP**. If `end_ping` is a router, then `ender_ping` will be initialized with `end_ping` as a value.

http://dx.doi.org/10.5772/65415

This step has the following explication: the current router, by having the destination IP address, can calculate the IP address of the destination network, by doing so, it can calculate the transmission route via the routing table (as it will be seen in the next step).

Also, if `end_ping` was a host, it is important to check if `current_ping` is equal to `ender_ping`, which would mean that the destination is actually a host of the current router. In this eventuality, it remains to be verified if the host exists, if the connection is active and if the host is online, in which case the package is forwarded (i.e. the route and the host are highlighted and the user is announced that the destination was reached).

Step 4. At this point, only the route from `current_ping` to `ender_ping` needs to be determined. This route has the following general form: R-R-R-...-R, so the routing tables can finally be used. `current_ping` will search in his routing table the network IP address (calculated based upon the destination IP address) of `ender_ping`. If there is no such entry **STOP**. If it exists, from the entry, the transmission connection can be determined. If this connection is inactive **STOP**. Otherwise, the connection is highlighted. If the next hop (the next router) is offline **STOP**. Otherwise, the next hop is highlighted. `current_ping` is re-initialized with this next router and it will be verified if the destination was reached. If it was reached, the application will notify the user, and if not `timer_ping` is restarted.

3. Experimental results

3.1. Updates synchronization—classical experiment

Floyd Sally and Van Jacobson have made an experiment [17] in which they proved that without a randomization of the duration of the update counter, all the devices tended to synchronize their update periods, thus periodically overloading the network.

With the same goal, we can re-validate their experiment much faster, by using the HypeR-SimRIP application. Even though the concept of the application requires by default the randomization of the 30 sec update period with a random value between −5 and 5, the application allows the user to modify these limits.

In the HypeRSimRIP application, in order to deactivate the above-mentioned randomization, the user must set equal values for minimum and maximum randomization limits (preferably both values should be zero) in the Settings window (see Figure 10) before starting the simulation.

For the experiment, consider 10 routers, in the configuration given by Figure 11, with a full graph generated between them (connections between every router), generated by using the 'Full Graph Generation' options from the 'Diverse' menu of the application (see Figure 12).

After assigning the IPv4 addresses, all the routers are activated via the 'Set Online/Offline' window (Figure 7).

Commencing the simulation, devices start transmitting RIP datagrams and the application will start to show the network usage (see Figure 13). Periodically, huge network usage explosions

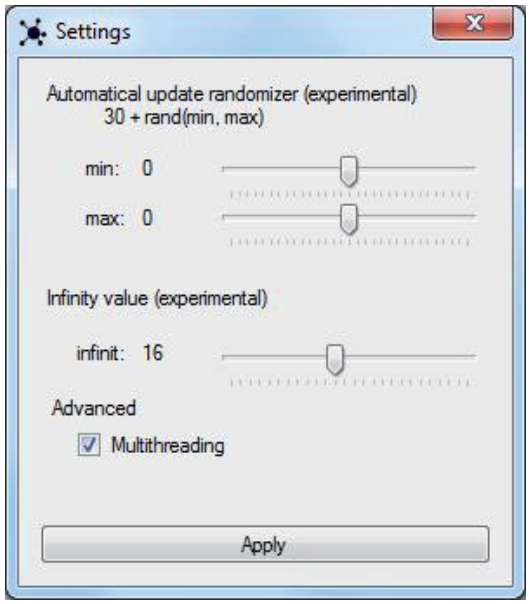

Figure 10. Settings window—randomization deactivation.

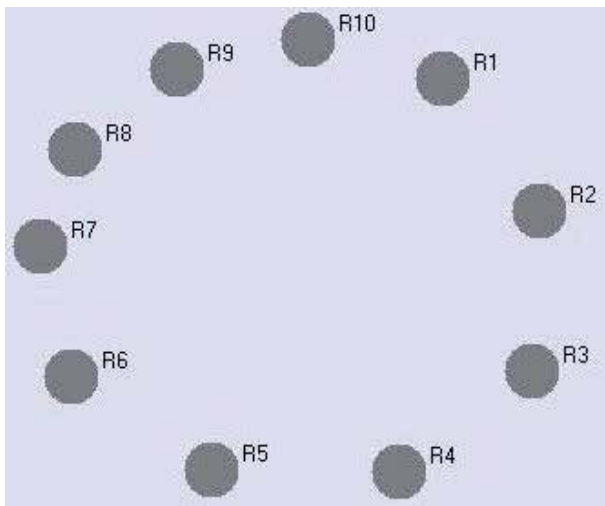

Figure 11. Ten router topology.

are observed: at first 484.496 bps, then periodically (every 30 sec) 171.360 bps. By using the temporal acceleration facility, it can be observed that this tendency will remain throughout the simulation of this experiment.

By repeating the experiment, with the randomization margin between −5 and 5, the network usage from Figure 14 was obtained.

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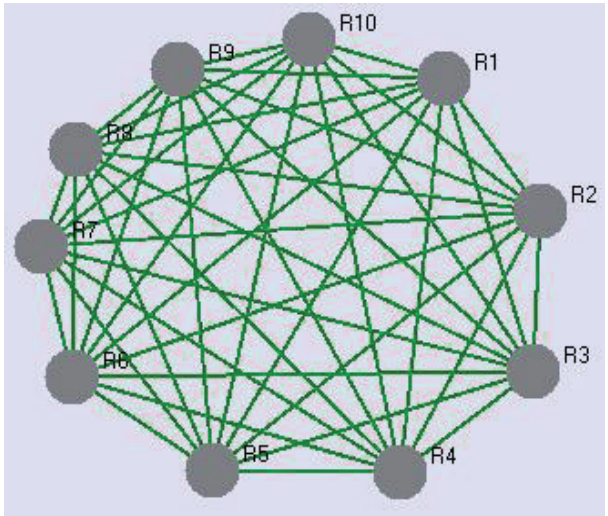

Figure 12. Topology determined by a full graph between 10 routers.

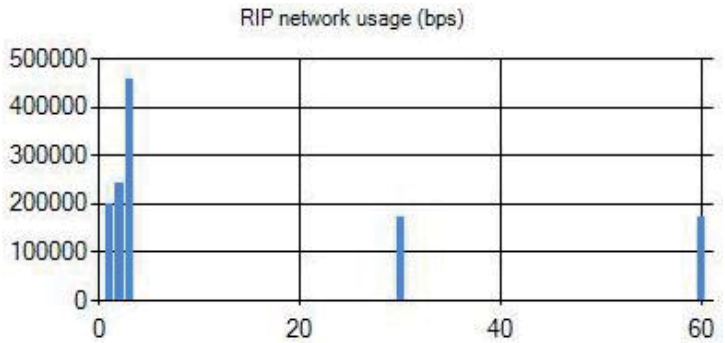

Figure 13. RIP network usage without randomization (first minute).

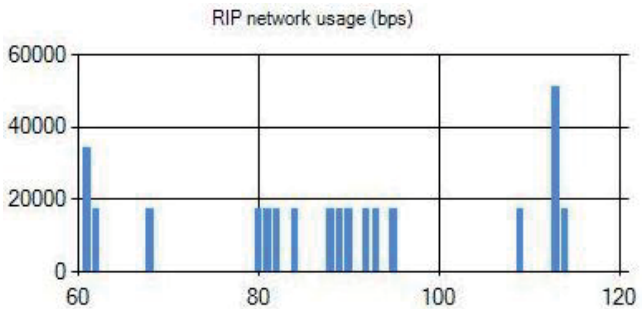

Figure 14. RIP network usage with randomization (second minute).

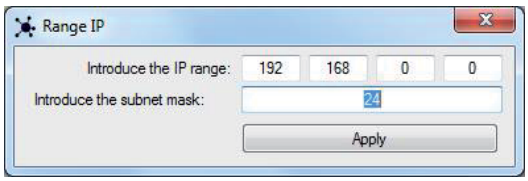

Figure 15. IP range window.

Most of the values during the update periods remained at 17.136 bps (10 times less than the minimum usage boom from the without randomization simulation), and in just a few exceptions, the network usage reached 51.408 bps (still half the minimum usage boom from the previous simulation).

In conclusion, because the transmissions are distributed, the network is not anymore disrupted significantly by the RIP datagrams, thus avoiding a possible network overload.

3.2. RIPv1-RIPv2 compatibility—practical example

Devices that implement RIP version 2 can either broadcast datagrams or multi-cast them. In the broadcast situation, devices that implement RIP version 1 can intercept transmitted messages and even respond to them, but because they were not configured to intercept multi-cast messages, they will not interact with multi-cast transmitted datagrams [14].

In order to utilize and highlight the above information, the following hypothetical situation will be presented and analysed using the HypeRSimRIP application:

A medium-sized company decides to hire a network administrator to create and ensure the maintenance of a network system inside their building. Assuming that the building has four floors and that on each floor there are two terminals (computers-hosts).

To ensure a good connectivity, the administrator will design a star-type topology (see Figure 6); on each floor, he will install a router, to which the respective two terminals will connect, and the four routers will inter-connect through a fifth router, which will provide the external network (e.g. Internet) connection. Obviously, to ensure full control of the corporate network, the administration terminal will be connected to this central router.

Thus, having designed the network, the administrator will continue by assigning the IP addresses provided by the Internet Service Provider (ISP), based on the sub-net mask and the requirements of the physical topology—suppose that the address is 192.168.0.0 with the standard mask /24 (255.255.255.0) (see Figure 15).

According to the VLSM technique of the HypeRSimRIP application, the administrator can now configure all routers with their corresponding parameters (static IPv4 addressing, for better security) (see Table 2). Finally, the network becomes operational (see Figure 16).

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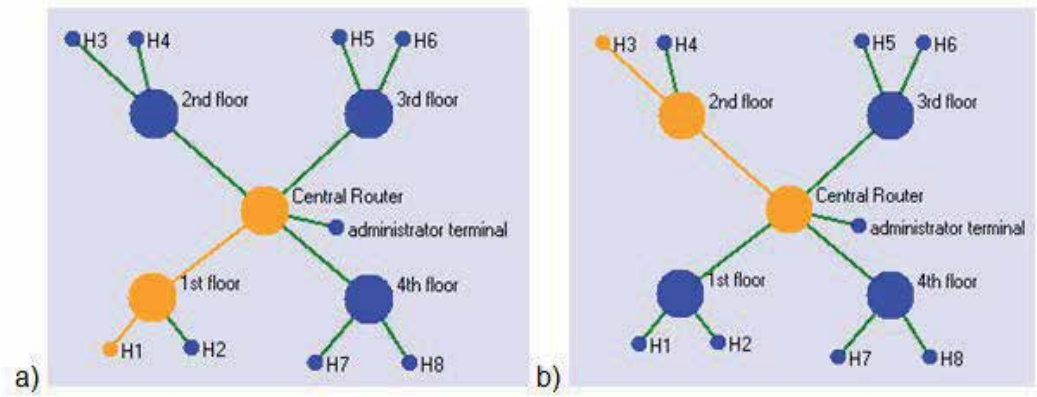

Figure 17. Highlighted routes: (a) from H1 to the central router and (b) from H3 to the central router.

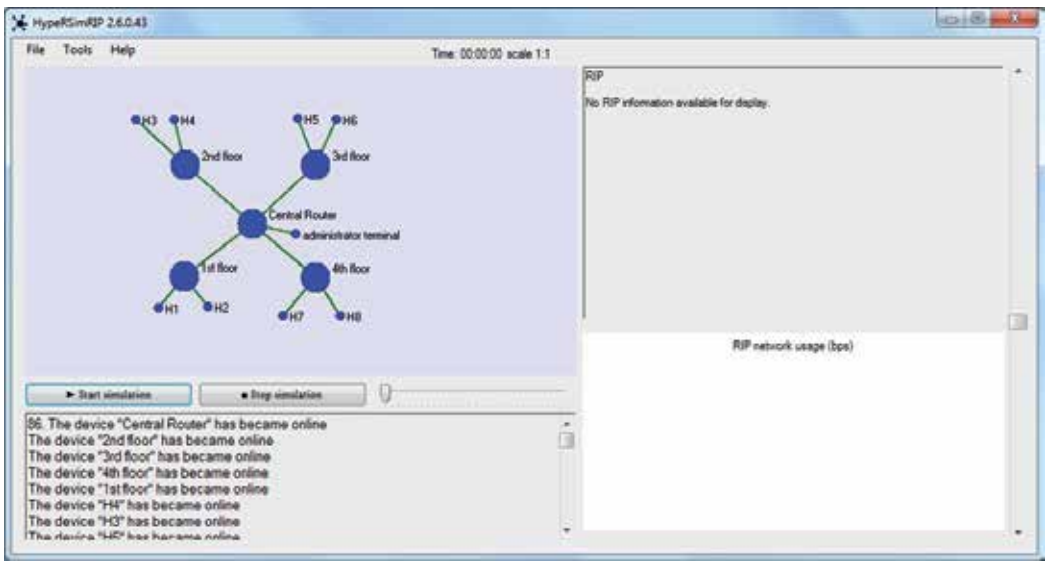

Figure 16. Online network.

Now, the administrator's design choice becomes obvious; any malicious information, any informatics attack that comes from the exterior, from the supernet, will be first intercepted by the administrator and dealt with. By using the route highlight facility of the program, the above-mentioned can be proven (see Figure 17).

By looking at Figure 18, it can be observed that any data package transmitted between two different floors will be routed through the central router. Thus, the administrator will have direct access to all the data transmitted inside the building. Such a perspective may have undesired consequences, such as the creation of direct routes between directly connected floors (to bypass the central router), which are undesired by the administration (see Figure 19).

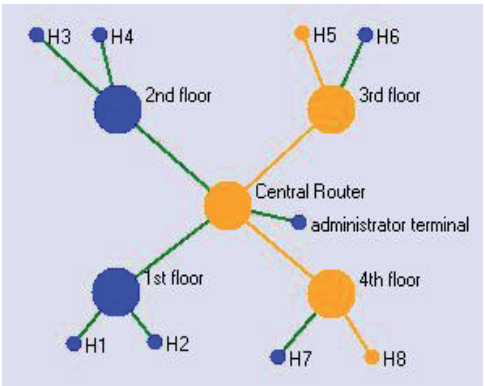

Figure 18. The route from H8 to H5 passes through the central router.

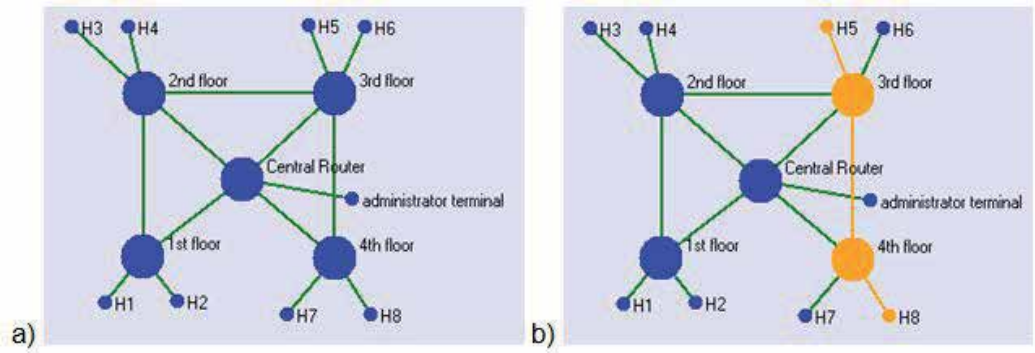

Figure 19. (a) The network topology after the undesired changes. (b) The route from H8 to H5 now bypasses the central router.

This problem can be immediately repaired without major efforts: the administrator can set the central router to use RIPv2 broadcast version (for backwards compatibility), and the four floor routers to alternate between RIPv1 and RIPv2 multi-cast: the routers on an odd floor to RIPv1 and the routers on even floors to utilize RIPv2 multi-cast.

In the HypeRSimRIP application, this can be done by using the 'RIP version switch' window (Figure 20), accessible from the context menu of every device. Once all the new settings have been introduced, it can be observed (Figure 21) that even though the illegal routes are still active, they have been avoided.

This example has thus presented a practical use of two Internal Gateway Protocols (IGPs) inside the same network and the interaction between the three RIP switches. Moreover, the following statement: 'A network system with multiple incompatible IGPs can have a full routing table, if and only if the transitioning entities can translate the routing information' [16] has been proven true, and also been given an example: here the transitioning entity is the central router.

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Figure 20. The RIP version switch window.

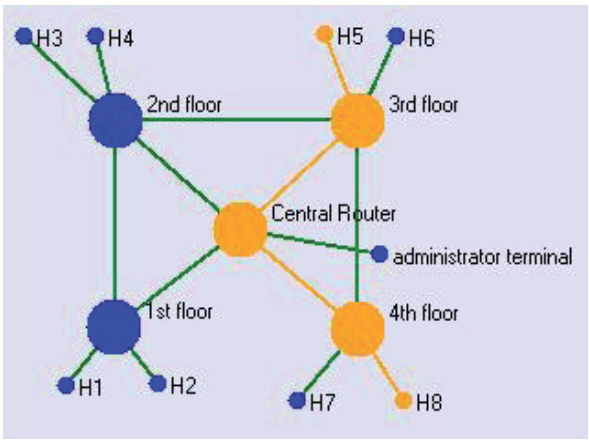

Figure 21. The route from H8 to H5 detours through the central router.

3.3. 'Changing infinity'—didactical experiment

Because the metric chosen for implementation by the RIP protocol is the hop count metric, and because for representing infinity, the value chosen is 16, the following drawback appears: If there exists a route longer than 15 hops, the protocol will not consider it (RIP uses the numeric value of 16 to mark unreachable devices) [13].

In this next experiment, a network system with routes of length 16 or bigger will be implemented, with the goal of highlighting the drawback. Assume a network system composed of 20 chain-linked routers as shown in Figure 22.

Starting the simulation, the network will converge after 18 sec. To illustrate the drawback, in Table 3, the routing table of the R1 router is presented.

The absence of connections with routers R17, R18, R19 and R20 can be observed. This takes place because they are situated at the distances of 16, 17, 18 and 19 hops, respectively, from R1.

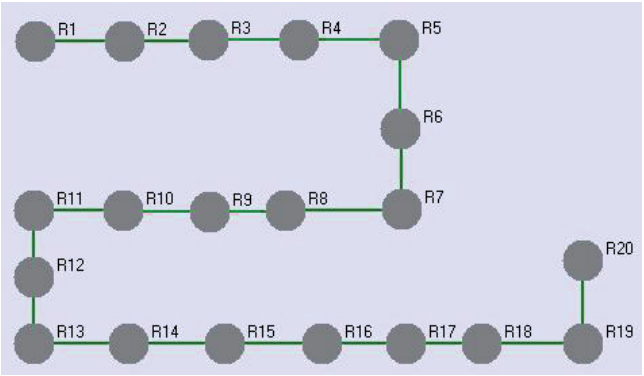

Figure 22. Network topology example in which the routing tables will be incomplete.

RIP Table - R1: 192.168.0.0/30 (Update in 6 sec.)
-> Connection with R2 via R2 at distance 1 (timeout:174)
-> Connection with R3 via R2 at distance 2 (timeout:174)
-> Connection with R4 via R2 at distance 3 (timeout:174)
-> Connection with R5 via R2 at distance 4 (timeout:174)
-> Connection with R6 via R2 at distance 5 (timeout:174)
-> Connection with R7 via R2 at distance 6 (timeout:174)
-> Connection with R8 via R2 at distance 7 (timeout:174)
-> Connection with R9 via R2 at distance 8 (timeout:174)
-> Connection with R10 via R2 at distance 9 (timeout:174)
-> Connection with R11 via R2 at distance 10 (timeout:174)
-> Connection with R12 via R2 at distance 11 (timeout:174)
-> Connection with R13 via R2 at distance 12 (timeout:174)
-> Connection with R14 via R2 at distance 13 (timeout:174)
-> Connection with R15 via R2 at distance 14 (timeout:174)
-> Connection with R16 via R2 at distance 15 (timeout:174)

Table 3. R1's routing table, after the convergence of the network—table automatically generated by the application

Although the initial traffic generated peaked at 117600 bps, it will stabilize at around 14016 bps in the absence of network topology changes and in the absence of some eventual (although improbable) synchronizations of automatic RIP updates (see Figure 23).

An interesting fact about this example is the initial form of the network usage chart—for the situation in which all routers have become simultaneously online. The reason for which the

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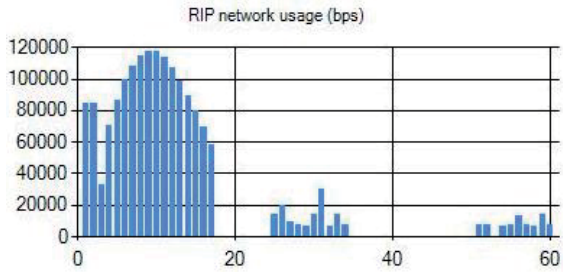

Figure 23. RIP network usage (first minute).

chart resembles a Gaussian bell can be explained mathematically: every router discovers one by one a new entity and thus forces RIP updates towards both its neighbours: Ri discovers Ri −1 and Ri+1, thus both Ri−1 and Ri+1 discover new routes so they each launch another two messages to their neighbours, and so on. An exponential ramification tendency is thus observed, but as soon as R1 and R20 are reached, they each send only one update, which will be ignored, because R2 and R19 were the gateways of all routes of R1 and R20, respectively, and so, because of the reverse poisoning [13], every route in the update will have a metric of 16. This transition from sending two messages simultaneously to only 1 creates a flattening effect on the chart—the chart had initially an exponential growth, and finally a quasi-linear drop.

The HypeRSimRIP application allows, for experimental purposes, to change infinity's numerical value. If, for example, it changed from 16 to 20, then all the routers could communicate between each other (Figure 24), but if it decreased to 5, a drastic decrease in the sizes of the routing tables can be observed (Table 4).

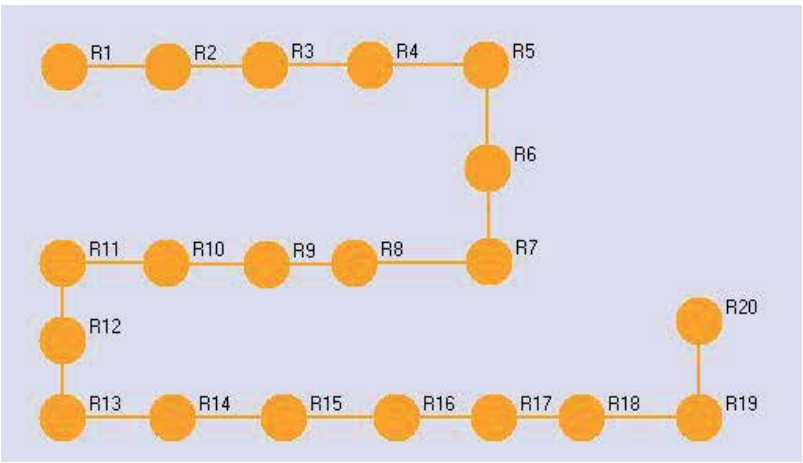

Figure 24. The route from R1 to R20 (infinity is represented through 20).

RIP Table - R1: 192.168.0.0/30 (update in 21 sec)
-> Connection with R2 via R2 at distance 1 (timeout:179)
-> Connection with R3 via R2 at distance 2 (timeout:179)
-> Connection with R4 via R2 at distance 3 (timeout:179)
-> Connection with R5 via R2 at distance 4 (timeout:179)
RIP Table - R2: 192.168.0.4/30 (update in 25 sec)
-> Connection with R1 via R1 at distance 1 (timeout:179)
-> Connection with R3 via R3 at distance 1 (timeout:179)
-> Connection with R4 via R3 at distance 2 (timeout:179)
-> Connection with R5 via R3 at distance 3 (timeout:179)
-> Connection with R6 via R3 at distance 4 (timeout:179)

Table 4. The routing tables of R1 and R2, after the convergence of the network (infinity is represented through 5)

4. Conclusions

The core of this article is represented by the development of the HypeRSimRIP application. HypeRSimRIP is a type 2 network hypervisor that allows the user to construct and manage an IP network in real time. It provides functional capabilities such as IPv4 addressing through sub-netting and VLSM, configuration of RIPv1 and RIPv2 protocols, connectivity test, etc. Moreover, the application implements several original educational facilities, useful for teaching network-related concepts: infinity value change, route highlighting. It is intended to also include in the application IPv6 addressing and a RIPng [16] implementation. Some of the personal contributions brought in this program are generation and display of IP datagrams, RIP datagrams, routing tables, charts of the network usage, ping and tracert-type commands, multi-threading (for a more realistic simulation), temporal acceleration, etc. Noteworthy are also the applications' experimental facilities, which allow the user to quickly recreate famous experiments such as the Floyd-Jacobson experiment [17].

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Chapter 5

Social Informatics and the Dynamic of Contemporary Society

Ionuț-Constantin Manole and Eugen Petac

Additional information is available at the end of the chapter

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Abstract

As the main engine of social development, education must adapt its new technological advancements to the benefit of the citizens and their needs by taking into account the building of a modern society that is based on knowledge. Computer technology becomes the most appropriate technical support, given the new challenges of the knowledge society. Within this context, the social informatics takes on new dimensions. Nowadays, information security is strongly connected to the investigation area of social informatics. Knowledge society and social informatics are being addressed in the paper in the first two parts. Information security in the contemporary society, within the context of building the knowledge society, is addressed in part three. In the fourth part, we propose the creation of an educational framework for the safe use of online virtual environment. Its purpose is primarily the awareness of the importance of security systems, taking into consideration the new challenges of social informatics in the modern society.

Keywords: Social informatics, knowledge society, information and communications technologies, information security

1. Introduction

Knowledge society is a strategic term, such as *post-modern society*, *post-industrial society*, *experience society*, *consumer society*, *risk society*, *media society* or the *information society*, and similar terms; they tend to focus attention on certain aspects. Issues such as knowledge and education are particularly highlighted by the term knowledge society [1].

Knowledge society is identified as a society based on the creation, dissemination and use of information and knowledge [1]. It is a society with an economy in which knowledge is acquired, created, disseminated and applied to strengthen economic and social development.

What we call the information society in the last decades is marked by increased globalization process, both economically as well as geopolitically. The new economy is promoting a new characteristic attribute, knowledge, empowering them to be integrated into the knowledge society.

Information society emphasizes the amount of information available and accessible. It focuses on technology. Knowledge-based societies are identified as societies that use and apply information in various areas of learning and development.

Manuel Castells [2] argues that 'dominant functions and processes in the information age are increasingly organized around the concept of networking'. According to Castells [3], 'information society is the new mode of human existence, in which the production, recording, processing and retrieval of information in organized networks play a central role'.

Reflected by the thesis: 'Knowledge is information with meaning, and information that acts,' the two characteristics of knowledge, Drăgănescu concludes 'Therefore knowledge society is possible only grafted on information society and cannot be separated from it' [4]. The information society provides knowledge to a higher level. The main features of the knowledge society are emphasized. The truth about existence is discovered through scientific knowledge that is extended and deepened through the society. Existing knowledge must be managed as technological and organizational knowledge. Innovation brings new technological knowledge. The new means, Internet, e-book and using the electronic methods of learning (e-learning), facilitates unprecedented spread of knowledge to everyone on the planet. Referring to the developmental effects of educational paradigm, the author points out that among the operating directions of the knowledge society it is necessary that the education system is based on the knowledge and information society methods (e-learning).

The term informatics is broadly defined as an area covering artificial intelligence, cognitive science, computer science, information science (processing, management and retrieval of information), social sciences and information technology (research, design, development, implementation, support or management of computer-based systems) [5].

Developed after a serious effort to review the specific indicators and of careful reflecting realities of contemporary society, Report to UNESCO [6] of an international commission on education in the twenty-first century, led by Jacques Delors, addressing sore topics joint to educational systems in modern society, seen through the need to adapt to the society of tomorrow. We present below the most relevant topics addressed for our paper:

- Education: a required utopia (a look to the future, tensions that must be overcome, design and build of our common future, lifelong learning—the engine of the society, stages and education connections proper assimilation of reform strategies, expanding international cooperation in the global village).
- Perspectives: from the local community towards a global society, from social cohesion to democratic participation, from economic growth to human development.

This shows that education, the society engine, must adapt the new technological advancements to the citizens and their needs.

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2. Social informatics—A broad definition

Social informatics is an area of research that examines social aspects of computerization. A more formal definition would be 'inter-disciplinary study of the design, use and consequences of information technology in interdependence with institutional and cultural environments' [7]. According to Kling, social informatics is a field that is defined by its content (and fundamental questions on it) rather than by a set of techniques and methods very similar to urban studies or gerontology. Social informatics is a research object with systematic, analytical and critical character, helping to 'develop theories that are relevant to the design, development and operation of information systems, including intranets, electronic forums, virtual libraries and electronic publications' [7].

Grabbing the spotlight is the concept of 'computer information systems as socio-technical systems' [7]. Kling's idea to achieve 'missing link' between human environment and the given attribute of simple tools given to the information technologies, can be considered beneficial to the online environment today.

Complex, interdependent, social and technical systems include the following:

- People in different roles and relationships between each other and with other system elements
- Hardware (computers, workstations, peripherals, telecommunication equipment)
- Software (operating systems, utilities and applications)
- Technical (scientific management models, schemes of voting)
- Support resources (training/support/help)
- IT structures (content, those content providers, rules and regulations, such as those that authorize people to use systems and information in specific ways, access control)

'These are not simply a static list, but are interconnected within a matrix of social and technical dependencies' [7]. So, it has been made the connection between the components of the system. Today, we can see the effects of this mind set adopted by many designers of computer systems, namely, proximity to the human element and its folding needs, along with a security structure of the combined system.

Although there are minor variations that are shown between the different definitions, but most experts agreed that social informatics is an inter-disciplinary field of study and research, diverse, comprehensive and highly dynamic regarding the changes caused by information technology and communications in social life. Another landmark is the harmonization of the society with and through the information and communications technology (ICT).

Social informatics area of investigation is extremely broad, including [8] the following:

- Studies and analysis on the impact of introducing information technology in society
- The importance of social context in computer networks (socio-technical networks)

- Computer-mediated communication (C.M.C.)
- Organizational changes resulting from the use of ICT (work, communication, structures, power relations)
- The relationship between technology and social change
- ICT and changes in education (distance learning, e-learning, etc.)
- Privacy and social control through ICT
- Project management with ICT support
- The impact on privacy and individual development
- Dynamics and trajectory ICT—policies and guidelines
- Public access to the Internet, etc.

Research information systems have the ability to draw attention to developing new technologies. Benamati [9] said that 'changing technologies obliges our discipline to change more quickly than others'. Web 2.0 phenomenon has captured the attention of industry technology and informatics, media and other professions and disciplines.

The Internet is in the fifth stage of its development. First stage, starting from its appearance in the 1960s until the late 1980s, ARPANET [10] has been a well-kept secret, used by government scientists and researchers. The second phase, between 1987 and 1992, has made open the Internet to the public. In the third stage, 1992–1996, began with the realization of the HTTP [11] protocol, on which was created the World Wide Web (WWW) [12] and search engines. The global network has become an information service accessible from 1991 and, as described by Berners-Lee [13] (1991), 'the WWW project combines techniques of finding information and hypertext to create an easy to use global information system, but powerful at the same time'.

In the fourth stage of development, the Internet becomes a place where people are organizing communities that collaborate, cooperate and sometimes compete. Some favourite digital tools and services at this stage include social networking sites, collaborative writing tools, network services, file exchange between customers/users (peer-to-peer) and more. O'Reilly and Daugherty describe this stage in the evolution of the network as a 'Web 2.0', O'Reilly [14], a term introduced and officially registered in 2004. O'Reilly offered a clearer definition of the term thereof as the (2006) [15]: 'revolution in computer industry caused by the move towards using the Internet as a platform, and to understand the rules for success on that new platform. The most important of these rules is this: Build applications that use the network effects to attract more people to use them'.

In the fifth stage since 2010, it begins Web 3.0—that is sometimes used as a synonym for Semantic Web, representing a 'web of data' that enables computers to understand the meaning of information on the WWW that means total dynamic web pages by including vector graphics and the introduction of 'Semantic Web' [16] as a tool of computing systems to observe information in texts and generate new information based on them.

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Regarding the Web 3.0,[1] we can say that enhances existing network resources on the Internet that can be read by users. This is done by adding extensions, called metadata, to existing documents, allowing data to be processed automatically by computers through the concept of similarity.

3. Information security in contemporary society

The introduction of computers in almost every dimension of the society has changed the way people and organizations obtain or use information, or doing business: greater efficiency is achieved, control of operations is increased and there is better access to information. Along with many benefits, computers and connecting them to the network presents negative aspects, such as the emergence of new types of offenses (distribution of computer virus), and the possibility of committing traditional crimes through new technologies (such as fraud or forgery).

With the spread of technology, more powerful and available at increasingly smaller prices, and massive expansion of inter-connectivity, offered to the potential attackers the possibility to create quick attacks without geographical barriers, often with serious consequences for the victims and with little chance of detection or incrimination. Because electronic attacks against information systems can make a lot of negative consequences of financial, operational, legal or strategic type—at the individual level, organization or national, the risks for electronic attacks must be well understood to be reduced or even eliminated.

Cybercrime is a real phenomenon these days, which is frequently reflected in the media. Fear of informatics attacks exceeds on intensity then that of ordinary theft or fraud. Criminological research on crimes carried out through computer systems aim to change the classic way that are seen as offenses in the criminal justice systems.

In the PhD study 'The legal aspects of cybercrime in the information society' (study COMCRIM) [17] realized for the European Commission by Ulrich Sieber, from the University of Wurzburg, Germany, the following categories and sub-categories of computer crimes are shown:

- Violations of privacy
- Economic offenses:
  - Penetration of computer systems in order to overcome technical security difficulties ('hacking')
  - Cyber espionage

1 The term is conceptually formulated for the first time in 2006 by Tim Berners-Lee, creator of the World Wide Web and director of the World Wide Web Consortium: 'People ask me what is Web 3.0. I think if you add vector graphics, and all content being dynamic, interactive and attractive, over Web 2.0, and also provide access to semantic web over an enormous data space, you get access to an incredible data resource'[18]. Also, he defines the Semantic Web as 'a component of Web 3.0, a data network that can be processed directly and indirectly by computers'[18].

- Piracy of computer programs
- Computer sabotage
- Computer fraud
- Distribution of pieces of information that is illegal or injurious (racist propaganda, dissemination of pornographic materials, etc.)

- Other crimes:
  - Crimes against life
  - Offenses related to organized crime
  - Electronic warfare

4. Effective use of educational framework to prepare society awareness on cyber security

The educational system has to be folded on the educational needs of current and future generations regarding electronic information security and safe usage of online environment. Therefore, an educational plan should be considered that combines both what has been achieved so far in social informatics, especially the safety information, and also the requirements and needs of their future. The emergence of Internet of Things (IoT) and the Internet of Everything (IoE) must provide to the educational environment the issue of future threats analysis or problems that may occur if future generations are not aware of them. As a result, the need for such a debate and planning is more than necessary.

Category	2014	2015	2016	2020
Consumer	2277	3023	4024	13,509
Business: Cross-industry	632	815	1092	4408
Business: Vertical-specific	898	1065	1276	2880
Grand total	3807	4902	6392	20,797

Source: Gartner, Stamford, Conn., November 10, 2015; Web:http://www.gartner.com/newsroom/id/3165317).

Table 1. Internet of Things—basic devices installed by category (Millions of units)

IoT is increasingly becoming a topic of conversation, in more formal (companies, organizations) and informal (in the family setting and occasionally in everyday people's relations) contexts. It is a growing concept that has not only the potential to influence the way we live or will we live, but also the way we work.

After the broadband Internet became widely available, the connection costs are falling, many devices are created with Wi-Fi capabilities and contain built-in sensors; technology costs

http://dx.doi.org/10.5772/65416

decrease and use of smart phones has become overwhelming. All these things lead to creating a perfect setting for IoT.

To the question: 'What is the Internet of Things?' We can answer in a simple and effective way that is the concept of connecting devices, virtually any device with a 'Open' and 'Closed' switch, can connect to the Internet. This includes everything from mobile phones, washing machines, coffee makers, lamps, wearable devices and almost anything else. It also applies to machine components, for example, an engine of a car or boat or drilling equipment.

A more general definition is given by ITU [19]: 'Internet of Things (IoT) is the network of physical objects—devices, vehicles, buildings and other elements—in electronics, software, sensors and network connectivity, integrated, allowing these items to collect and exchange data'.

Analysis firm Gartner says that [20] by 2020 there will be over 26 billion connected devices. It is a large number of connections (some even estimate this number to be much higher than 100 billion). IoT is a huge network that connects 'things' (which also includes people-implanted medical devices for monitoring or survival, like pacemakers). The relationship will be between people-people, people-things and things-things.

Regarding Internet of Everything (IoE) [21], 'is a term with expanded meaning that focuses on devices and consumer products connected to the Internet and equipped with expanded digital features. It is a philosophy in which the future of technology is composed of several different types of devices and elements who are connected to the Internet worldwide. The term is somewhat synonymous with the Internet of Things (IoT)'.

The new rules for the future will be, 'anything that can be connected will be connected'. It is not difficult to see how and why it is such an important topic today; certainly it opens the door to a lot of opportunities but also to more challenges. Security is a big problem, which is often brought to the fore. With billions of devices connected together, what can people do to ensure that their information will be safe? Will anyone be able to enter the device and thus get access to the whole network? Also, IoT opens worldwide companies to more security threats. Then there is the issue of privacy and personal data sharing. This is a sensitive topic even today, so one can only imagine how that conversation will evolve and concerns when talking about many billions of connected devices. Another problem that many companies will face is on the massive amounts of data that these devices will produce. Companies will have to find a way to store, track, analyse and cope with the large volume of data that will be generated. There are numerous websites that promote online safety, but the way they are working is not interactive and productive.

Pedagogical context provides a mean through which the student is educated in the online environment and not just informed. It is necessary to use some pedagogical tools in the propagation of the elements of social informatics. It is also necessary to emphasize from the pedagogical point of view, the use of information security services. Specific teaching methods such as systematic exposing of knowledge, conversation method, questioning method and others must be in the spotlight. It must be used in a specific way of organizing individual security services lessons, and also methods for evaluating school performance results.

We propose the creation of an information system to accommodate the needs and cognitive characteristics, reported on a number of indicators (such as age, sex, concerns, needs, etc.).

The need to create an educational platform for security services lies in the connection between real and virtual environment. Security services are a key point in the future society. The making of an interactive platform to create a centralized computerized system has a role in educating students for the safe use of virtual online environment.

The platform should be of interactive portal-/cloud-like architecture, having integrated basic computer security services.

User guidance will be made depending on the area of interest: security banking application, electronic information security (online and offline, on various kinds of media), guide for Internet browsing, social security, protection of the person in the virtual environment, etc.

It will be taken into account: security policies, creating and managing passwords, user types (standard user/system administrator), security of physical connections, network vulnerability, Internet services security, firewall, handling security incidents, viruses, resources on cyber security, etc. It will be used in modern solutions to create an interactive information system between user and informational database.

The database will contain information structured on interest category. Various parameters will be taken into account to guide the platform's user in finding and assimilating required information. Specific teaching methods will allow a greater degree of efficiency of the educational platform. What should be considered when creating such a platform is the way of interaction with users; thus, current technologies offer new ways of interaction. For example, the user can create a more detailed profile, when entering the platform. Profile that should be done on the basis of questions addressed effectively. The profile can contain not only information related to general data, but can be customized, but not to be understood as custom (which could affect privacy). The application can guess what the user wants to obtain. On the basis of collected information, a security - Strengths, Weaknesses, Opportunities, Threats SWOT analysis of the user profile may be done. From the pedagogical point of view, information collection can be performed using programmed instruction and computer-assisted learning. Through this training method, the subject learns paced, the educational material is divided into small sequences of study, followed by tests, the subject and instructor (the education platform here) can observe the progress of the training immediately.

The SWOT analysis can be dynamic, thus making step-by-step improvements on the level of education in information security services, to the one who is accessing the platform. Finally, and also intermediate, the user can see his minuses, what has he learned and how is he progressing in his educational path. The information system cannot take the place of a teacher, but it can replace and improve it by offering numerous benefits, being an adjuvant to the lack of time, distance and availability of many users who would like to improve their knowledge of security information services in the knowledge society we live in nowadays.

Conversations about IoT will continue to be done all over the world, while we seek to understand the way this will impact our lives. Also, we try to understand how these many

http://dx.doi.org/10.5772/65416

opportunities and challenges will arise in the context that more and more devices start to join IoT. The Internet offers to the children great opportunities to discover, create and connect, but can also become a dangerous factor in the education and maturation of a child. For now, the best thing we can do is that the current and future generations to be educated about what is IoT and the potential impact that can be observed on the way we work and live.

5. Conclusions

The way how society is developing nowadays, by relying on knowledge, has been leading to the need for ever-faster expansion of the concept of network inter-connection, in a word: communication. This communication is created without borders of any kind, such as cultural, economic or territorial. The flow of information is becoming bigger, and the areas of interest are more and more diverse. Informatics is becoming the technical support that is the most conducive to this new challenge. But like any support, how we use this base becomes the focus of discussion.

Concluding on our study, we could say that information technology is neither good nor bad, referring to its usage. The way technology is used gives its moral coordinates. Thus, if the society will not be trained to use these emerging technologies from the development of computer networks (such as Internet banking, online communication, brought to new levels today, large data transfer, increased power expression, in different contexts and for almost any topic of debate, creating virtual personalities, etc.), it is likely to witness an unwanted event, generally speaking, the obsolescence of the online environment.

Offenses made by computer systems influences real life more powerfully nowadays. In the coming years we will face a technological assault increased from Internet of Everything, when we will see the most types of devices existing today connected into networks. The benefits will be enormous, and threats will be more than troubling.

In order to control many different devices in our common life, both personal and collective, it must pose a problem to the pedagogical context in which this has the solution: moral and preventive education in the online environment through effective teaching tools. In moral education users must be educated to use responsibly and consciously the resources of information technology and communications, and in preventive education they must be educated to know the dangers they are exposed to and take action to mitigate them. In this context we can discuss about new challenges such as artificial intelligence, virtual reality, cloud computing, network virtualization, software-defined networks (SDN), big data, intelligent vehicular ad hoc networks and information security.

The more the society gets translated into the online environment, the more everyone living in modern society may suffer. How society understands new technologies and their strength becomes a deciding factor in the future development. Kling's idea to bring into attention 'interconnected matrix of social and technical dependencies' must be developed through the pedagogical factor. Educating the general public should be made gradually and in close relation, as far as possible, with age and its particular characteristics.

Computers are using within Web 3.0, semantic understanding of the data. This is an opportunity to generate new training methods. Information security should not be introduced and presented separately to the society from the users' online experiences. It should be used as a satellite through the users' online journey. Something like a permanent assistant, who is dynamic and friendly with the participants in the web system, and also provides information on every step of online browsing. Today, it can be guessed by developing artificial intelligence, various features of the human personality. Nowadays there is an opportunity, that was only a dream a few decades ago, to automate various processes by creating a virtual model that meets in users training, pedagogical features.

Thus, the online environment will enjoy a greater receptiveness and openness to the general public of all ages. Will fulfill in this way what expressed O'Reilly through the words: 'to understand the rules for success'[15] in the Internet platform, by using 'the networks effect'[15] in building applications to attract more people to use them. This will result in bringing a greater efficiency and safety in the interconnected computer networks and thus in people's lives.

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Chapter 6

An Interdisciplinary Analysis Regarding Economic and Social Development in the Rural Area of EU Member Countries from Central and Eastern Europe

Fănel Dorel Șcheaua

Additional information is available at the end of the chapter

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Abstract

The European Union is the organization that currently has in its structure most countries of the European continent. Founded initially as a trade union between Germany, France, Italy, Belgium, Netherlands and Luxembourg after the Second World War, it has evolved over time to the political union accomplished in 1993, along with the organization name change from European Economic Community (EEC) into the European Union (EU). Simultaneously with the EU expansion by adopting new member states continued sustainable development of economic activities within the community. The rural European area includes most EU territory and the main component of the population. Therefore, an analysis is required to be made on economic indicators that define EU rural areas, for the highly developed regions in the West and for the new member states from the Central and Eastern European region. The objective of this paper is to provide a comparative analysis on specific economic and social indicators for the rural area of the countries positioned in Central and Eastern Europe which are in the position of new EU full members and the level of their contribution to the economy of the union. The paper has an interdisciplinary character by the fact that reunites principles of disciplines as economics, social and political sciences.

Keywords: Interdisciplinary, rural economy, social development, rural area of EU members in Central and Eastern Europe, EU rural space

1. Introduction

Today the European Union (EU) brings together economic and political criteria for all 28 members with a population of just over 500 million inhabitants and covers an area of over 4 million km^2 of land divided between urban and rural areas in immediate proximity to urban

agglomerations. To perform an interdisciplinary analysis of rural areas in the EU, an overview is needed of what represents today this interstate union. It must be taken into account both political and economic criteria as well as the social impact achieved with the development programs realized and intended for these specific areas. The current stage was reached after several extensions by adopting new union members at different times. Thus, in 1973, the expanding included the U.K., Ireland and Denmark, and in 1981 Greece and Spain, with Portugal in 1986. In 1995, three European countries decided to enter the EU, these being Austria, Finland and Sweden. In 2004, it was registered the largest EU enlargement with the accession of 10 new members: Cyprus, Estonia, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia and Hungary which had at the date of accession a population of over 100 million inhabitants, according to European Union, 2015. The EU enlargement in 2004 increased the land area by approximately 23% and the number of inhabitants by about 20%. In 2007, from January 1, Bulgaria and Romania joined the EU, and in 2013 Croatia became the newest member state. By joining the EU, countries in Central and Eastern European continent opted for access in a community in which they have the opportunity of sustainable development for their economy. This development is possible through enhanced trade relations between union members, investments launch in key areas of the economy, creating new jobs and opportunity of labour movement within the EU to those countries that have opted to accept workers from Eastern countries. Significant funding were allocated from the EU budget for agriculture in order to enable farmers from Eastern countries to obtain better agricultural harvests on the cultivated areas and to improve the endowment with efficient equipment that could reduce working time, fuel consumption per surface unit and emitted pollutants into the environment. Farmers in the rural areas of Eastern European countries now have the opportunity to sell their products directly on the European market, thereby ensuring an improvement in their income levels and living standard. Therefore, joining the EU accounted for the countries of Central and Eastern Europe a unique opportunity, which ensured them the accelerated development of their economies and hence an increase of living standards for the population based on results in the economic branches. The political barriers between member states were eliminated, while assuring sustainable economic development that can ensure social benefits for the residents of these areas [13, 17].

2. Specific economic indicators for the Central and Eastern Europe states

On 1 May 2004, a total of eight applicant countries positioned in Central and Eastern Europe became full members of the EU. These were the Czech Republic, Slovakia, Slovenia, Hungary, Poland, Lithuania, Latvia and Estonia. In 2007, from 1 January, it was the time for Romania and Bulgaria to become new EU members and in 2013 Croatia gained the right to full membership. Thus, an objective was achieved aiming to eliminate the principles of division between European countries imposed by historical agreements between great powers. The EU enlargement eastwards followed important objectives regarding political stability in the region, maintaining democracy and peace, but also on the economic plan aimed to extend the common market among members. Thus, the EU economy has become the strongest economy in the

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world based on the most developed intra-community common market. At the moment of accession, the new member states are bringing their own contribution to the EU in terms of surface area and population, as shown in statistical data values presented in Table 1 (according to European Union, 2015), which includes information on the Central and Eastern Europe countries, values for the total surface area, number of inhabitants and Gross Domestic Product (GDP) recorded in 2014 [16].

Current No.	EU member state	EU accession year	Total surface (km²)	Population (Mil. Inhabitants)	GDP in 2014 (billion Euro)
1.	Czech Republic	2004	78867	10.512	154.739
2.	Slovakia	2004	49035	5.41	75.21
3.	Slovenia	2004	20273	2.06	37.24
4,	Hungary	2004	93024	9.87	103.217
5.	Poland	2004	312679	38.48	413.13
6.	Lithuania	2004	65300	2.943	36.309
7.	Latvia	2004	64573	2.001	24.06
8.	Estonia	2004	45227	1.315	19.525
9.	Romania	2007	238391	19.94	150
10.	Bulgaria	2007	111002	7.245	42.011
11.	Croatia	2013	56594	4.246	43.085

Table 1. Statistical data regarding the countries of Central and Eastern Europe [1]

In Figure 1 plotted dots show the situation of EU countries in Central and Eastern Europe by area.

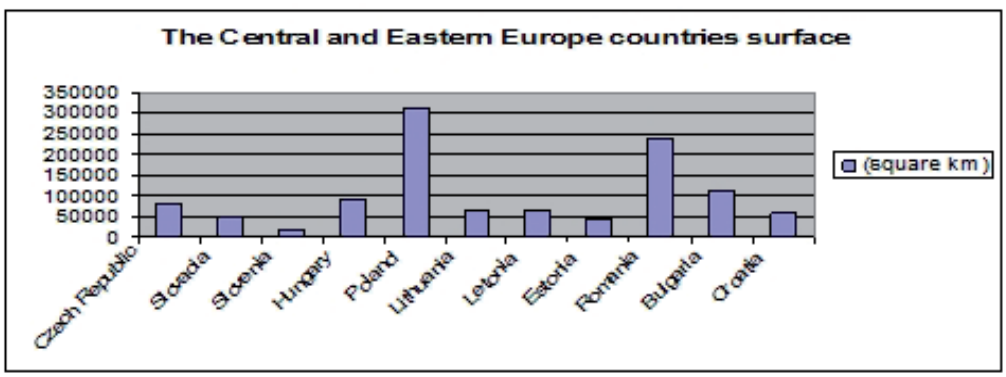

Figure 1. The EU countries of Central and Eastern Europe surface [1].

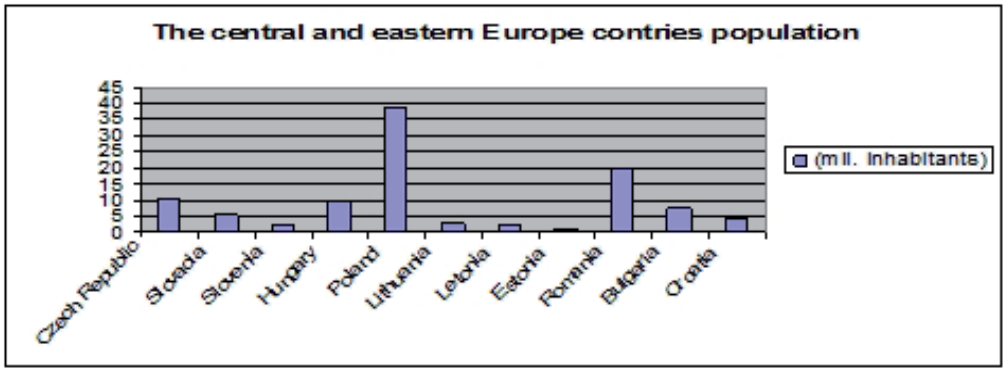

Figure 2. The population of the EU countries of Central and Eastern Europe [1].

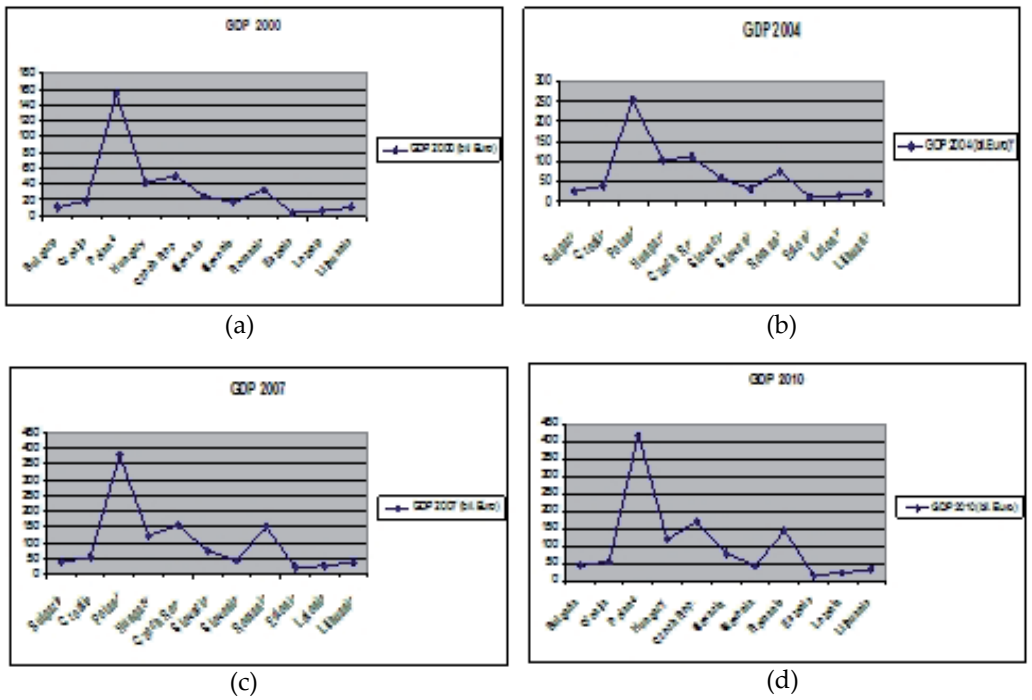

Figure 3. Values of GDP in 2000–2010 for Central and Eastern Europe countries [1]. (a) GDP in 2000. (b) GDP in 2004. (c) GDP in 2007. (d) GDP in 2010.

In Figure 2 are presented information about the population number, while Figure 3 shows the comparative GDP results recorded for the Eastern European countries in 2000, 2004, 2007, 2010 and 2014. Progressive growth of the GDP value can be observed for the majority of Eastern European countries in the years following EU accession compared to 2000 and even 2004. GDP

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regarded as a macroeconomic indicator provides information on the economic situation of the new EU member countries. Total amounts of GDP are presented in Figure 4 on each economy in part, from where it can be seen that Poland has the first position being the country with the largest economy in the region, followed by the Czech Republic, Romania and Hungary for top positions.

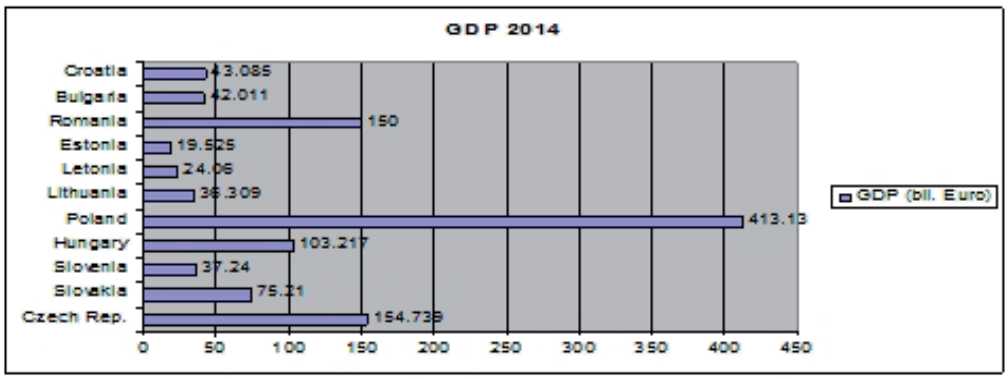

Figure 4. The 2014 GDP of the EU countries of Central and Eastern Europe [1].

The values of exports and imports were also analysed as a percentage of GDP for each Eastern European economies in the period of 2000–2009 (Figure 5 and 6) to observe possible differences in these characteristics between EU pre-accession and post-accession of the Eastern economies. On graphical representations can be observed the values for each year where most countries have registered exports values close to 40%, except Slovakia, Hungary, the Czech Republic, Slovenia and Estonia who have approached or even exceeded the 80% threshold of GDP for exports.

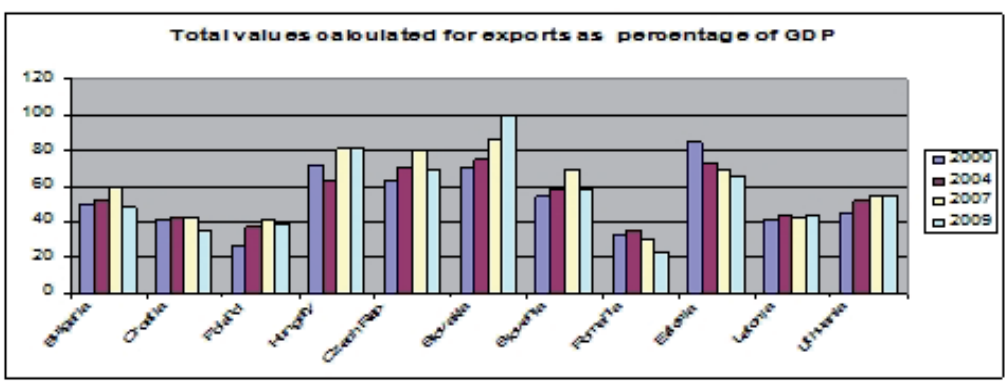

Figure 5. Total values calculated for exports as a percentage of GDP (2000-2009) [1].

For the percentage values of imports achieved can be noticed as an average value of over 50% of GDP value over the analysed years, and some countries such as Slovakia, Estonia, Hungary,

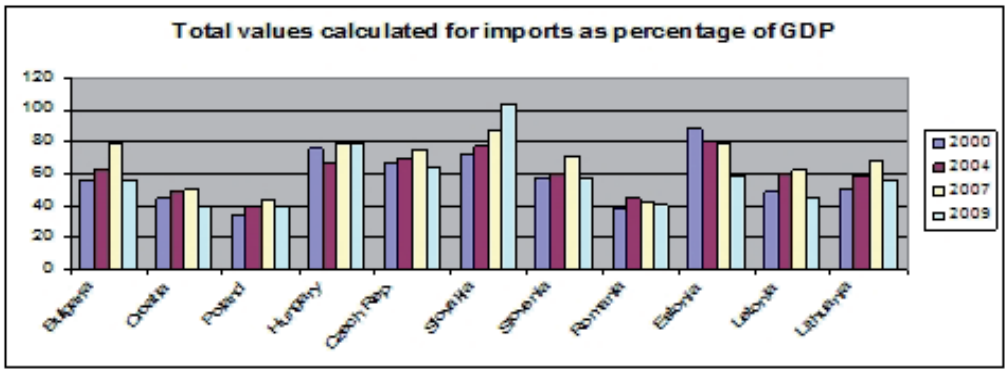

Figure 6. Total values calculated for imports as a percentage of GDP (2000-2009) [1].

the Czech Republic and Bulgaria are close or even exceed the 80% of the GDP value. Also, using an important macroeconomic indicator, represented by gross national income (GNI), information can be obtained regarding the total income earned by residents of analysed countries and based on the obtained values a comparison can be accomplished regarding the purchasing power with direct implications for living standards in a particular country. Thus, GNI per inhabitant for the Eastern European countries was calculated, EU Members, for the period 2000–2009 and the results are shown in Figure 7. Visible differences between countries depending on the economy level of development can be observed, but the trend is upward for all 11 analysed countries since 2000, continuing with the EU accession years 2004 and 2007 and continuing until 2009.

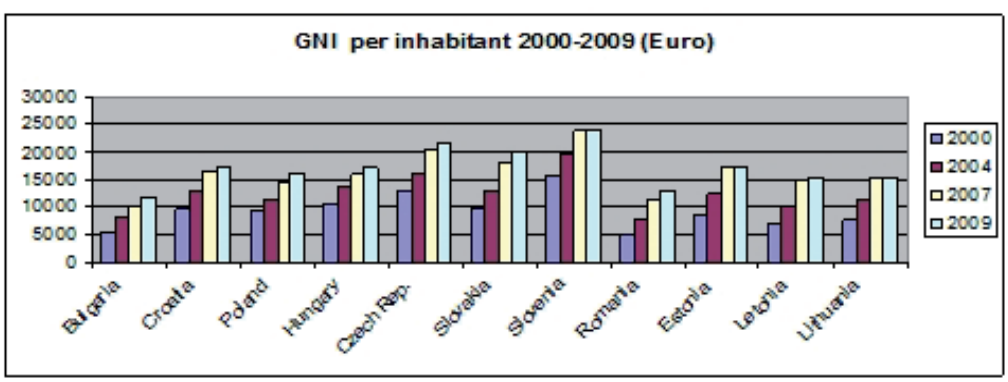

Figure 7. Values calculated for GNI per inhabitant of Central and Eastern countries (2000–2009) [1].

Undoubtedly, the upward trend of GNI per each economy has been achieved as a result of the reforms carried out by each country as a result of the EU accession process, which has generated positive effects in their own economic branches.

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3. Rural areas of EU member states in Central and Eastern Europe

The rural area represent the entire territory positioned outside large urban areas comprising small settlements whose inhabitants have an occupancy rate in agriculture, forestry, industry or other branches of rural economy. Development of rural areas is a priority in EU policy because rural areas represent more than 80% of the surface and comprises over 50% of the total population. Due to different levels of development among member countries there is a significant gap between western rural spaces and rural areas of the new member states from Central and Eastern Europe, where the main activity that occupies a large part of the population is agriculture, forestry and manufacturing of raw materials resulting from these domains. Within the EU there is common agricultural policy (CAP), which represents the framework according to which all activities from the primary sector are driven in the European rural economy. Since 1962, when it was launched, the CAP has been a partnership between agriculture and society that has as the following objectives:

- Increasing agricultural productivity to ensure affordable and offer consumers a constant food.
- Ensure an acceptable level of income for EU farmers and a standard of living similar to the urban areas.

European agriculture supported through the CAP must provide an increasing production of basic foods as a result of continuous population increase. It also takes into account the sustainable management of natural resources, supporting continuous development of European rural areas and rural economy.

As a direct aid through CAP, three main directions can be defined as follows:

- Support for development of rural areas.
- The actions for market support.
- The aid granted for the farmers income.

For implementing the established measures, CAP has currently at its disposal up to 40% of the EU budget and CAP budget in 2014 was about 58 billion Euros, according to European Union, 2015. Through their work related to agriculture and forestry, the employed workers in these branches have an important role in providing a sustainable management within rural areas, because in these regions are created and preserved natural habitats including fauna and flora specific for rural areas in various European countries that would otherwise be destroyed. While in the past agriculture represented the basic concern of the European rural areas inhabitants, today this economic sector has decreased as percentage share in GDP of countries with developed economies due to the increase of branches in the manufacturing industry [17].

Younger people believe that agriculture is no longer a profession of great attraction and are choosing professions in urban areas, where the income level is higher. Therefore, through the CAP must be supported the initiative to attract young people in rural areas, in order to ensure the necessary continuity in agriculture, but also the income level should be comparable to those

in urban areas. In contrast to the Western developed countries, heavily industrialized, in Central and Eastern European countries, agriculture continues to hold a higher proportion of GDP and higher employment rate of the rural residents in this economic sector. Thus, must be analyzed the space comprised outside large urban areas of the new EU member countries as rural areas in which specific activities are conducted regarding agriculture, forestry, fishing, product manufacturing and where the historical traditions and customs of the rural areas inhabitants are kept from generation to generation. Overall, if we refer to the new EU member countries from Central and Eastern Europe, we can say that their rural area occupies most of their territory and population, as we can see from the graphic representations shown in Figures 8 and 9 [2].

So, if we analyse graphical representations made, there are few Eastern European countries where rural area is less than 85% of the total territory. These are the Czech Republic, Lithuania and Latvia. For all other countries the rural area occupies over 90% of the country's total territory and for Slovenia the whole territory can be considered as rural area.

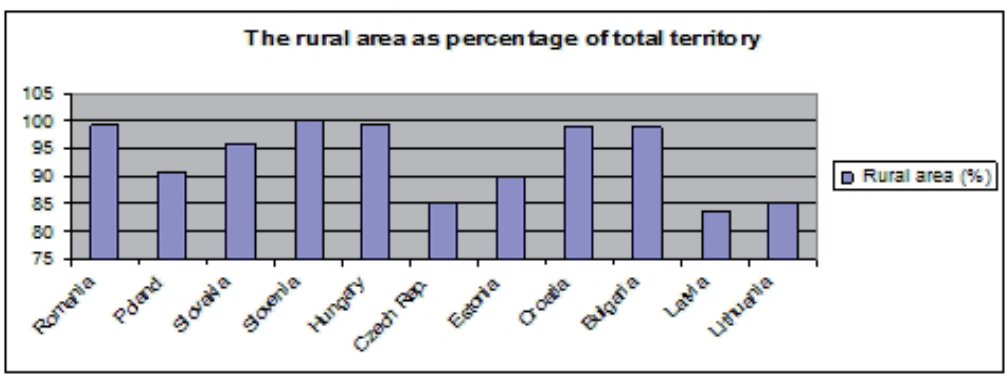

Figure 8. The share of rural areas as a percentage of total area for the Central and Eastern Europe countries [2].

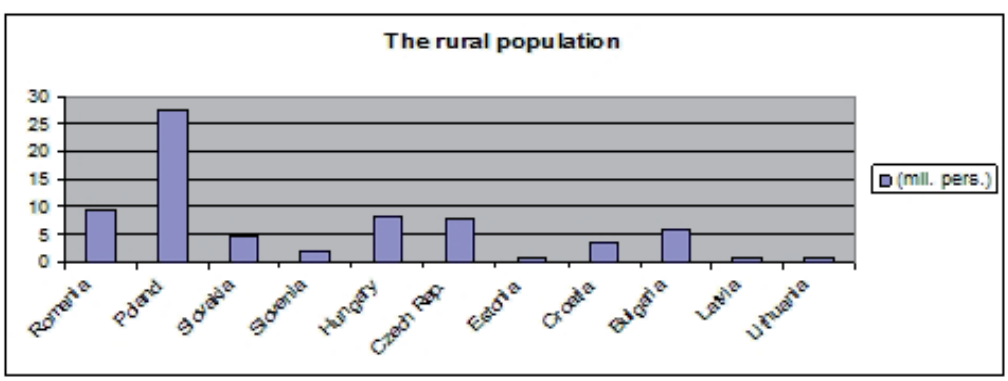

Figure 9. The rural population of the Central and Eastern Europe countries [2].

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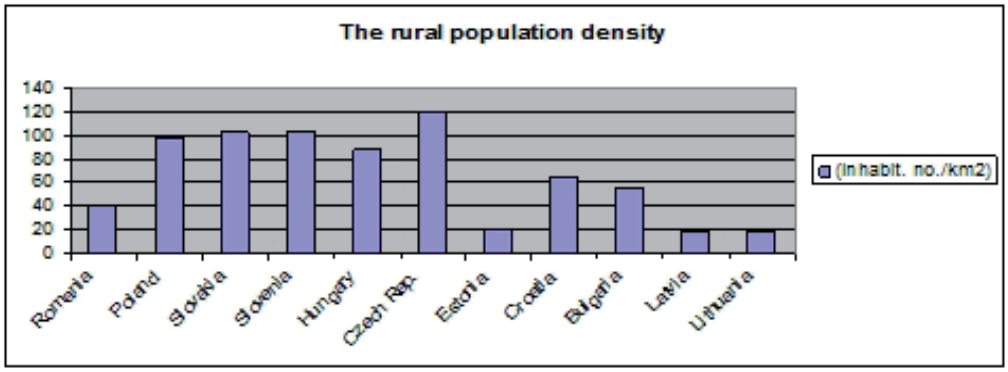

Figure 10. The rural population density in Central and Eastern Europe [2].

Regarding the Eastern Europe rural areas population density, it can be said that large percentage of the total population is established in rural areas and in terms of density values are lower than 20 inhabitants/km^2 for Estonia, Latvia and Lithuania, as shown in Figure 10. For the other EU member states average values are recorded, for example, Romania with less than 40 inhabitants/ km^2, Bulgaria with more than 50 inhabitants/ km^2, Croatia with more than 60 inhabitants/ km^2, while for other countries the values are more than 90 inhabitants/ km^2; the highest value is of the Czech Republic with almost 120 inhabitants/ km^2.

The main economic sectors, specific to the rural areas of Eastern European countries, are represented by agriculture, forestry and manufacturing of raw materials resulting from these activities. Regarding the land areas used in agriculture, in Figure 11 are presented the corresponding values of land areas used by each country for both agriculture and forestry. Poland and Romania have the first ranking places having each over 14 and 13 million hectares used in agriculture, followed at long distance by Hungary and Bulgaria with more than 4 million hectares each.

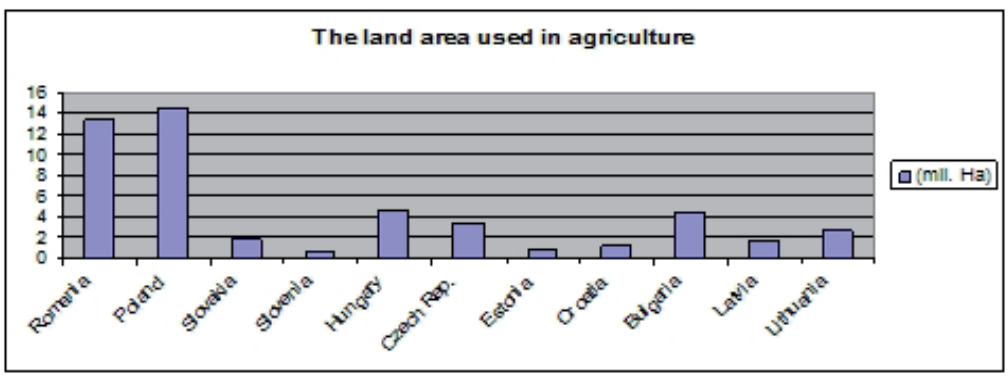

Figure 11. The land areas used in agriculture by the Central and Eastern Europe countries [2].

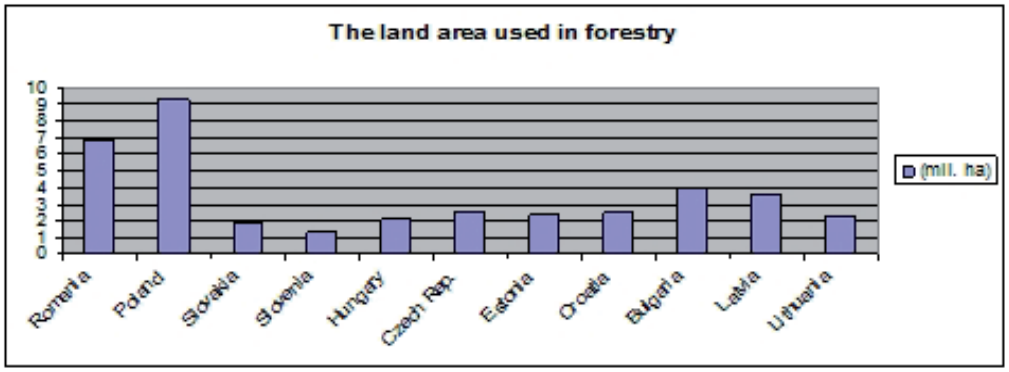

Figure 12. The land areas used in forestry by the Central and Eastern Europe countries [2].

Referring to land areas used for forestry, as shown in Figure 12, Poland with 9 million hectares and Romania with more than 6 million hectares again occupies the top positions, followed by Bulgaria, with almost 4 million hectares, and Latvia with over 3 million hectares. For the rest of the countries, there are areas between 1 and 2.5 million hectares used for forestry.

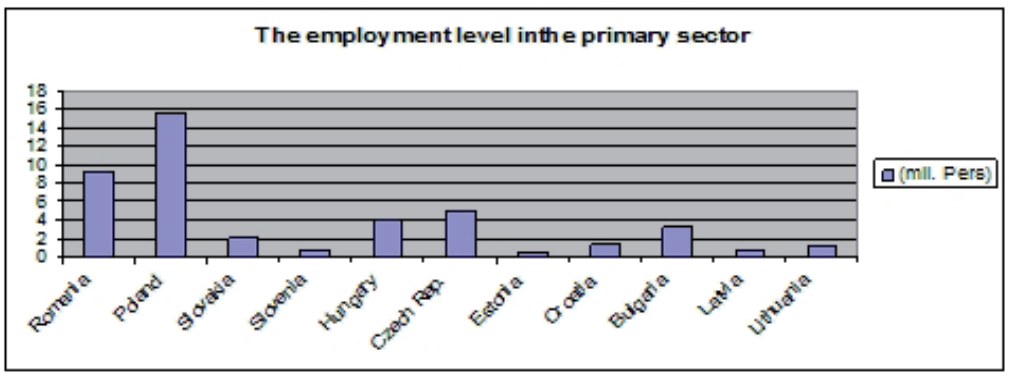

Figure 13. The employment level in the primary sector [2].

Analysing the employed labour force in the primary sector of Central and Eastern Europe countries rural areas (Figure 13), we can see that Poland holds the first place with over 15 million persons employed, followed by Romania with over 9 million people employed and for the next places there are Czech Republic and Hungary with 5 and 4 millions of employed people. Bulgaria has over 3 million people employed in the primary sector.

Also must be shown the direct contribution of the rural areas primary sector to gross national income (GNI) of the Eastern European countries, as shown in Figure 14, (according to European Union, 2015). Top positions are occupied by Bulgaria and Romania with the highest percentage share of gross national income (GNI), located around 6%. The following levels are

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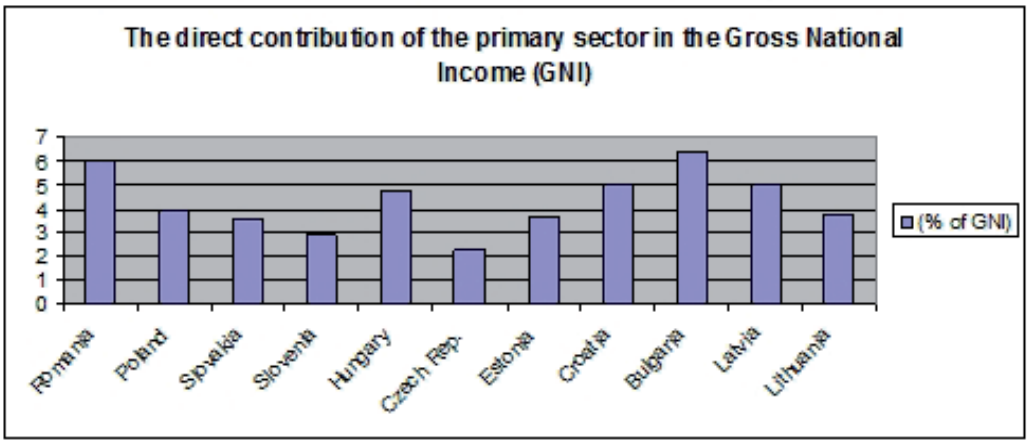

Figure 14. The direct contribution of the primary sector to the gross national income (GNI) of the Central and Eastern European countries [2].

around 5% for Hungary, Croatia and Latvia, and the lowest values recorded just over 2% for the Czech Republic and Slovenia by almost 3% of its gross national income (GNI).

4. The investment programs within the EU for the Central and Eastern Europe countries planned for rural economy development

Following the accession were initiated assistance programs for the new member states financed from the EU budget in order to revitalize various economic sectors, but especially to ensure rural areas development and environmental protection, down to human rights promotion and protection of external borders.

The immediate economic results for the new member states were represented by export improvements, the access and providing stable position on the European market of small businesses.

The short-term generated effects for the new member states were represented by the following:

- Elimination of customs duties on agricultural and food products in bilateral trade with EU countries.
- Increasing competition through access to the European common market.
- Fluctuations in the prices of certain products.

However, the positive long period effects are expected after joining the EU for the new member states economy related to the following:

- Achieving an accelerated economic growth.
- Attracting of direct foreign investment from the European partners.
- Creating new jobs.
- The possibility of movement of labour force within the Union.
- Increasing the trading relations with intra-Community partners.
- The possibility of attracting structural funds.
- Rural sector development and agriculture based on the Common Agricultural Policy.

Regarding the membership costs, the new member countries of the EU, contribute to financing the EU budget by a percentage of GNI, set at about 0.7%, a percentage from the proceeds of value added tax (VAT) of about 0.3%, but also from the import duties proceeds applied to all purchased goods from outside the EU, that most part become a revenue for the EU budget. [13, 14].

Thus, the EU's annual budget is about 145 billion Euros, according to European Union [2].

To illustrate how rural areas economies of the EU countries of Central and Eastern Europe are stimulated, the rural development programs with strategic objectives for each country are presented.

Poland was the only EU country that has managed to pass the economic crisis without having experienced any effect. In Poland agriculture occupies almost 12% of the total number of available labour force and gross value added (GVA) is low compared to Western countries, but close to the average of Eastern European countries [15].

Through the Rural Development Programme (RDP), Poland will be able to develop the rural economy through the use of 13.5 billion Euros, of which 8.6 billion Euros from the EU budget and the difference from the state budget.

Followed are the agricultural farms, competitiveness and viability by providing investment aid for nearly 200,000 farms, creating more than 20,000 jobs and encouraging association of agricultural producers.

Investment support will be also directed to environmentally friendly farming according to the European Commission, 2015 [18].

For Romania, we can say that although there is a real economy growth, among the highest increases in the EU, however, the resources for investment financing represented by the EU funds have been insufficiently exploited so far. For example, the absorption of Structural and Cohesion Fund (SCF) was in 2015 up to 63%, its lowest level throughout the EU and for the European Agricultural Fund for Rural Development (EAFRD) has been reported an absorption rate of approximately 82% (Table 2) according to European Commission [3].

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Year	Total amount absorbed (%) EAFRD	Total amount absorbed (%) SCF
2010	17.7	1.9
2011	33	5.6
2012	43.5	11.6
2013	60.1	33.7
2014	75.8	52.2
2015	82.3	63.3

Table 2. The situation of EU funds absorption for Romania [3].

In Figure 15 is shown the graphical representation of the EU funds absorption rate.

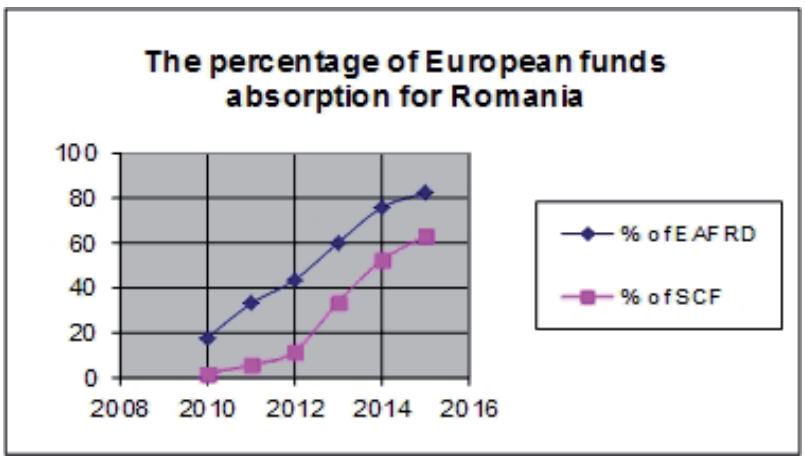

Figure 15. The percentage of EU funds absorption for Romania [3].

The Romanian RDP programme for the 2014–2020 periods has been adopted and its priorities are as follows:

- Ensuring competitiveness in agriculture and forestry development;
- Promoting measures for environmental protection by restoring, preserving and enhancing agricultural and forestry ecosystems;
- Economic development of rural areas that can generate new jobs and ensuring improved living conditions for the rural areas inhabitants.

A period of 7 years will be invested in developing the Romanian rural area economy around 9.5 billion Euros, of which 8.1 billion from the EU budget and the difference is financed from the state budget. These investments will lead to the modernization of over 3000 farms and helping to install more than 9000 young farmers so that they will be able to open their business

in agriculture. Over 25,000 new jobs will be available in the rural areas economy and 3000 new businesses will be opened in the field. Also, more than 1.3 million hectares of agricultural land and over 0.8 million hectares of forests will receive payments for the support and maintenance of biodiversity and promotion of environmental protection practices.

For Bulgaria, RDP program includes investments of approximately 2.9 billion Euros by 2020, of which 2.4 billion Euros from the EU budget and the rest representing the contribution from the state budget. The investments will be directed to agricultural and forestry sector, to support small and medium farms, and young farmers who want to launch their business in the field. Approximately 4000 new jobs will be available in new small businesses started up in Bulgarian rural areas, which will lead to the employment of more than 30% of the rural population. [19]

Hungary will have at its disposal 4.2 billion Euros for the development of rural economy, of which 3.4 billion Euros from the EU budget and the rest represents national contribution. They are supported activities related to the restoration, preservation and improvement of ecosystems, poverty reduction and economic development of rural areas. The aid is expected to start over 2600 investment projects in the agriculture and food industry. Hungary focuses on innovation and directs 3.6% of the RDP towards actions that support innovation and cooperation projects under the European Innovation Partnership (EIP) [4].

The Czech Republic will be able to invest 3.1 billion Euros in the economy of rural areas, of which 2.3 billion from the EU budget and the rest representing national funding to initiate actions for the development of rural areas by 2020. The priority actions are for enhanced management of natural resources, encouraging environmentally friendly farming practices and ensure increased competitiveness in agriculture and forestry. Over 3400 farms will receive support for investments and nearly 1400 investment projects in forestry technologies, and more than 800 projects in the food industry will receive funding. It will create almost 2000 new jobs in the rural economy, according to European Commission [5].

The Slovak rural areas will benefit of 2.1 billion Euros for development by 2020, of which 1.545 billion Euros from the EU budget and the rest is national co-financing. Investments will be made in the agriculture and forestry sectors aiming an enhanced competitiveness. Over 1200 farms will be upgraded and 400 enterprises in the field of food industry will receive funding.

Other objectives are the rational use of natural resources and encouraging the environmentally friendly agriculture practices. Increasing rural economy will be achieved through investments made in productive enterprises that will generate the creation of about 2000 new jobs [6].

Croatia is the newest EU member and for economic development in rural areas it will have about 2.3 billion Euros, of which 2 billion from the EU budget and the rest from the state budget. Croatia's development strategy is directed towards restructuring and modernization of farms and the food industry. Over 5000 farmers will receive investment support to grow their small farm and about 1000 young people will have the opportunity to become young farmers [7].

Slovenia will use 1.1 billion Euros for implementing the national program for rural economy development, with priorities set for the following:

- Restoring, maintaining and improving ecosystems related to agriculture and forestry.

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- Increasing competitiveness in agriculture and sustainable forestry practice.
- Social inclusion and rural development.

At least 600 new jobs will be created, and more than 60% of the rural population will benefit from the implementation of development program in Slovenia [8].

Estonia will have to invest in the economy of national rural areas around 0.993 billion Euros, of which 0.823 billion from the EU budget. The priority actions are directed to the environment practices on water, soil and biodiversity. The farms will receive investment support and rural economy will be prioritized for development [9].

Latvia will receive from the EU budget 1.08 billion Euros and with a national contribution of 0.5 billion Euros will have a total of 1.58 billion Euros at its disposal for rural economic development until 2020. At least 3500 farmers will receive support to modernize their farms, to go out with their own products on market and to diversify its product offerings. New jobs in agriculture field will be also created and boost development of organic farming [10].

Lithuania will be able to invest 1.9 billion Euros in the next years until 2020, of which 1.6 billion Euros from the EU budget and the rest from the state budget. Support will be directed for modernizing and improving the economic performance of small and medium farms and nearly 8000 farmers will receive investment aid. Preserving biodiversity, promoting organic farming, creating new jobs and economic development of rural areas are also among the objectives pursued [11].

In Figure 16 is shown graphically for each country the amount of capital values that will be invested in 2014–2020 for the development of rural economies.

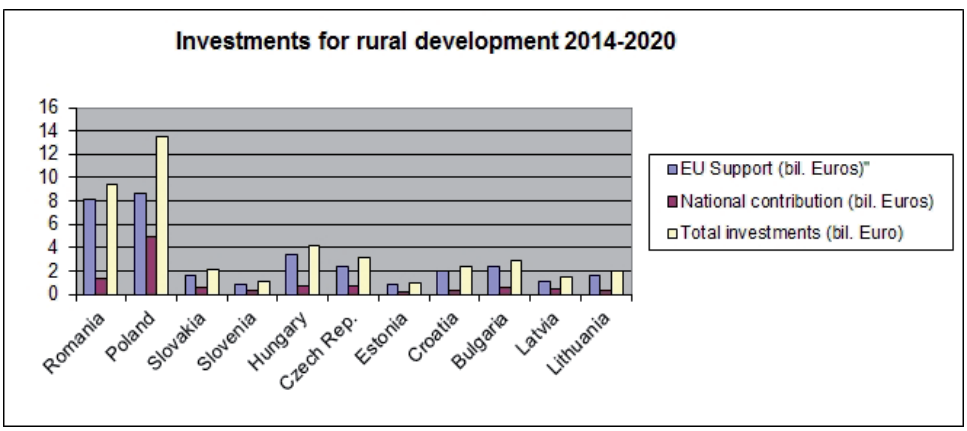

Figure 16. The graphical representation for the direct investments amount for developing of Central and Eastern Europe countries rural economy (2014–2020) [12].

The highest values of investments amounts are directed to Poland and Romania, each country enjoying the EU support, which directly contributes to over 8 billion Euros in development of rural areas of the largest countries in the region, followed by Hungary, the Czech Republic

and Bulgaria, with about 3 billion Euro and other Eastern European countries with proportionally lower values.

As can be seen from the presented data, currently the EU member states in Central and Eastern Europe have now more than ever the opportunity to develop their rural areas economy through direct investment in the primary sector, to modernize farm exploitation, to realize rational exploitation of natural resources, to build establishments of new production facilities in order to ensure new jobs for the inhabitants of rural areas and ensuring a higher standard of living similar to urban areas. These opportunities exist because of substantial aid coming from the EU, aiming to assure in this way a gradual harmonization of working and living conditions of its inhabitants by developing rural areas in which they work and live.

5. Conclusions

EU integration of the Central and Eastern Europe countries had positive effects on their rural areas economy of the new union members. These are represented by direct economic advantages by increasing investments in the rural economy in order to develop the production means, to create new production structures that would better exploit the resulted products from agriculture or forestry which now have a higher added value and a better quality according to the EU standards.

Also the access to EU structural funds offers multiple facilities for the development of rural economies, creating and modernizing of specific infrastructure, creating new jobs for rural areas residents of Eastern European countries and improving their life standards.

By joining the EU, the identities and traditional values of each nation individually from Eastern European countries were not affected, but were especially ensured an active participation to achieve the reunification of the European heritage which now totals all values from each specific area.

The economic criterion stimulated the option for EU enlargement, in order to fulfil the primary objective of becoming one of the strongest economies in the world and the most extensive and developed consumer market that exists in the world today.

Countries of Central and Eastern Europe bring now their contribution to the attaining of the EU strategic objectives, participation at their establishment from the position of full members and the way which they started in the European family is one that ensures a good future in which they have the possibility to develop their economies in an accelerated manner based on active participation at the common market.

Rural areas will become those areas that will retain their labour force employed in agriculture, forestry and processing of raw materials derived from these domains, where income levels are satisfactory and provides the opportunity of a higher standard of living similar to urban areas.

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Chapter 7

Isolation System Model Subjected to Random Vibrations

Fanel Scheaua

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65418

Abstract

The construction of bridges or viaduct structures represents major infrastructure works of vital importance for human communities, and therefore they must be made to withstand both the traffic and the seismic events. Therefore, all necessary measures should be taken so that these structures can remain functional even after the action of earthquakes of considerable magnitude. A high level of safety for these structures can be ensured if within the resistance structure some special mechanical systems are mounted, which will be able to improve the building assembly behaviour when an earthquake occurs. This kind of mechanical system capable of ensuring a high level of safety for the isolated structure is described in this paper. The isolation system assembly consists of a rolling pendulum device combined with elastomeric system. This system was built and experimentally tested at random vibrations. The experimental results are presented regarding motion parameters recorded at the pier and superstructure level. The combination between effects of the two dissipating system types represents the optimum solution intended to achieve an improved response of the isolated structure when subjected at dynamic actions. Therefore, it represents a special system which can be successfully used in the endowment of bridge or viaduct structural type.

Keywords: Dissipation system, rolling friction, anti-seismic device, experimental modelling

1. Introduction

Within a region infrastructure elements such as highways, roads and rails has strategic importance because it determines the economic growth and the level of development for that region. The bridge or viaduct structural types represent special structures that provide access for crossing a river course or a valley, assuring a vital connection between human communities. Therefore, such structures must be kept in operation even when high-magnitude earthquakes occur. To be able to withstand the demands in dynamic regime to which these special structures

are subjected, the design engineers must consider the use of resistant materials and appropriate dimensioning of the resistance structure. In addition to these methods, special protective systems are being used that can provide structure isolation against destructive dynamic actions. Such systems are successfully used for the endowment of bridges and viaducts worldwide. These protective systems are mechanical systems capable of assuming some of the earthquake energy aiming to dissipate and transform it into another form of energy. Usually, the mounting solution for the dissipating energy devices is interposed between the structural frames of the bridge or viaducts. Therefore, the total energy of the earthquake is not reaching the superstructure being consumed at the isolation system level. An experimental model of the hybrid isolation system is described in this paper. This model consists of a rolling pendulum system combined with an elastomeric system. The idea of building such a system was to achieve the combined effects of the two systems types represented by rolling dissipative system and elastomeric system. This system has been experimentally tested on a reduced scale structure and the results are shown in the following.

2. Dissipation device model assembly

The mounting principle of the dissipation system can be accomplished through attachment to the structural frames of the isolated structure. It can be seen that it can be mounted between the foundation and the superstructure of the bridge ensuring a disconnection between the two structural elements. Therefore, the earthquake-induced efforts at the foundation level cannot be fully transmitted to the superstructure because they are consumed by the composed dissipation system. Figure 1 shows the mounting principle and mathematical model of isolation system at the bridge structure.

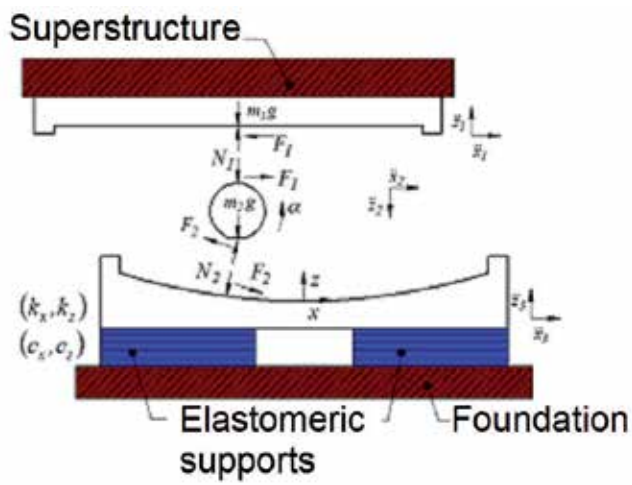

Figure 1. Composed isolation system mathematical model [1, 2].

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The equation of motion with rolling system can be written as:

$$m_1\ddot{x}_1 + F_r sign(\dot{x}_1) = -m_1\ddot{x}_3 \tag{1}$$

where F_r is the restoring force.

Also, the addition of elastomeric systems determines the following equations of motion:

$$\begin{cases} m\ddot{z}_3 + c_z\dot{z}_3 + k_z z_3 = 0 \\ m\ddot{x}_3 + c_x\dot{x}_3 + k_x x_3 = 0 \end{cases} \tag{2}$$

3. Experimental test

An experimental bridge structure was built at a reduced scale to which a composed isolation system, also built on a small scale, was added. The isolated structure assembly equipped with the dissipation system is schematically shown in Figure 2. The rolling friction device is composed of two main rolling plates (a flat and a spherical surface), a central spherical part positioned between the two main rolling surfaces which moves by rolling ensuring relative movement of the two main surfaces. Thus, a specific movement undertaken by the foundation ground along with the bridge pier is filtered through the rolling friction and the elastomeric isolation system, so that the request is not fully transmitted on vertical direction to the superstructure which tends to remain in equilibrium position during any dynamic action.

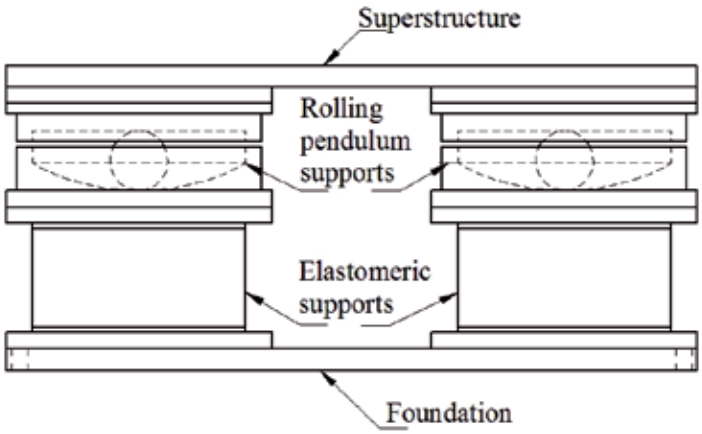

Figure 2. Schematic representation for the isolation system model assembly [3].

The bridge model has four isolation systems positioned at the ends of the beam or superstructure. Tri-axial accelerometers have been mounted in the bridge pier and beam. The excitation

is provided with a special device that provides a set of random vibrations at the pier level. Because of the excitation force of random value, at the isolation system level, the spherical steel parts are rolling on the main steel spherical surface, while the friction coefficient is in the range of 0.15–0.18 (Coulomb friction without lubrication) [4, 5].

The experimental results recorded are presented for the main transversal and longitudinal directions of movement at the level of support pier and the isolated superstructure. Figure 3 presents the values recorded at the pier support on the transversal direction of motion.

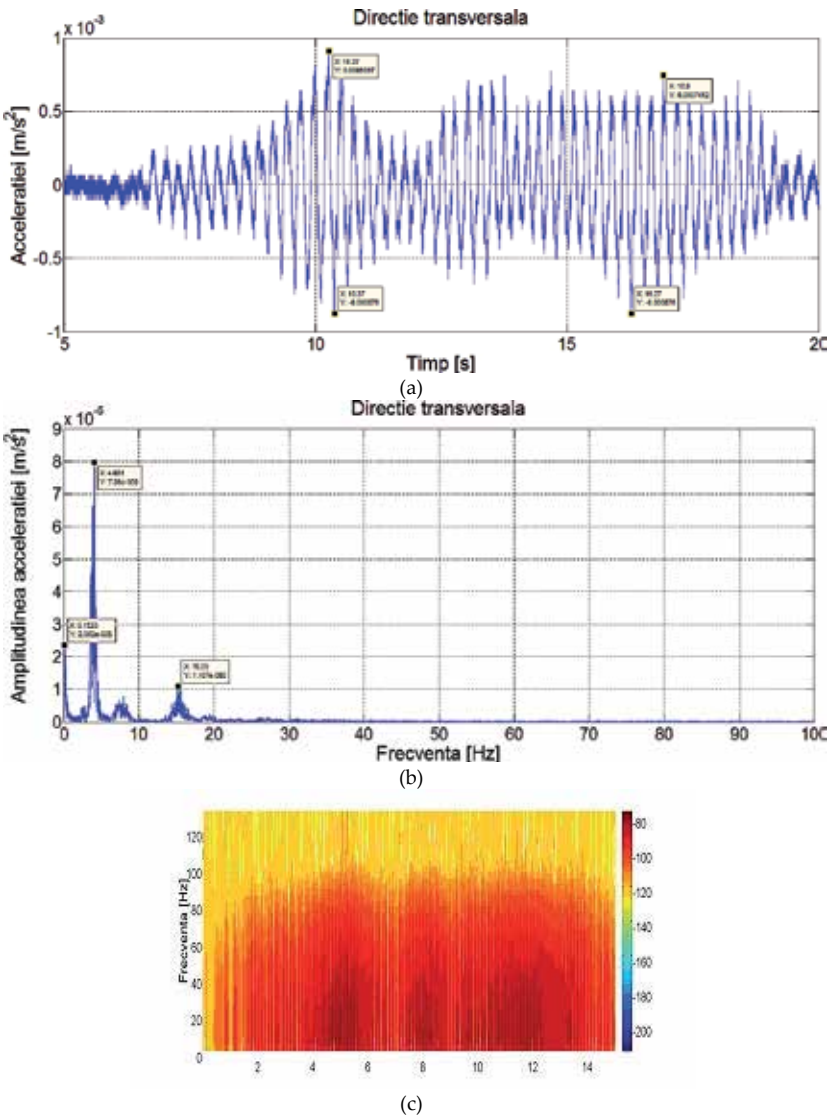

Figure 3. Experimental results obtained for pier transversal direction of motion. (a) Acceleration values vs. time. (b) Acceleration amplitude values vs. time. (c) Spectrogram of frequency values vs. time.

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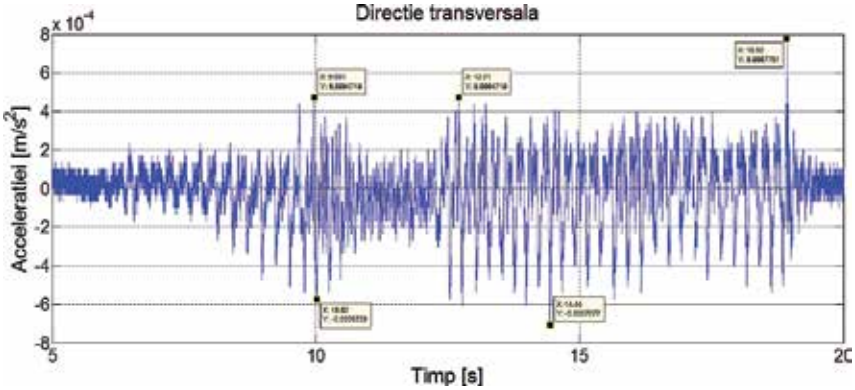
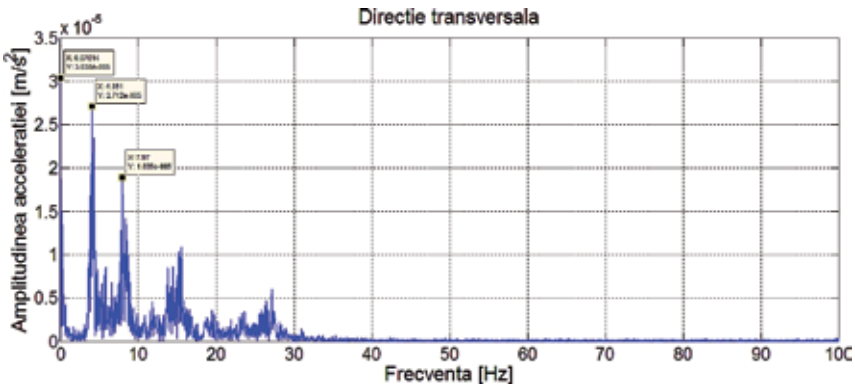
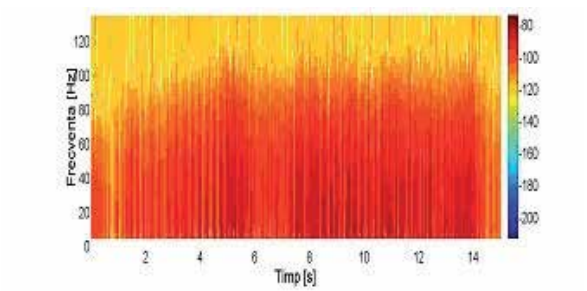


(a)



(b)



(c)

Figure 4. Experimental results obtained for superstructure transversal direction of motion. (a) Acceleration values vs. time. (b) Acceleration amplitude vs. frequency. (c) Spectrogram of frequency vs. time values.

The results obtained are presented in order to highlight the differences between the values obtained at the support pier and at the superstructure level. Figure 4 presents the recorded values at the superstructure level on the transversal direction of motion. Figure 5 presents the values obtained at the support pier for the longitudinal direction of movement.

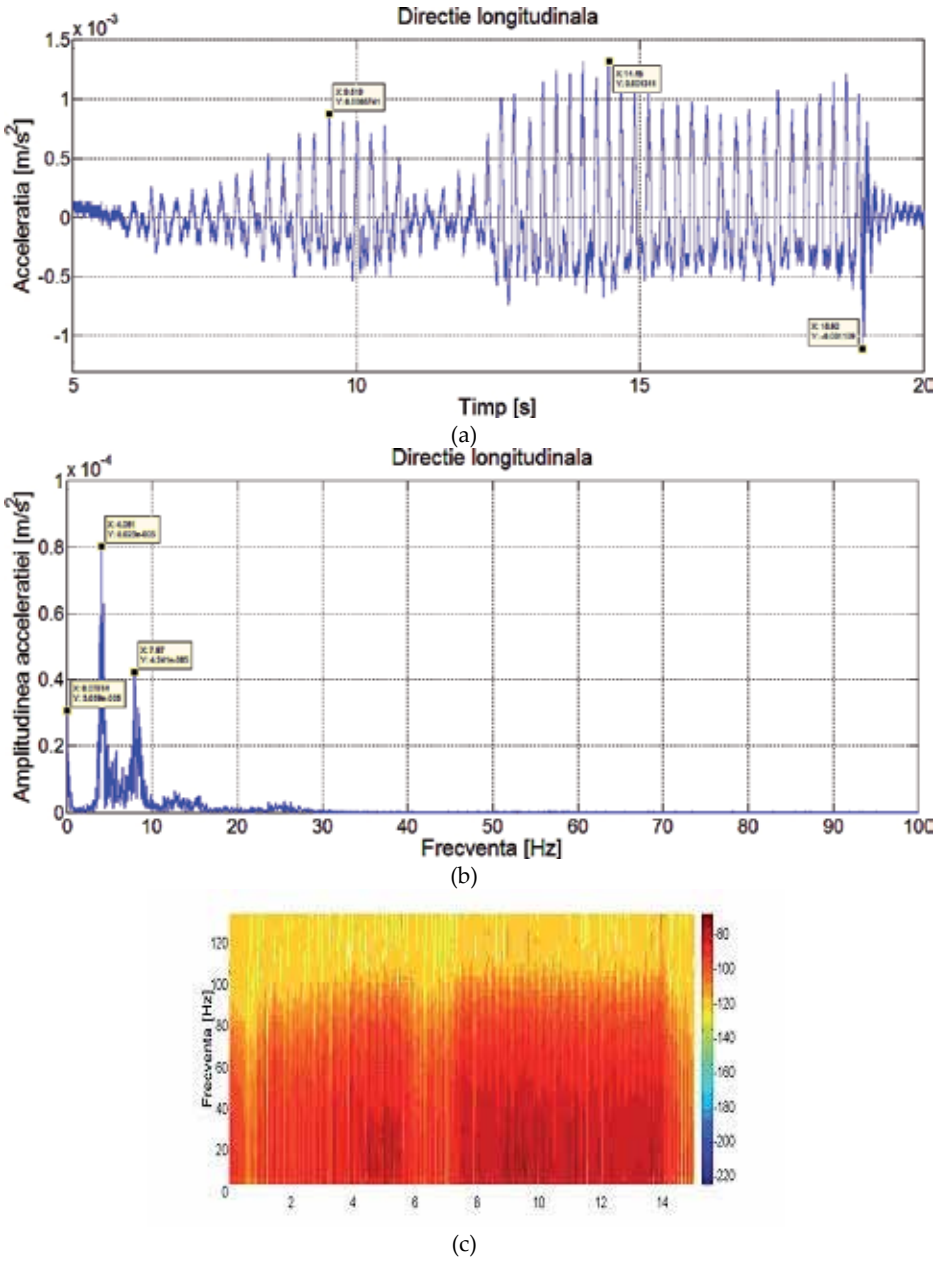


Figure 5. Experimental results obtained for pier longitudinal direction of motion. (a) Acceleration values vs. time. (b) Acceleration amplitude vs. frequency values. (c) Spectrogram of frequency values vs. time.

Figure 6 presents the obtained result values at the superstructure level for the longitudinal direction of movement.

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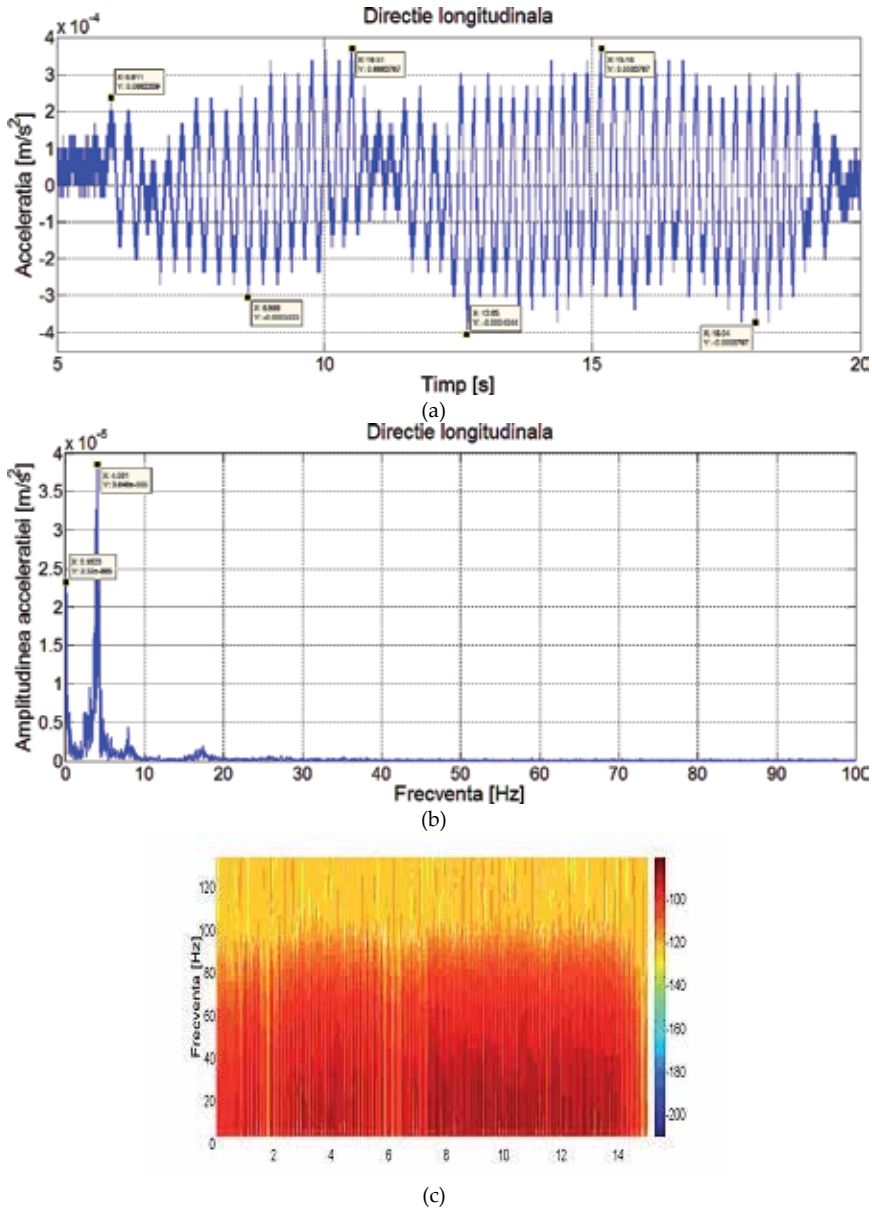
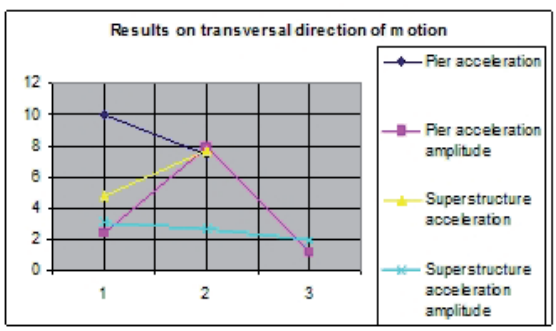


Figure 6. Experimental values obtained for superstructure longitudinal direction of motion. (a) Acceleration values vs. time. (b) Acceleration amplitude values vs. frequency. (c) Spectrogram of frequency values vs. time.

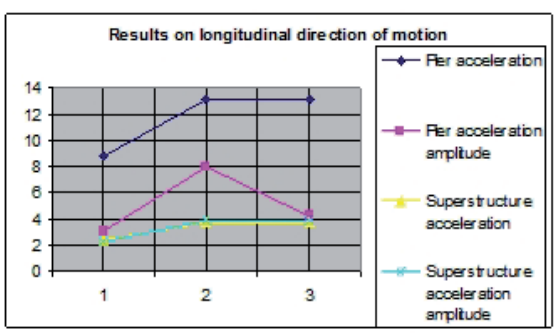
The values obtained for acceleration amplitude at the level of pier and superstructure are presented in Table 1 for both transversal and longitudinal directions. The differences between the values obtained at the support pier and the superstructure for both directions of movement can be observed due to isolation system action.

Values for transversal direction of motion			
Pier		Superstructure	
Acceleration $[m/s^2]\times10^{-5}$	Acc. amplit. $[m/s^2]\times10^{-5}$	Acceleration $[m/s^2]\times10^{-5}$	Acc. amplit $[m/s^2]\times10^{-5}$
9.97	2.362	4.718	3.03
7.412	7.95	7.751	2.712
	1.107		1.895
Values for longitudinal direction of motion			
Pier		Superstructure	
Acc $[m/s^2]\times10^{-5}$	Acc amplit $[m/s^2]\times10^{-5}$	Acc $[m/s^2]\times10^{-5}$	Acc amplit $[m/s^2]\times10^{-5}$
8.741	3.059	2.359	2.32
13.11	8.023	3.707	3.848
13.11	4.241	3.707	3.848

Table 1. Numerical values obtained for both transversal and longitudinal directions of movement



(a)



(b)

Figure 7. Graphical representation for the recorded values on the transversal and longitudinal directions of motion. (a) Transversal direction of motion. (b) Longitudinal direction of motion.

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Figure 7 presents the graphical representation of numerical results obtained on transversal and longitudinal directions of movement.

On the graphs, representations of the values obtained and the motion mitigation trend at the isolated superstructure level can be observed due to action of the hybrid isolation system mounted.

4. Conclusions

A composed isolation system has been described and experimentally tested in this paper. For the presentation of experimental results obtained the spectral analysis was used. The images obtained by decomposing of the waves produced as a result of the application of excitation on the structural model were recorded and arranged by wavelength and frequency. The values obtained are presented taking into account the isolated structural element and the recording on main directions of movement. The main maximum values recorded for the motion amplitude at the level of support pier and superstructure were highlighted. The general trend is of motion mitigation for the superstructure as can be seen in the both transversal and longitudinal direction of movement. A set of random vibrations was chosen in order to move the structure because it simulates the action of a real earthquake.

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Chapter 8

Air Abrasion: Interdisciplinary Modern Technologies—Approach to Minimally Invasive Treatment of Dental Caries

Albertine Leon, Luiza Ungureanu and Cristina Puşcaşu

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65419

Abstract

Dental air abrasion is a minimally invasive, ultraconservative method, with indication of choice for incipient fissural caries, which still count for 90% of newly appeared caries and raise diagnosing problems of the lesional stage. In this context, the aim of the paper was to use and assess dental air abrasion as an alternative technique for the preparation of dental structures, both on extracted teeth and on patients. Bio-Art microblaster was used on 14 extracted teeth and 6 patients for the removal of fissural caries in molars and premolars. After being acquainted with the technique and according to the specific protocol of use, minimally invasive preparations were made, followed by their restoration with adhesive materials. The advantages of the method, also specified by similar surveys, were: absence of pain, vibration, noise, pressure, and heat that are generated by conventional methods (burs), leading to high acceptance by patients.

Keywords: Air abrasion, dental caries, adhesive restorations

1. Introduction

Classic/conventional decay treatment addresses the carious lesion and not the disease as an ensemble, engaging dentists in repetitive, stereotypical practice, often alien of patient psychosomatic structure. Major patient reluctance in soliciting caries treatment consisted in fear of pain, dental anesthesia, and noise generated by rotary instruments, especially high-speed handpiece [1, 2], leading to the avoidance of conventional dental treatment by almost 50% of them [1].

The remarkable progress registered in caries diagnosis tools, technologies, and restorative materials used has led to ultraconservative, minimally invasive approach in decay treatment,

with preservation of dental hard tissues (enamel, dentine) and even of affected dentine, which is capable of remineralization. Such advances have exclusively been conceivable due to consistent interdisciplinary cooperation between the field of dental medicine—that means to offer its patients the best treatment possible and the least invasive all along, and the field of applied modern technologies—which generates all the materials and equipment required for this purpose. The results of this interdisciplinary research have led to new approaches at carious disease as a whole and, concurrently, to ultraconservative attitudes. In this context, preparation of hard dental tissues benefit nowadays from alternative, "nondrill" methods, which offer special benefits, both for patients and dental practitioners, such as the following:

- Reduction of fear and increase of confidence in caries treatment
- Positive impact on patients' quality of life
- Addressability of all patient categories
- Improvement in practitioners' performance and satisfaction

The concept of minimally invasive caries treatment was introduced to dental medicine in the beginning of the 1980s through preventive resin restorations, followed in the 1990s by atraumatic restorative treatment (ART) and chemomechanical treatment (CarisolvTM). At present, new methods are available, such as air abrasion, sonoabrasion, ozone, and laser therapy [3]. Although air abrasion was first developed in the 1940s by Dr. Robert Black and improved by Dr. J. Tim Rainey, it resurfaced and grew in use barely in the 1990s, together with minimally invasive and adhesive dentistry [4, 5].

Air abrasion, as an alternative technique of cutting hard dental tissues, is an ultraconservative method in the following situations:

a. Incipient caries of pits and fissures, which are difficult to diagnose and which, despite preventive measures, still count for 90% of newly appeared caries in children and adolescents [6]. In this uncertain diagnosis [7], the practitioner may opt either to treat the lesion or only to monitor it, with questionable benefits in time [8]. In this specific lesional stage, air abrasion is the method of election, as bur preparation of pits and grooves would remove a greater quantity of healthy dental tissues as compared to air abrasion, which is more conservative [9].

If, after air abrasion removal of organic debris in pits and fissures, no decay is found, dental sealants are applied, benefiting from improved adhesion. If caries is found, the preparation is continued until complete removal of decay, with minimal loss of hard healthy tissues, being followed by preventive resin restoration.

b. In case of dental abrasion, erosion, and abfraction, air abrasion removes, without cutting dental structures, the shiny surface layer which is inappropriate for good adhesion. Thus, rough surface results [10, 11], adequate for the adhesion of restorative materials [12, 13].

c. In case of marginal repair or restoration resurfacing, air abrasion removes a small quantity of dental tissue or restoration material, respectively, increasing restoration's life span and esthetics.

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Other benefits of air abrasion caries treatment are as follows:

- It does not require dental anesthesia.
- It does not produce noise, vibrations, pressure, or heat.
- It removes only the decayed tissues with minimal loss of healthy tissues.
- It eliminates the risk of microfracture and microcrazing at the level of enamel margins.
- Dentinal tubules remain clogged after air abrasion therapy.
- It improves bond strength of restorative materials to enamel and dentin.
- The method is fast and simple—in the same dental appointment several incipient caries can be treated.

Air abrasion precautions of use during caries treatment include the following:

- It is not used in deep cavities, due to the risk of opening the dental chamber.
- It is not recommended in subgingival caries and also for removal of amalgam restorations, due to releasing mercury aerosols.
- An efficient protection is required for dental practitioners (mask, glasses, gloves) and patients (glasses).
- The risks of abrasive powder inhalation, emphysema, gingival, or smooth oral tissue lesions which might occur to patients are prevented by the use of rubber dam.
- The flow of abrasive particles and air pressure are controlled by the device; the narrow diameter of the ejecting needle, the position, and distance from where the abrasive flow is projected , all of these thus avoiding any possible accident.
- High-speed suction is required to remove the abrasive powder that accumulates during treatment.
- Patients with pathologies such as severe dust allergy, asthma, and chronic pulmonary disease should avoid air abrasion procedures [4, 5, 14, 15].

The air abrasion device resembles a small sandblaster and acts through a flow of extremely fine abrasive particles—sodium bicarbonate, aluminum/silicon oxide, bioactive glass (according to the clinical situation)—which is projected with force from the handpiece on tooth surface, by use of air or gas propulsion.

2. Aim

The practical evaluation of air abrasion technique (Bio-Art microblaster, Bio-Art, Brazil) was made in clinical applications such as fissure sealing and preparation of ultraconservative cavities.

3. Material and method

Bio-Art microblaster (Bio-Art, Brazil) is a pneumatic, portable, ergonomic, and easy to install and use air abrasion handpiece. It is specially designed for simple, small-scale clinical interventions, being practical, precise, and ensuring accuracy in use (Figure 1).

Figure 1. Bio-Art microblaster, Bio-Art, Brazil [16].

The handpiece is produced in two models:

1. The standard model, containing a fixed 138° nozzle.
2. The Plus model, containing two removable and autoclavable nozzles, mounted at 138° for anterior teeth and 90° for posterior teeth.

The equipment package contains: microblaster, quick coupling, handpiece connector, various nozzles, tank for abrasive powder, and user manual.

The aluminum oxide abrasive powder used in the survey was 75 μ grit, which was suitable for removing fissure stains and questionable incipient caries [16].

The occlusal fissures of 20 teeth (molars and premolars) were prepared (14 extracted teeth and 6 clinical cases). The following materials were used:

- 37% phosphoric acid, Rx Etchgel, Dental Life Sciences, UK
- Point 4 composite kit, Kerr, US
- Rx ColourFlow Orange, Dental Life Sciences, UK (flowable composite for restoring extracted teeth)
- Rubber dam kit, Hygenic Fiesta, Coltene, Switzerland, for isolating the operatory field in patients
- G-aenial Universal Flo A2, GC, Japan (flowable composite for restoring patients' teeth)

The following principles [14–18] were considered when using the air abrasion device:

http://dx.doi.org/10.5772/65419

- The working technique should be tested on extracted teeth prior to patient application, as tactile sense is absent.
- The nozzle tip should be placed 5–10 mm far from tooth surface and slow translation moves are made [16].
- It is not recommended to insist in a single spot during preparation, as too much tooth structure will be removed.
- Frequent working pauses should be made, in order to assess the results of preparation every few seconds.
- Inspection with 5× dental magnifying glasses (loupes) is recommended, in order to assess air abrasion efficacy of cutting dental structures.

4. Results

4.1. The air abrasion preparation protocol with Bio-Art microblaster on extracted teeth consisted of the following steps [19]

- Selecting 14 teeth with fissure stains/questionable incipient caries
- Mounting the teeth in putty silicone base
- Coupling the microblaster to the dental unit
- Preparing pits and fissures by air abrasion to obtain ultraconservative cavities
- Restoring prepared cavities with flowable composite—Rx ColourFlow Orange, Dental Life Sciences, according to the protocol

The preparation and restoration of two extracted lower molars are shown: one with deep stained occlusal fissures (Figures 2–6) and the other one with fissural caries (Figures 7–11) [19].

Figure 2. Lower molar with deep, stained occlusal fissures.

Figure 3. Aspect after air abrasion.

Figure 4. Application of etching gel.

Figure 5. Application of adhesive.

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Figure 6. Restoration with Rx ColourFlow Orange.

Figure 7. Lower molar with fissural caries.

Figure 8. Aspect after air abrasion.

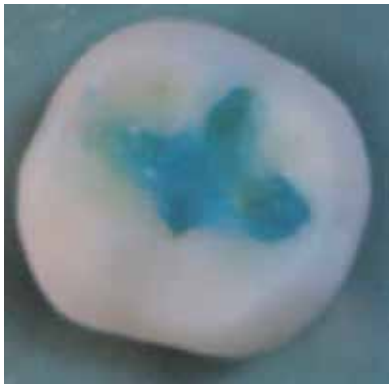

Figure 9. Application of etching gel.

Figure 10. Application of adhesive.

Figure 11. Restoration with Rx ColourFlow Orange.

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4.2. Clinical cases

Bio-Art microblaster was used in six clinical cases that displayed stains and incipient caries in the occlusal pits and fissures, according to the subsequent steps [19]:

- Coupling the microblaster to the dental unit
- Applying rubber dam
- Preparing carious lesions by air abrasion, according to the previously mentioned indications and precautions of use
- Morphofunctionally restoring of teeth according to the protocol: acid etching for 30 seconds with Rx Etchgel; application and photocuring the adhesive for 20 seconds; application, adaptation, and photocuring G-aenial Universal Flo A2 composite for 40 seconds

The sequences of clinical steps are shown in Figures 12–17 [19].

Figures 12-17. Patient I.A., 30 years old, female; Tooth 3.5 (lower premolar) displaying superficial occlusal decay. Treatment phases.

Figure 12. Lower premolar with superficial occlusal decay.

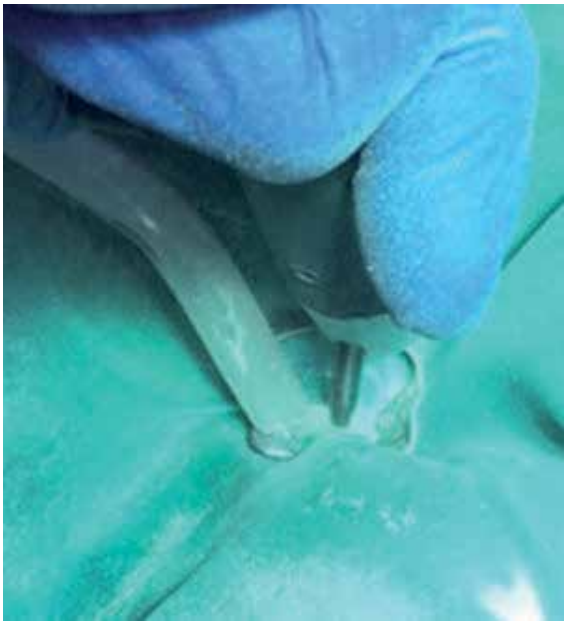

Figure 13. Air abrasion in use.

Figure 14. Aspect after air abrasion.

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Figure 15. Application of etching gel.

Figure 16. Application of adhesive.

Figure 17. Restoration with flowable composite, G-aenial Universal Flo A2.

4.3. Another possibility of using air abrasion is adhesion improvement in view of applying orthodontic retainers [19], which is shown in Figures 18–23

Figures 18–23 show air abrasion use in view of improving orthodontic retainer adhesion.

Figure 18. Initial aspect.

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Figure 19. Air abrasion in action.

Figure 20. Aspect after air abrasion conditioning of dental surfaces.

Figure 21. Application of etching gel.

Figure 22. Application of adhesive.

http://dx.doi.org/10.5772/65419

Figure 23. Final aspect, after retainer application.

5. Discussions

The appearance of adhesive materials and their increasing use has led to more conservative preparation of dental tissues. Alternative techniques to bur preparation have emerged and developed. They have the advantage of being minimally invasive, removing altered dental tissues with minimal sacrifice of sound tissues; they do not produce vibrations, noise, pressure, or heat and are well tolerated by patients, being painless in the majority of situations, thus rarely needing anesthesia. All these advantages are displayed by the air abrasion technique, which is more often used in dental practice. Research made on air abrasion assessed various aspects of its application technique. Special attention was granted to clinical, macroscopical, and microscopical evaluation of retention of various restoration materials applied on teeth prepared by air abrasion. The degree of patient acceptance and dentists' opinions on this method were also investigated.

The most important aspect of air abrasion to be considered is practicing the method on extracted teeth, prior to applying it to patients. Thus, dentists become acquainted with the method, which lacks tactile sense, and also learn to control certain parameters which influence the preparation: working distance from the operatory field, nozzle orifice diameter, air pressure in the device, abrasive particles dimensions, and flow [20]. By mastering these parameters and applying the specific protection measures recommended, efficient and safe dental preparations are obtained, leading to high acceptance by patients [2, 21, 22], as our study revealed as well. Although time spent for air abrasion therapy was found to be 1.5 higher than in case of burs, it tends to shorten as more preparations are performed [23].

Air abrasion was found suitable for diagnosing fissural caries and conditioning occlusal surfaces prior to sealant application. The results after 6 months evaluation demonstrated sealant retention in 83% of treated teeth [24]. Also, sealant retention rate was higher when applied to sound pits and fissures prepared by air abrasion and acid etching than in those prepared only by acid etching, at evaluations made after 6, 12, and 24 months following application [25]. However, another study found no statistical difference in sealant retention degree after tooth preparation by acid etching or air abrasion at 1-, 2-, and 5-year evaluations [26].

Shear bond strength of various materials applied to enamel after air abrasion was another topic investigated. Thus, Ellis et al. [27] assessed shear bond strength of sealants applied to enamel surfaces prepared by air abrasion, with and without etching with 35% phosphoric acid. Their results demonstrated that shear bond strength was greater when air abrasion was associated with acid etching.

Wright et al. [28] evaluated microleakage produced at tooth-sealant interface in three different situations: pits and fissures prepared by rotary instruments and acid etching; air abrasion preparations; and dental sealants applied after acid etching. The least microleakage appeared in bur preparation, followed by acid etching.

Borsatto et al. [29] assessed enamel shear bond strength in teeth treated by acid etching (15 seconds with 37% phosphoric acid) or by air abrasion or by combining the two methods. Survey findings were that air abrasion could not substitute acid etching, their association being needed for best results.

Abraham et al. [30] made a review of research made on nondrill methods (air abrasion, laser, and chemomechanical method) and their efficacy in treating dental decay. The study conclusions were that the alternative techniques were not superior to dental burs in removing carious lesions, although having the advantage of preserving more sound dental tissue. The duration of nondrill interventions is increased as compared to bur preparations but patients tolerate them better, especially because of the lack of pain, thus being especially useful in children and anxious patients. Other conclusions referred to the need of exercising nondrill methods on extracted teeth before being applied to patients and to the higher costs of equipment acquisition, compared to conventional rotary handpieces.

More studies are needed in order to assess all the aspects that concern the use of nondrill methods.

6. Conclusions

1. In order to assess the practical use of air abrasion with Bio-Art microblaster, the occlusal pits and fissures of 14 extracted teeth were prepared, followed by 6 clinical cases.

2. Air abrasion preparation of pits and fissures when the caries diagnosis is uncertain may lead to removal of organic debris, leaving rough enamel capable of providing adequate

http://dx.doi.org/10.5772/65419

sealing. In case of fissural caries, air abrasion prepares ultraconservative, adhesive cavities, for preventive resin restorations.

3. Exercising air abrasion technique on extracted teeth is mandatory, in order to avoid useless sacrifice of healthy hard dental tissue and any other undesired side effects in patients.

4. Although preparation time takes longer than in case of burs, air abrasion technique is better accepted by patients, especially due to lack of pain; preparation time might diminish with practitioner's increase of experience.

5. Air abrasion with Bio-Art may be safely applied to patients if the protocol of use is followed and specific protection measures are taken.

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Chapter 9

The Medial Turn in Knowledge Society

Aldo Haesler and Michelle Dobré

Additional information is available at the end of the chapter

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Abstract

Many discourses tend to consider change in techniques as the main trigger for social change and economic development. This paper proposes the original hypothesis that the development of new techniques occurs *at the end* of a long lasting societal process, not as its cause. The rising of the knowledge society since the 17th century is engaged today in what we called *the medial turn* – defined as a cultural shift through the generalized digital communication. This process is the conclusive stage in the modernization process of societies conceived as positive-sum-game networks. Based on MacLuhan's famous idea that the "medium is the message", we address a few questions specialists and engineers are to be confronted to in the medial age.

Keywords: technique, engineering, digital media, knowledge society

1. Introduction

The impact of the form of the media had more structuring effects in the domains of scientific interaction and cooperation than anywhere else in the field of social communication. The "global village" emphasized by Marshall McLuhan (1967)(1) 50 years ago, which has been largely criticized and ironized by his bygones at the time, has now become the overall reality. It is possible to define it as a scientific global village without borders, centers, or authorities. But this paradigmatic shift is generally considered either as the expression of the ultraliberal ideology (as a particular expression of the Hayekian "Grand Society") or as a simple expansion of dematerialized communication in "reflexive modernity" (Anthony Giddens). All this is not false, but it is merely reductive because what really happens today is the emergence of a third form of communication we are far from understanding properly. The most cautious attitude toward this shift is a humble heuristics with a great portion of skepticism regarding linear historicity—which always considers the new as the continuation of the old in another form—

and some epistemological creativity more interested in original questioning than in preserving certainties.

2. The medium is (also) the message

The form of a media dwells in its technological hardware. What McLuhan asserts with his legendary formula is more than the classical Aristotelian hylemorphism that postulates the nondissociation of form and content; it is actually its complete turnaround. McLuhan never said that the medium is a message as such, but only that the form of a given message could be completely different if the medium changed, e.g., if a roman law expressed in simple scripturality is translated into mechanical scripturality at the Gutenberg Age. The first step to be taken, if we want to investigate this transformation in the meaning of the message, is to consider how this new kind of communication functions in technological terms. In other words, how the hardware determines the software. Traditionally, technicians and engineers were supposed to understand how things work and perform to their best. But if we read McLuhan correctly, it is much more than that. One could infer that their real job refers to (or at least should) the way their artifacts open a field to meaningfulness, whose options are, afterwards, constructed by social forces. It is well known now that the invention of the wheel by Inca engineers or handymen never ended linearly in new forms of circulation and territorial policies [2,3], but was simply (but is this so simple?) used as a tool for new toys. The main difference between the Inca handyman and the engineer of our medial age is that the handyman was never asked to imagine what kind of options and meanings his invention could acquire, whereas the contemporary engineer, on the contrary, has to assume this important effort. The point is that this effort is not necessary because of the universal accessibility of information, not even (!) because of the risks that technological innovations carry on; the point is, let aside that nobody else could perform this effort, this is (or should be) part of his or her scientific responsibility.

Another point should be mentioned too. We could argue that this mission is assumed by prospective studies that could be part of the education and the professional training of the engineers. But that is only the obvious, shallow part of the problem. The most important function is, in fact, to outline all the possible options opened by hardware techniques; we refer to what we could call the aesthetic part of technical investigation. When the perspective was discovered during the Quattrocento in Italy, nobody could imagine what kind of consequences this new representation technique could have in mathematics, physics, and, especially, in practical arts like architecture. It was necessary to wait for Erwin Panofsky [4] to understand the link between all these disciplines and arts. It took five centuries for the relation between this invention and its consequences to be seriously understood. No need to say that such delays are nowadays impossible to accept.

3. From power to knowledge

Since Arnold J. Toynbee, human history can be periodized in three different societal regimes: (1) nomadic hunter gatherers, (2) traditional societies, and (3) modernity. The most important

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sociological question is to understand how these societal regimes establish their cohesion. While nomadic societies are hold together through a strong symbiosis between actors, society, and environment, all integrated by ties of symbolic exchange, traditional societies mainly reproduce their synthesis by the media of power [4]. The particularity of this media is that it cannot be shared, you have the power or you have it not. If you lose it, somebody else would get it and reversely. In this sense, power is a resource for a zero-sum-game. Power must be legitimated. Since human agents are led by conscience and not by their instincts, situations of big risk of societal collapse excepted, this legitimation can only be reasonably asserted and universally admitted if a transcendent dimension guarantees power relations. In other words, God's will is the guarantee to legitimate social hierarchy. Due to the astronomic discoveries in the late 16th century, which drew scholastic thinking into deep contradictions between its Aristotelian frame and the newly discovered realities, the transcendent dimension backed away, especially in Europe [5]. The everlasting wars during all this century began to embody again the figure of a Deus absconditus, a hidden God who turns his back on humanity, away from the consequences of the misusages of human free will. This situation of a complete contingency is unique in human history. In the absence of God, humans had no other choice but to use their own reason (which is, after Augustinus, a gift of God) to master a kind of social order, to avoid collapse, and in other words, to share their reason and knowledge in order to figure and end to disorder and war. Instead of the transcendent divine will, a new world had to be created, imagined through the immanence of reason. But this new way to manage human affairs involved another resource than power, i.e., reason and knowledge. This is the turning point: reasonable knowledge is a resource for positive-sum-games, totally different from the zero-sum-power fuelled games. And there is more. If done properly —and this is an institutional issue of paramount importance—sharing knowledge between two or more sources gives place to a synergetic effect. This effect can only be reached if ideas and reasons have the freedom to circulate. So, the knowledge society has its roots in the early Enlightenment. It fueled the process of individualization and rationalization supported by the proofs that their synergetic answers were capable to create social order in God's vacancy.

Modernity is not a creation of scientists, technicians, lawyers or philosophers; it is the creature of the positive-sum-game. Under given conditions, this game is the chance to interconnect different kinds of knowledge in order to achieve new solutions and innovations. The misleading idea was that the man is a homo faber. He is that indeed. But he was a homo faber during all his history and did not wait the late 16th century to develop his abilities and it is, therefore, important to acknowledge that these competences began to be cumulative and synergetic only as parts of a positive-sum-game. This means that by essence knowledge sharing opposes to power games. Knowledge is the only win-win game possible. Alas, the dark side of the process is that, if human transactions are considered under this light, there is no limit in human material needs. The Greek called this illimitation pleonexia, which is the mother of all Hybris, the loss of measure. It is insofar a perversion of "human nature" since the material universe, in any traditional society, must be conceived as a strictly limited and ordered cosmos. The conception of unlimited goods is impossible in the mind frame of such a cosmos. Thus, whereas the synergetic effects achieve Enlightenment and all the modern achievements in the ideational world, this process has its shadowy or even cursed side in the illimitation of the material world.

Parallel to the elaboration of knowledge society during the 17th century, this new paradigm of human transactions gives place to what we call "risk society" since Ulrich Beck in late modernity.

Another consequence of the positive-sum-society is individualization. Even if freedom of will and action is certainly the most important normative achievement of modernity, this constitutive part of the individualization process has its dark side too. In a traditional zero-sum-society, social ties are strong and give human beings a kind of ontological security they cannot afford anymore. Social ties are strong in the traditional world because everything in the "great chain of being" (Arthur O. Lovejoy), which forms its cosmos, is linked by relations of indebtedness, especially among humans. And, the social logic of zero-sum-games is the imbalance of cost and benefits in every form of transaction. If (A) makes a profit (a+) on the costs of (B), (a+) and (b−) are equivalents under the condition that in a further transaction (A) has to carry the costs and (B) will profit on histurn—either as a reduced (A/B) or enlarged form of exchange (A/B/C….A). Under the condition of positive-sum-game, (a) and (b) are not in a relation of indebtedness, but of mutual profit, either in a reduced dual (a+) ⇒ (b+) or in collective form (a +) ⇒ (b+) ⇒ (c+), etc., like in Mandeville's fable of the bees (1704), where private vices contribute to public virtue. In such a situation, social (debt) bonds are replaced by the individual pursuit of profit, happiness or vice. This pursuit is moral insofar, as the individual advantage (a+) can be considered as the condition for (b+) or (c+). This is the exact definition of individuality. In other words, the price of freedom is not just loneliness, but also the ontological insecurity. In place of God, modern individualistic societies placed the ongoing process of Mandeville's fable.

The two pillars of modernity, illimitation of goods and individualization, share obviously the same root; and insofar, the two dark sides of these pillars, the ecological collapse due to unlimited growth and social loneliness, are coming from the same origin. Unfortunately, this origin has hardly been unveiled.

4. Orality, scripturality, and beyond

But let's get back to our initial concern, the form of communication. If we consider its history we can distinguish one shift and a half—and possibly another full shift occurring today. The first and most important shift is the passage from orality to scripturality, from the word to the letter [6,7]. Besides the obvious effects of this transformation—from direct to indirect communication, from immediate to mediated proof, from concretion to abstraction, etc., —Walter J. Ong and Jack Goody underscore its cognitive effects in the direction that, once again, the medium is the message. Literacy, as training to read linearly from one side to another and from above to below, transforms the perception and understanding of the world while restructuring our brains. Once we have learnt how to read, we live in another world than in the oral one, by forgetting the memory of the former world. Another shift occurred when Johannes Gutenberg invented his printing machine. Here too the consequences were of unexpected relevance. The dereliction of high literacy (Latin and Greek) in favor of the lingua franca homogenizes

http://dx.doi.org/10.5772/65420

territories and, according to Anderson [8] builds the modern nationalist imaginary. Not to speak about the protestant schism, the democratization of knowledge, the formation of the public sphere, and, last but not least, the production of paper money. The whole process of secularization relies on this invention. In clear words, it is this invention that renders possible the modern positive-sum-society. Gutenberg was a genius handyman; he should have had the speculative intelligence of a Copernicus to draw conclusions about his invention. Both lived at the same time. We can only speculate about what would have happened if they had actually met.

Our intention in this short essay is to highlight the opportunity of a third revolution in the form of communication that we call the medial turn. By medial turn we understand the computerization of communication through electronic social networks and devices. The main differences between scriptural and medial communication are as follows:

1. The material supports are not anymore paper, pens, books, libraries, archives, newspapers, or bookshops, but hardware and software, electronic networks and architectures, and so on.
2. Immaterial issues as grammatical skills, knowledge, memory, patience, interiority, rhetoric capacities, or linear thinking are replaced by algorithms, googling, iconic capacities, high-speed competences, flexibility, ubiquitous abilities, constant updates, personal flexibility, etc.
3. Instead of linear communication, the medial world performs reticular through growing and more and more interconnected networks; besides this spatial effect, communication excludes the factor time by instantaneity.
4. On the cognitive level, the patient linear and causal thinking is replaced by high-speed rhizomatic and simultaneous cognitive structures.

The following four options should therefore be tested:

1. The medial turn is just a continuation of the Gutenberg-galaxy: there is no McLuhan-galaxy; scripturally is the last word in human communication; it is the posthistoric hypothesis.
2. The medial turn fulfills the program of scripturality; it is a qualitative shift of scripturality due to computerized devices; mediality fulfills scripturality; we can speak about as the hypothesis of reflexive modernity.
3. Mediality is per se a revolution in human communication; literally, communication is replaced by icons and numbers; we can call it that the postmodern hypothesis.
4. "Gutenberg" was only the first step in a process we largely ignore and we only named "modernity" by default; this second step should help us understand what the process of modernization really means; we call it the protomodern hypothesis (Haesler, forthcoming 2016)./11/

These four hypotheses [9,10] are all true and productive but each one from another perspective. The main criterion to distinguish them is purely heuristic: which hypothesis generates more

questions? As a matter of fact, we can neglect the first one, which is based on the "end-of-history" assumption (Fukuyama's thesis). It is enough to say "nothing new under the sun," besides the pure quantitative effect of dematerialized communication. The second one is also heuristically poor. The only question of interest is what scripturality is missing, compared with mediality. Obviously, it is the ubiquity of communication and the shift from the stock to the flow of information, as underscored by Rifkin in The Age of Access [12]. As far as in the medial age we no more have to know what, but only to know where we get the information, the Google sphere offers us an effective relief. Due to this alleviation, we can communicate without any local and temporal restraints. The postmodern hypothesis is the most radical one and seems to be the richest, in heuristic (discriminant) terms. In his thesis of "singularity," Kurzweil [13] postulates a post- or trans-human age in which, through the "law" of Moore, machinery intelligence supersedes the human one. But this radical perspective that scenarizes an anthropological revolution, where only a small elite of super humans will remain consistent with machinery, while reducing the rest of humanity to "human waste" [14], is a kind of "end of history" too; it is the proper end of human history. So, its heuristic power should be at first eschewed for ethical reasons, but it could also be for epistemological reasons. Since the "context of discovery," according to Reichenbach [15], still engages human creativity (not to speak about the "context of justification), which always has its unpredictable and imaginary part, this anthropological revolution would exclude human nature from the whole process of discovery and opens the door to endless algorithms.

If the hidden agenda of modernity is the substitution of zero-sum-game by positive-sum-game structures in the medial society, the price to pay for all the synergetic effects of this sort of games is double: (1) on the one hand the algorithmic management of every form of scarce resources, and (2) on the other hand the reduction of human nature to a hybrid, as cynically emphasized by the new guru of world sociology, Latour [16]. Probably, the algorithmic management of scarce resources could not be worse than the actual agonizing muddling-through strategy of short-term thinking politicians. On the other hand, the reduction of humans to nothing more than cross-points in a universal network destroys their uniqueness (mere singularity!) in all living systems, to be the only species who is conscious of the consciousness of other humans and to be aware that the others know it as well.

The hardware of the medial age is now close to perfection. According to our McLuhanian assumption that, as the medium determines the message, the hardware will determine the software, the only specialist to be able to imagine what kind of software could be produced by that kind of hardware are the engineers. It is quite an understatement to say that they are not fully aware of this responsibility.

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Chapter 10

Application of New Generation Geometrical Product Specifications—Position Tolerancing

Pavlina Kalcheva Toteva-Lyutova, Stoyan Dimitrov Slavov and Krassimira Stoyanova Koleva

Additional information is available at the end of the chapter

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Abstract

The geometrical product specifications (GPSs) from new generation are composed of several standards issued by the ISO/TC 213. They are related to the way of denoting the requirements in the design engineering drawings, such as drawing indication, definition of tolerance and values of specifications, characteristic, parameters and definitions of actual features. They also include requirements relating to compare verification, measure instrument and calibrate size, distance, radius, angle, form and position of geometrical features, roughness profile, waviness profile, primary profile, surface imperfection and edges. A lot of new and mathematical terms, the size system, indications of dimensions other than linear sizes by using geometrical tolerances, uncertainty series, etc. are introduced in this chapter. The aim of this chapter is to explain the new requirements of new generation standards for geometrical product specifications related to positional deviation. The advantages and disadvantages of the possibility to indicate the accurate requirements for location of surfaces and axes are discussed.

Keywords: ISO, standards, specification, verification, dimensioning, tolerancing, position

1. Introduction

Locational deviation is such type of deviation, which determines the deviation of a feature (for example, surface, line and point) from its nominal location. The location is relevant to one or more (other) datum feature(s). The locational deviation also comprises the form deviation and the orientation deviation (for example, the surface, axis or median face; see Figure 1) [1]. The locational deviations are assessed over the entire feature, when not otherwise specified. Locational deviations are derived analogously to the size, form and orientation deviations.

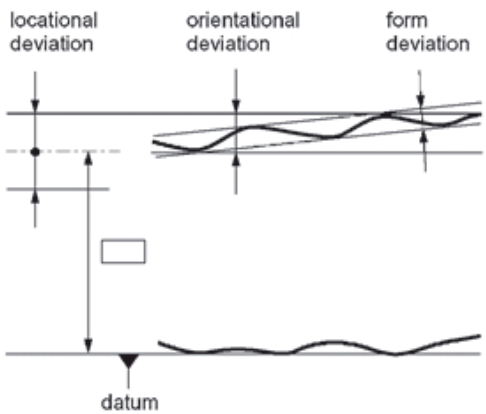

Figure 1. Form deviation, orientational deviation and locational deviation [1].

The definition of the positional tolerance is given in ISO 1101 [2], and methods for positional tolerancing are described in ISO 5458 [3].

In the method of positional tolerancing, the location of features is determined by theoretical exact dimensions and positional tolerances (points, axes, median faces and plane surfaces) relative one or more datum(s) to each other. In this case, symmetrical arrangement of the tolerant zone around the theoretically correct position is given.

2. Tolerancing of features by position

The location of features is one of the most frequently used applications of dimensions on technical drawings. Tolerancing may be either by coordinate tolerances applied to the dimensions or by geometric (positional) tolerancing.

Positional tolerancing is especially useful when applied on a maximum material condition (MMC) basis to groups or patterns of holes or other small features in the mass production of parts. This method meets functional requirements in most cases and permits assessment with simple gauging procedures.

2.1. Tolerancing methods

The location of a single hole is usually indicated by rectangular coordinate dimensions extending from suitable edges or other features of the pan to the axis of the hole. Other dimensioning methods, such as polar coordinates, may be used.

There are two standard methods of tolerancing the location of holes: coordinate and positional tolerancing.

1. Coordinate tolerancing (Figure 2 a) refers to tolerances applied directly to the coordinate dimensions or to applicable tolerances specified in a general tolerance note.

http://dx.doi.org/10.5772/65412

2. Positional tolerancing (Figure 2 b –d) refers to a tolerance zone within which the centre line of the hole or shaft is permitted to vary from its true position. Positional tolerancing can be further classified according to the type of modifying associated with the tolerance positional tolerancing, reciprocity requirement (RPR);positional tolerancing, maximum material condition basis (MMC) andpositional tolerancing, least material condition basis (LMC).

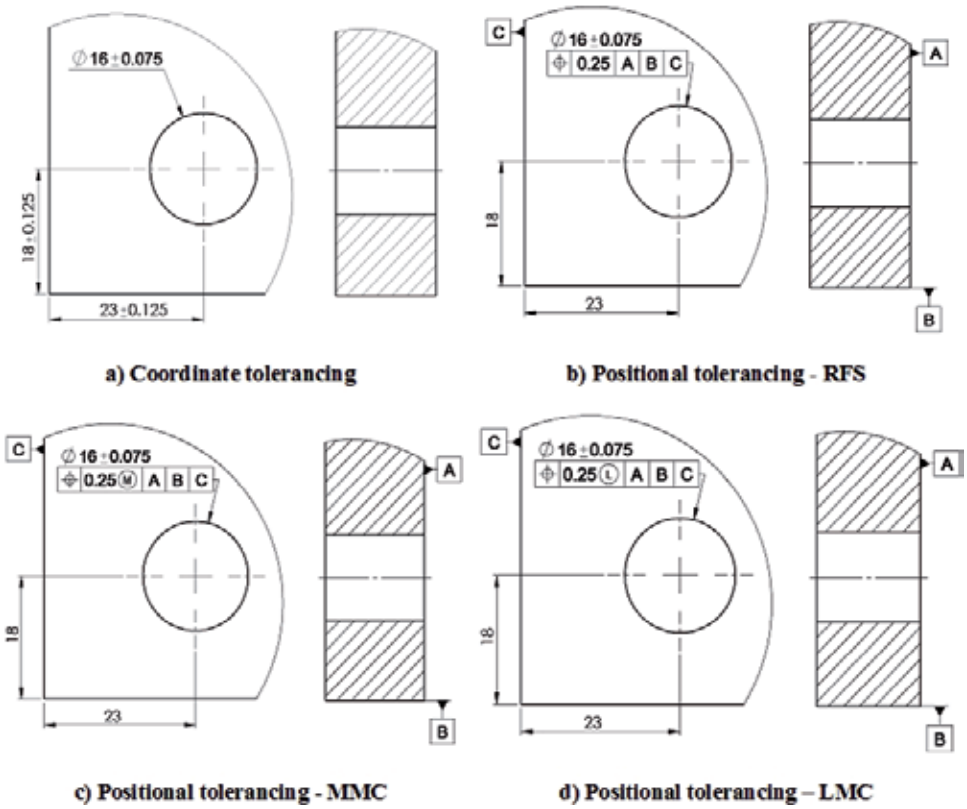

Figure 2. Overview of the standard methods of tolerancing the location of holes and the geometric tolerance parameters and symbols.

These positional tolerancing methods are part of the system of geometric tolerancing.

When the MMC or LMC modifying symbol is not shown in the feature control frame, it is understood that RPR applies.

Figure 3 a –d shows the tolerance zones by this way of tolerancing.

Any of these tolerancing methods can be substituted for another, although with differing results. It is necessary, however, to first analyse the widely used method of coordinate tolerancing to explain and understand the advantages and disadvantages of the positional tolerancing methods.

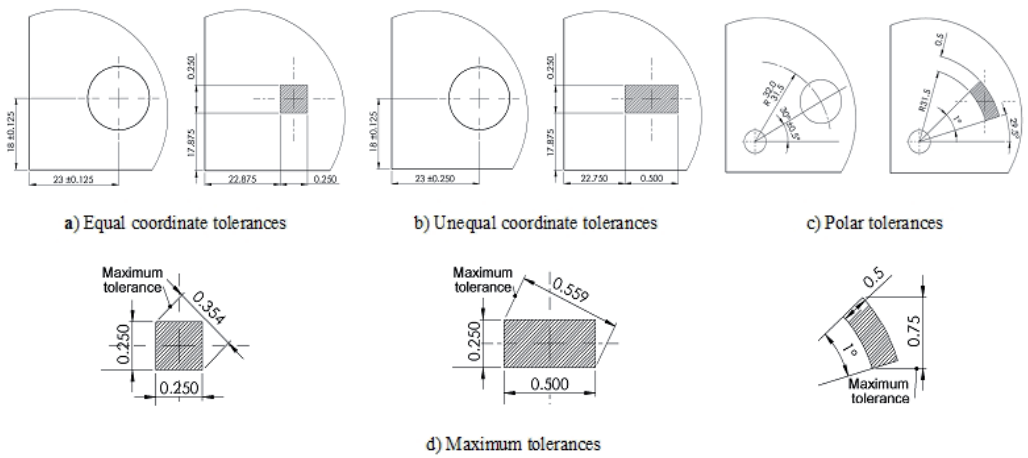

Figure 3. Overview of the coordinate and polar tolerances.

2.1.1. Advantages of coordinate tolerancing

The advantages of direct coordinate tolerancing are as follows:

It is simple and easily understood and, therefore, is a method commonly used.

It permits direct measurements to be made with standard instruments and does not require the use of special-purpose functional gauges or other calculations.

2.1.2. Disadvantages of coordinate tolerancing

There are a number of disadvantages to the direct tolerancing method:

It results in a square or rectangular tolerance zone within which the axis must lie. For a square zone, this permits a variation in a 45° direction of about 1.4 times the specified tolerance. This amount of variation may necessitate the specification of tolerances that are only 70% of those that are functionally acceptable.

It may result in an undesirable accumulation of tolerances when several features are involved, especially when chain dimensioning is used.

It is more difficult to assess clearances between mating features and components than when positional tolerancing is used, especially when a group or a pattern of features is involved. It does not correspond to the control exercised by fixed functional GO gauges often desirable.

2.1.3. Main advantages of positional tolerancing

In comparison with dimensional coordinate tolerancing, the positional tolerancing has the following more important advantages:

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Function-related tolerancing with the largest possible tolerances is possible because functional relationships are better and directly indicated, and relationships to one or more datum(s) can be indicated unequivocally.

It is possible to indicate cylindrical tolerances. In comparison with tolerances of rectangular cross section, 57% larger tolerances are possible. In most cases, this is related to the function-related tolerancing, for example, mating of cylindrical surfaces (such as bolts with holes).

A simple application of the maximum material requirement with additional gain of tolerance is possible when using positional tolerancing.

2.2. Position tolerance according to ISO 1101

In ISO 1101 [2], the position tolerance of a point (see Figure 4), a flat surface or a median plane (see Figure 5) and a line (see Figure 6) are given.

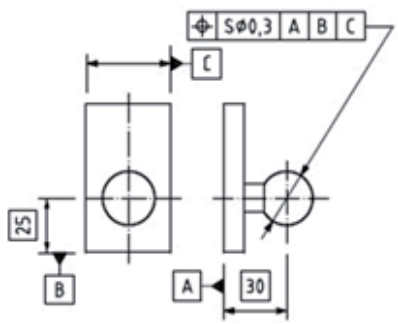

Figure 4. Position tolerance of a point.

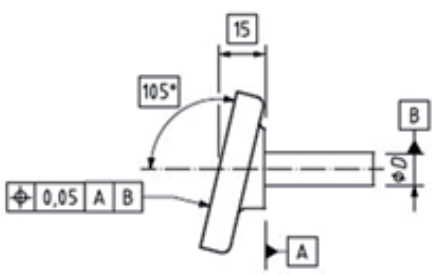

Figure 5. Position tolerance of a flat surface or a median plane.

The definition of the actual centre of a sphere has not been standardized in ISO 1101. According to this standard, the actual (extracted) centre of the sphere must be within a spherical zone (with diameter 0.3), and the centre of this zone shall coincide with the theoretically exact position of the sphere, according to datum planes A and B and to datum median plane C (see Figure 4).

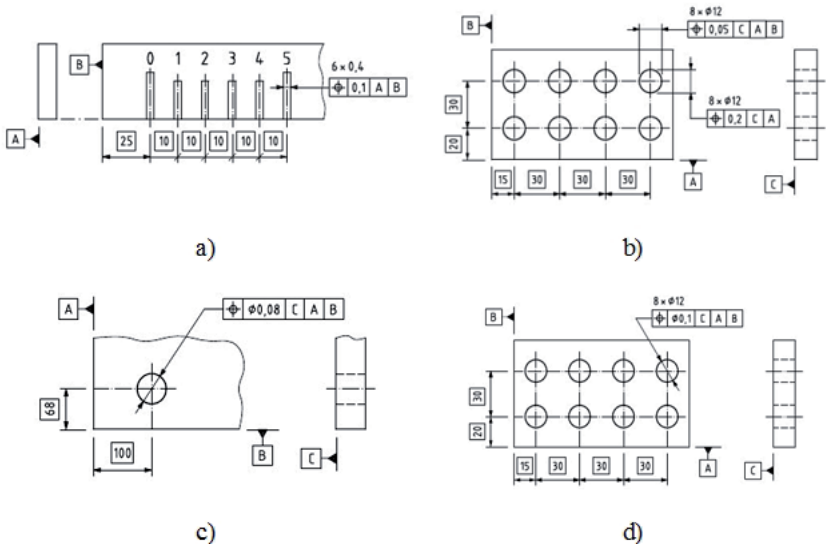

Figure 6. Position tolerance of a line.

The actual (extracted) centre line of each of the scribe lines shall be distributed between two parallel planes 0.1 apart, which are symmetrically located about the theoretically exact position of the considered line, according to datum planes A and B (see Figure 6a).

The actual (extracted) middle line of each hole shall be located between two pairs of parallel planes. These planes are positioned 0.05 and 0.2 apart, respectively, in the direction specified and perpendicular to each other. Each pair of parallel planes is orientated according to the datum system and symmetrically distributed about the theoretically exact position of the considered hole, according to datum planes C, A and B (see Figure 6b).

The actual (extracted) centre line must be within a cylindrical zone of diameter 0.08. Their axis must be coinciding with the theoretically exact position of the considered hole, according to datum planes C, A and B (see Figure 6c).

The actual (extracted) centre line of each hole must be within a cylindrical zone of diameter 0.1. Their axis must be coinciding with the theoretically exact position of the considered hole, according to datum planes C, A and B (see Figure 6d).

The actual (extracted) surface shall be distributed between two parallel planes 0.05 apart, which are symmetrically located about the theoretically exact position of the surface, according to datum plane A and datum axis B (see Figure 5).

3. Material condition basis

In ISO 2692:2014 [4], the maximum material requirement, the least material requirement and the reciprocity requirement are defined. The correlation between dimensional and geometrical

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precision of the element is determined by functional requirements, such as providing opportunities for assembling parts with clearance (in this case, requirements for maximum material are established) or, if necessary, to restrict the minimum wall thickness between the elements of one and the same part (in this case, it implies a requirement for a minimum material).

3.1. Reciprocity requirement (RPR)

Reciprocity requirement (RPR) is only possible after a toleranced feature has been used. RPR should be included as an additional requirement on drawings when maximum material requirement (MMR) or least material requirement (LMR) is used. In this case, the RPR is indicated by the symbol R placed after the symbol M, or the symbol R placed after the symbol L.

Thereby, the size tolerance of the feature is replaced by the collective requirements MMR and LMR by using the additional requirement RPR. The size can take full advantage of the maximum material virtual condition (MMVC) and the least material virtual condition (LMVC) by means of RPR. The choice of distribution of variation allowance between dimensional and geometrical tolerances based on manufacturing capabilities is possible when RPR is used. The indication "0 M" can be expressed with RPR whilst maintaining the same work piece characteristics.

3.1.1. Maximum material requirement and RPR

In Figure 7a and b, examples are shown how the RPR can be indicated on drawings by the symbol R placed after the symbol M itself placed after the geometrical tolerance of the derived feature of the feature of size in the tolerance indicator to alter the maximum material requirement for the surface(s).

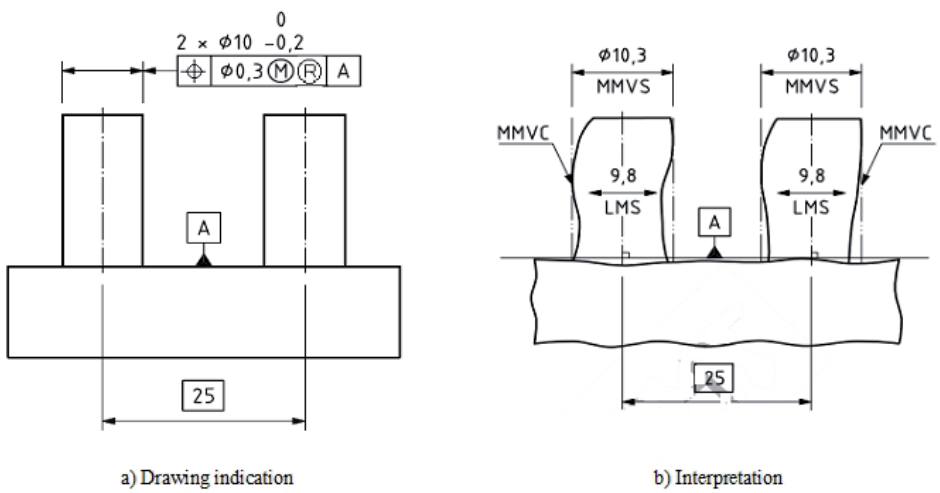

Figure 7. Examples of MMR for two external cylindrical features based on size and position (location) requirements.

An example with the assembly comprising a plate with two holes 25 mm apart is illustrated in Figure 7b. There is a requirement about holes to be perpendicular to the contact surface of the plate. The following interpretation is according to rules and definitions given in ISO 2692:2014:

a. The extracted feature of the toleranced pins shall not violate the maximum material virtual condition (MMVC), which has the diameter of 10.3 mm.

b. The extracted feature of the toleranced pins shall have everywhere a local diameter larger than LMS = 9.8 mm. The RPR requirement allows the size tolerance to increase.

The location of the two MMVCs is theoretically correct —at a distance of 25 mm relative to each other and perpendicular to the datum A. The RPR allows the dimensional tolerance increasing when the geometrical deviation does not take full advantage of the maximum material virtual condition (MMVC).

3.1.2. Least material requirement and RPR

In this case, the RPR indicated on drawings by the symbol R placed after the symbol L itself placed after the geometrical tolerance of the derived feature of the feature of size in the tolerance indicator to alter the least material requirement for the surface(s).

3.1.3. Related datum features with maximum material requirement

The maximum material requirement for datum features results in the following three independent requirements:A requirement for the surface non-violation of the maximum material virtual condition (MMVC). The maximum material virtual condition (MMVC) of the related datum feature shall not be violated by the extracted (integral) datum feature from which the datum is derived. A requirement for MMS when there is no geometrical tolerance or when there is a geometrical tolerance not followed by the symbol M. When the related datum feature has no geometrical tolerance or has a geometrical tolerance of form not followed by the symbol M, the size of the maximum material virtual condition (MMVC) of the related datum feature is the maximum material size (MMS). A requirement for MMS when there is a geometrical tolerance of form followed by the symbol M. When the datum feature has a geometrical tolerance of form and this tolerance is followed by the symbol M (see Figure 8), the size of the maximum material virtual condition (MMVC) of the related datum feature is the maximum material size (MMS) plus (for external features of size) or minus (for internal features of size) the geometrical tolerance.

The symbol M is placed on drawings after the datum letter(s) in the tolerance indicator, when MMR applies to the datum feature. If the datum is obtained from a feature of size, the use of symbol M after the datum letter is only possible indication. The corresponding sequence of letters identifying the common datum is indicated within parentheses, when maximum or least material requirement applies to all elements of the collection of surfaces of a common datum. The sequence of letters identifying the common datum is not indicated within parentheses, when maximum or least material requirement applies only to one element of the

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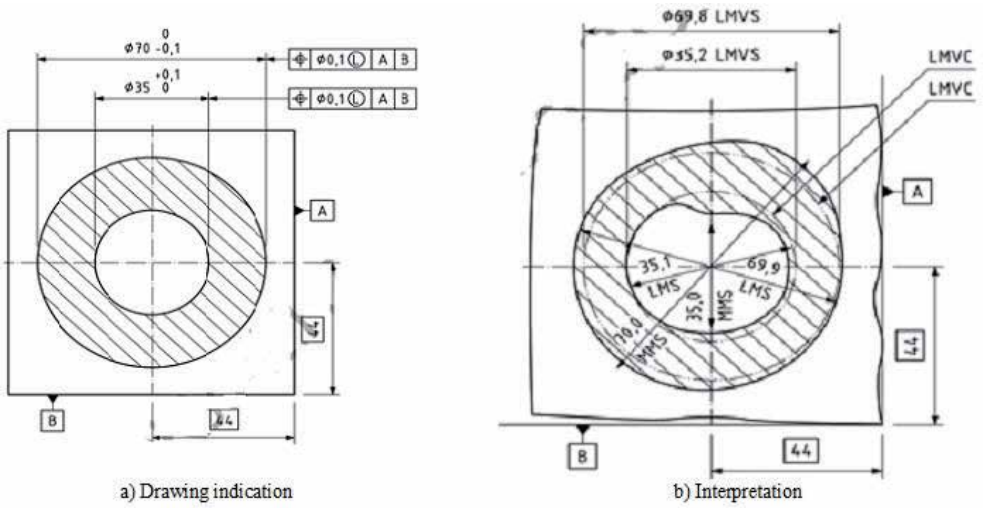

Figure 8. Example of LMR for two concentric cylindrical features (internal and external) both controlled by size and location (position) to the same datum systems A and B.

collection of surfaces of a common datum. In this case, the requirement applies only to the feature identified by the letter placed just before the modifier, and it specifies for the surface(s) in the following rules.

3 1.4. Related datum features with least material requirement

When the toleranced feature applies to the least material requirement (LMR), the indication on the drawing is the symbol L placed after the geometrical tolerance of the corresponding feature of the size in the indicator of the tolerance.

The symbol L is applied to the tolerancing of the features on both sides of the wall to fully control the minimum wall thickness. LMR can be implemented in two different ways, as follows.

In Figure 8, it shows the location tolerance for the two different sides of the wall, which can refer to the same datum axis or datum system. The symbol L, in this case, applies to the two toleranced features.

The intended function of the part illustrated in Figure 8 is the ability to resist internal pressure and prevent breakout.

The interpretation is based on the following rules and definitions given in ISO 2692:2014:

a. The diameter of least material virtual condition is LMVC = 69.8 mm, and the LMVC of the external feature shall be fully contained in the material.

b. Everywhere a local size of the extracted feature of the external feature shall be smaller than MMS = 70.0 and larger than LMS = 69.9 mm.

c. The diameter of the internal feature of the least material virtual condition is LMVC = 35.2 mm, and the LMVC shall be fully contained in the material.

d. Everywhere a local size of the extracted feature of the internal feature shall be larger than MMS = 35.0 mm and smaller than LMS = 35.1 mm.

e. The least material virtual condition (LMVC) of both the external and the internal features shall be in a theoretically exact orientation and the location relative to the datum system at a position of 44.44 mm.

It is permissible to have reference between location tolerances of the derived features for both sides of the wall as the datum. The tolerance for the toleranced feature and the datum letter is followed by the symbol L in this case.

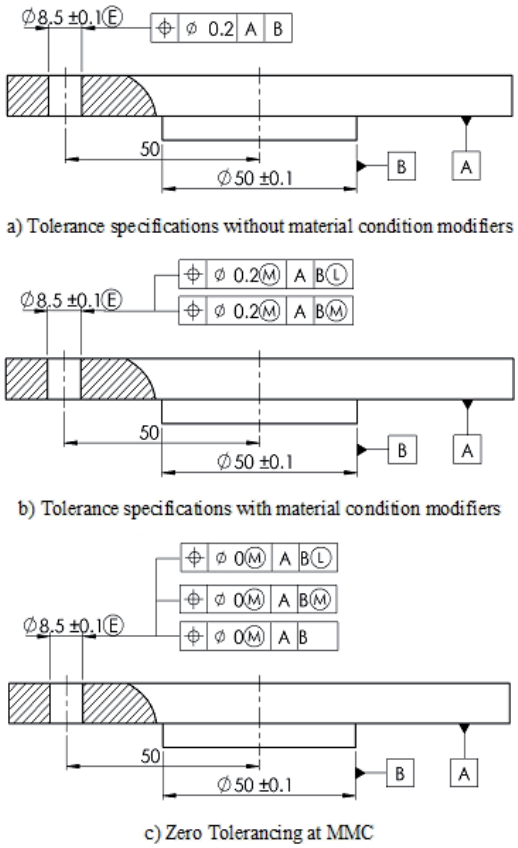

Figure 9. Examples of application of the new concepts to indicate the positional deviation.

If the datum is obtained from a feature of size, the use of the symbol L after the datum letter is only possible. The corresponding sequence of letters identifying the common datum is indicated within parentheses, when maximum or least material requirement applies to all

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elements of the collection of surfaces of a common datum. The sequence of letters identifying the common datum is not indicated within parentheses, when maximum or least material requirement applies only to one element of the collection of surfaces of a common datum. In this case, the requirement applies only to the feature identified by the letter placed just before the modifier.

Figure 9 shows practical examples of application of the new concepts to indicate the positional deviation in the drawings. In Figure 9 a, dimensions are indicated by E, if required a high mounting requirement is used the symbols for MMC and LMC (see Figure 9b) and O M inform to envelop requirements with connection to form and location tolerances (see Figure 9c). Some instructions about selecting tolerance of position control modifiers are given in Figure 10.

Modifier	Commonly used in these functional applications	Relative cost to produce and verify
Ⓜ	• Assembly; • Location of a non-critical FOS;	Lowest
Ⓛ	• Minimum wall thickness; • Minimum part distance; • Minimum machine stock; • Alignment;	Greater than MMC; Less than RFS
RFS invoked by showing no modifier	• To control a symmetrical relationship; • When the effects of bonus or datum shift will be detrimental to the function of the part; • To control minimum machine stock; • Centering; • Alignement;	Highest

Figure 10. Instruction about selecting tolerance of position control modifiers.

ISO 5458 [2] describes the principle of positional tolerancing for the location of regular and irregular features. However, for clarity, only regular-shaped features such as holes, bolts, studs or pins, parallel-sided slots, keys and keyways have been shown.

In Table 1, some specification modifiers [2] are given.

Description	Symbol
Combined zone	CZ
Separate zones	SZ
Orientation only	><
Simultaneous requirement N° i	SIMi

Table 1. Specification modifiers for linear size

By default, based on the independency principle defined in ISO 8015 [4], a geometrical specification of form, orientation, location or run-out, without modifier, applied to *n* geomet-

rical features (*n* being greater than one) is equivalent to *n* independent geometrical specifications: each geometrical feature shall be considered individually and each specification shall be considered individually (independent between them). The resulting independent tolerance zones correspond to an implicit indication of the separate zone (SZ) modifier: the "all around" modifier does not create itself a united feature or a pattern.

When positional tolerancing is applied to several geometrical features and all the non-redundant degrees of freedoms of the tolerance zones are unlocked, either the separate zone (SZ) modifier or the combined zone (CZ) modifier shall always be indicated in the second compartment of the tolerance indicator. To create one homogeneous pattern, the CZ modifier shall be indicated in the tolerance section of the tolerance indicator. To create a new level of pattern defined as a homogeneous pattern of more than one homogeneous pattern, an additional CZ modifier shall be indicated after the sequence defining the previous level of pattern. One CZ in the tolerance section defines a single pattern. The sequence CZ in the tolerance in the tolerance section defines a pattern of patterns of patterns (pattern of Level 3).

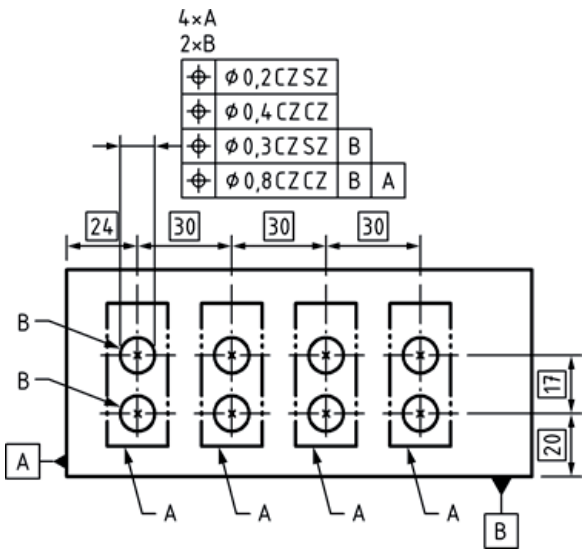

Figure 11. Example of identification of a pattern for repetition.

Figure 11 shows four specifications: The first specification (CZ SZ without datum) manages four independent patterns. For each pattern, the specification considers the following: As a toleranced feature, the collection of two extracted axes As a tolerance zone, the combined zone composed of two cylindrical zones of diameter 0.2 mm constrained in location between them at 17 mm. The second specification (CZ CZ without datum) manages four dependent patterns, resulting in only one specification considering the following: As a toleranced feature, the collection of eight extracted axes As a tolerance zone, the combined zone composed of eight cylindrical zones of diameter 0.4 mm constrained in location between them at 17 mm in a direction and 30 mm in a perpendicular direction. The third specification (CZ SZ with datum

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B) manages four independent patterns constrained in location from B. For each pattern, the specification considers the following: As a toleranced feature, the collection of two extracted axes As a tolerance zone, the combined zone composed of two cylindrical zones of diameter 0.3 mm constrained in location between them at 17 mm and constrained from datum B at 20 mm. The fourth specification (CZ CZ with datum systems B and A) manages four dependent patterns, constrained in orientation from datum B (perpendicularly) and in location from datum A, resulting in only one specification considering the following: As a toleranced feature, the collection of eight extracted axes As a tolerance zone, the combined zone composed of eight cylindrical zones of diameter 0.8 mm constrained in location between them at 17 mm in one direction and 30 mm in a perpendicular direction and constrained from the datum systems B and A, respectively, at 20 and 24 mm.

To avoid ambiguity, when a positional specification applies to several features and not all of the non-redundant degrees of freedom for the tolerance zones are locked, either an SZ modifier or a CZ modifier is always indicated.

All types of geometrical characteristic symbol can be used to establish a geometrical specification in a pattern. However, to create a pattern specification, a CZ modifier can be indicated in the second compartment of the tolerance indicator.

4. Conclusion

The tolerances of position can be used to control the theoretically exact location of features and simulate mating part relationships. They may be modified to MMC and LMC to ensure flexibility in verification and simulation and may be used to control features in coaxial relationships, to provide symmetrical controls of features relative to a centre plane and to ensure generous margins of cost savings.

In the present work, the new requirements of new generation standards for geometrical product specifications (GPSs) related to positional deviation, the advantages and disadvantages of the possibility to indicate the accurate requirements for location of surfaces and axes and some instructions about selecting tolerance of position control modifiers are given.

Reviewed standards for GPS can only be used effectively after the relevant staff has been trained to use and interpret the symbol language. GPS should primarily be used for new drawings and new projects. Only the problematic ones amongst the old drawings should be considered for translation into GPS.

Engineering drawings with incomplete or incorrectly indicated tolerances can result in a lot of issues, such as questions for the production planning, manufacturing and/or inspection engineers, necessity of reworking, occurrence of defects in products, etc. Only engineering drawings with correct and completely indicated tolerances can provide manufacturing of precise as necessary and economic as possible work pieces. This is an important point in achieving business competitiveness.

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Chapter 11

Factors Enhancing Creativity in Technical Higher Education

Valentina Mihaela Pomazan

Additional information is available at the end of the chapter

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Abstract

Extended experience and knowledge need creativity as a third component to create a base for any innovative endeavour or advancement. Transdisciplinary approach and an opening for creative integration of the information are crucial in any educational endeavour. This paper reports correlation analyses performed on the results of a quantitative and qualitative study based on five dimensions (creativity components, personal, interpersonal, equipment and conjectural), aiming to determine the incentive and inhibitor factors of creativity in the activity of the engineering student work groups. Strong liaison between creativity components and personal, alternate experiences were detected, while inertial approaches in learning and dependence to guidance and equipment were identified as deterring creativity.

Keywords: Innovative thinking, correlation analyse, transdisciplinarity, creative integration

1. Introduction

The modern society needs specialists that can undertake non-standard decisions and actions in solving technical and economic problems. Above strict and rather narrow qualification stands the social need for persons to be able to enrol high-tech solution for accomplishment of human needs, under various social, cultural and feasibility constraints.

An assessment presented in 2007 by the Institute of Directors [1] grouped the skills and qualities that employers seek as items in four sets: employability, people, social and personal qualities.

In the employability set, creative and innovative thinking was considered quite important by 51% and very important by 40% of employer respondents, after advanced oral communication

skills, appreciated as quite important by 46% and very important by 42% of the employers. Decision-making skills received, correspondingly 51 and 38%, while problem-solving skills were considered quite important by 37% and very important by 59% of the employers, positioned on the third place after ability to meet deadlines (29 and 60%, correspondingly) and attention to detail (34 and 61%). As it appears, half of the employers appreciate creativity, in strong liason with problem solving.

A recent survey conducted by the Millennial Branding [2] reveals that, in the engineering fields, effective communication skills are crucial to success. The second soft skill found crucial in an engineer's career is creativity, defined as the driving force behind innovation and increasingly gaining recognition as the new capital in the actual economic conditions. As a consequence, creativity should be treated like a skill that needs to be identified, cultivated and trained. One effective way to do that is to foster a creative culture during the educational process and many authors propose some turning keys to develop a culture for innovation and creativity [3].

In conclusion, extended experience and knowledge need creativity as a third component to create a base for any innovative endeavour or advancement.

2. Triggers of the innovation

Although creativity can be considered as extremely subjective, its main output, the innovation is strictly monitored and considered an important indicator of progress and development. In general, the innovation is distinctly defined as technological and non-technological innovation. An insight at the innovation would lead to very pragmatic results and conclusions, all linked to the internal mechanism of the enterprise and its economic status. Behind the drivers and goals of the innovations resides the creative thinking and the capacity to access and correlate holistic information regarding the economical units, its competitors, social and economic environment. This can be done only with a transdisciplinary approach and an opening for creative integration of the information.

The primary driver of the innovation is the improvement of the quality of goods and services and the second is the increasing of the range of goods and services [4]. In 2012, approximately 40% of the enterprises in EU-27 were found technologically innovative and over 42% reported non-technological innovation. New methods of organising work responsibilities and decision making were the leading innovation in 20 countries, followed by new business practices and reorganisation of external relations. Enterprises more often are motivated to reduce the reaction time to customers' needs or by the need to improve the communication and sharing together with the ability to develop new products or processes.

In Romania, the innovative enterprises attained last year 20.7%, with the types of innovation described in Figure 1. In Europe, in general, among the triggers of change, the increase in turnover seems the most important, as described in Figure 2.

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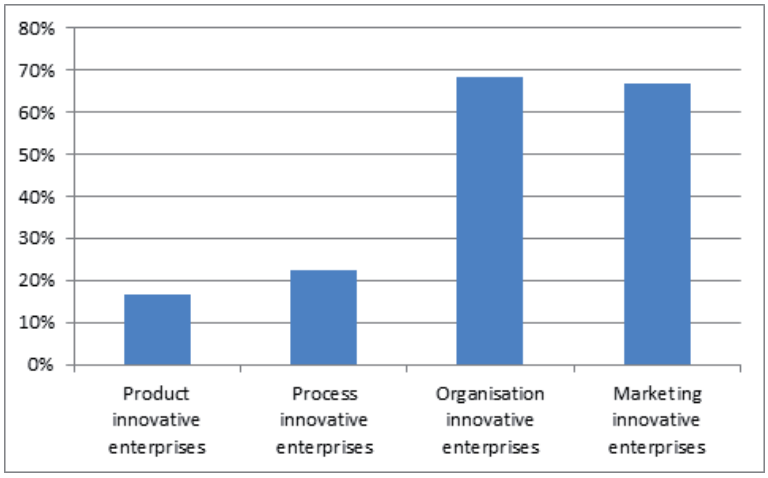

Figure 1. Types of innovation in Romania, 2015.

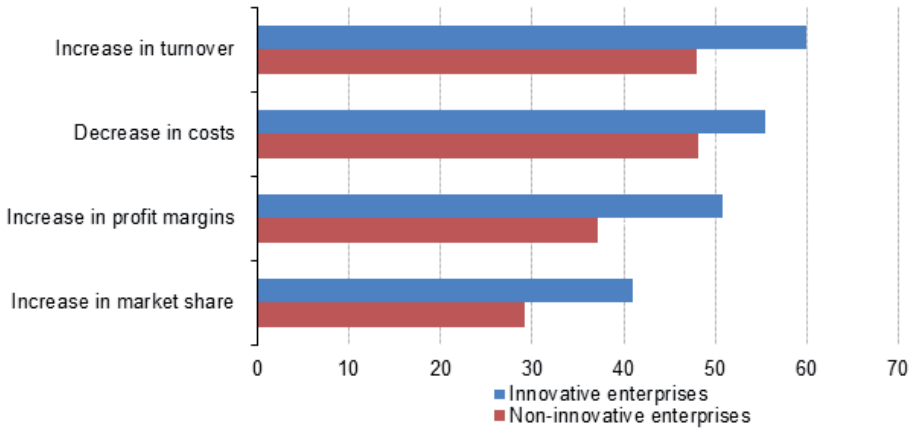

Figure 2. Highly important goals in innovative and non-innovative enterprises, EU-28, 2010–2012 [5].

3. Argument

Starting with creative teams established in the 1970s in France, nowadays is more and more obvious that lonely thinkers who produce relevant contributions to science and technology, even if extremely talented, are *rara avis*. Plethora of information and the complexity of technological, time and social constraints require effective groups of specialists with various points of views. For obvious reasons, young people are preferred as sources of ideas and creative specialists and attracted in research projects at various levels. As a consequence,

nurturing creativity is a crucial task for education at all levels. In polytechnic higher education the challenge is to adapt the syllabi and curriculum as a holistic approach to the real-world problem solving. Creative student groups are one of the solutions closest to the day-by-day engineering challenges.

Even though student creative teams are not easy to establish and sustain, they follow the same group rules as enterprise or any real-world research teams and can provide the precious output of experience and innovation: small groups of people linked by trust thrive on the associative functioning. This concept is underused in Romanian polytechnic universities, which suffer from scarce financing, lack of efficient policies regarding the research quality management and are rather rigid regarding the new pedagogy behind a learning context where temporary "chaos" of questioning and doubting is encouraged and evaluation rules change. Naturally, one might imagine the extent of the outcome of more flexible education methods, where personal experience is mostly considered and personal point of view encouraged. It is characteristic for technical and applied sciences domains the validation and augmentation of one's personal point of view in a group or peers. Student groups are one of the closest approaches to the real world of engineering, but still, they are far from being used in teaching and examination due to the ill-functioning bridging with the so-called objective evaluation. On-going standardised testing is restraining the ability to see and present reality from different angles. Even so, each and every one reports learning and education, in general, as a personalised experience, the resulting knowledge being always the integration of the "standard academic package" in own frame of beliefs and practical experience.

Technological innovation is strongly connected with creative approach to practical problems. The methods to nurture technological creativity were described by G.S. Altschuller in the so-called Theory of the Solution of Inventive Problems (original TRIZ) with the related Algorithm of Solution of Inventive Problems (original ARIZ) [6], but the steps approached there do not fully apply for students groups enrolled in a creative quest. The students in creative groups need to learn to organise their work and the methods of research in technology and engineering. Also, the motivations are different and instable and conduct to absenteeism or discouraging attitudes and drop-out. The leaking pipe phenomenon depletes the initial enthusiastic groups of students of those who lack proper motivation, despite their aptitudes for investigation and knowledge.

This paper is the result of a research aiming to find the triggers for creative thinking in groups of engineering students. This study came as a need to identify ways to stimulate students to succeed during preparation of their final exams and thesis, enhancing their ability to produce original work. In fact, as Sir Ken Robinson emphasised, "…everyone has huge creative capacities as a natural result of being a human being. The challenge is to develop them. A culture of creativity has to involve everybody not just a select few" [7].

4. The method

This paper reports correlation analyses performed on the results of a quantitative and qualitative study, aiming to determine the incentive and inhibitor factors of creativity in the activity of the engineering student work groups.

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4.1. Study set-up

The following groups of items (dimensions) were considered: creativity components, personal, interpersonal, equipment and conjectural. The creativity components acknowledged for this study were: the interest for paradox, curiosity, originality, the ability to question and doubt, fantasy, the ability to make associations, conceptual representation, intuition, aesthetic perception, willingness to take risks and openness. They were appreciated for each student by the supervisor of the student groups and correlated with other components of the dimensions. As research instruments a questionnaire and semi-structured interviews, enhanced with direct observations, were used. Supervisor, sophomore students and master students enrolled at Mechanical Engineering Faculty from Ovidius University filled in the multi-item questionnaire and their answers were registered in a data base for further analysis. The response rate was 93.5%, with an error of 4.3%.

4.2. Sampling

Sampling parameters for the respondents are presented in Tables 1 and 2. It is obvious the majority of urban respondents (69,64%) and the gender asymmetry of the group (56,25% male and 43,75% female respondents). The age of the respondents was not a criterion, as all of the students were in the 20–25 years old group.

Masculine	63	56.25%
Feminine	49	43.75%
Total	112	100.00%

Table 1. Gender structure of the sample

Urban	78	69.64%
Rural	34	30.36%
Total	112	100.00%

Table 2. Respondent provenience

4.3. Methodology

The supervisor and the student surveys aimed to capture the levels of intensity for each response. The student questionnaire aimed to capture the amount of agreement or disagreement on a six-point Likert scale. An even Likert scale intensity ranking was preferred to enforce clear delimitation of the responses. The survey was built on the dimensions presented in Table 3:

Creativity components	Personal	Interpersonal	Equipment	Conjectural
The interest for paradox, curiosity	Existence of role model(s)	Supervisor support	Quality of the research equipment	Mission clarity
Originality	Existence of a mentor in any filed	Team members support	Research premises	Balanced tasks
The ability to question and doubt	Experience in crafting, manufacturing, repairing things	Communication	Access to information	Visibility of the results
Fantasy	Theoretical/ scientific knowledge on specific subject	Challenging team	Support to access materials, consumables or special equipment	Organization risk policy
The ability to make associations	Theoretical/ scientific knowledge on alterne subjects	Team cohesion		Any kind of benefit, rewarding
Conceptual representation	Sport, dancing, scenic movement experience (hobby)	Degree of individual freedom within the team		Future usage/ applicability of the work
Intuition	Musical and visual art experience (hobby)	Personal contribution recognition		
Aesthetic perception	Literature/ poetry experience (hobby)			
Openness	Awareness of personal development goals			
Not being afraid to take risks	Awareness of professional goals			
	Awareness of personal social goals and achievements			
	Ability to stand-up/ have own say			

Table 3. Grouped items of the survey dimensions

Additional data acquired from the interviews and design practical activities were used by the supervisor to characterise each student creativity components, as listed in the first column of Table 3. Each group of students were supervised during a semester. At the end, students were interviewed with concern to the survey dimensions.

Each group of students was formed by the students themselves, based on affinities to each other and to the design mission. The design mission was formulated by each group, from the

http://dx.doi.org/10.5772/65421

prerequisite research and real needs in specific engineering domain. All the initial design themes were presented in front of four large groups, commented and selected by the students, voting the importance, relevance and attractiveness. Around the design themes portfolio, the student groups were formed and the mission statements were defined. A project calendar was set and compulsory deadlines and milestones were agreed between the members of each group.

Correlation analysis was performed in order to track down any connection between the creativity components with personal, interpersonal, conjectural and endowments set of items. As such, motivating factors and barriers in expressing one's creativity were identified, at the level of the group studied.

5. Data analysis

The median values for the answers regarding interpersonal, were rather high in what concerns the supervisor role ($M = 5.4$), perceived as a mediator and important professional guide. During the interviews, occurred the fact that students, at least at the beginning of the work in student groups, have low self-confidence in what concerns their ability to bring to the end the design mission, mostly because they lack practical experience, also lack experience to apply in specific situations the theoretical knowledge. Median scores presented in Table 4 show that respondents consider the team support and good communication as very important creative incentives, but show certain disregard to the degree of liberty within the team (Table 4). During the interviews, this appeared to be linked to a certain fear to liable for any/some aspects of the project. Also, this was linked with the rather low availability to undertake risky decisions regarding the engineering design or project management.

The own contribution recognition reached high scores, and shows a delicate balance between the team-work values and personal contribution delimitation, often source for abandoning the project or rejection of critics.

Interpersonal	Median values
Supervisor support	5.4
Team members support	4.35
Communication	5.4
Challenging team	3.2
Team cohesion	4.4
Degree of individual freedom within the team	2.8
Personal contribution recognition	4.6

Table 4. Interpersonal dimension scores

Conjectural dimension scores are shown in Table 5 and reveal that respondents do not link the creative endeavour to its immediate applicability, while balanced tasks, clear mission received high scores. In our opinion this might reveal a dependence on clear, standardised framework, schematic thinking, which might stand against creative approach. An interesting low received organisational risk policy shows that the students do not necessary link this component to the creativity-simulative environment.

Conjectural	Median values
Mission clarity	4.25
Balanced tasks	5.4
Visibility of the results	4.35
Organization risk policy	2.65
Any kind of benefit, rewarding	5.27
Future usage/ applicability of the work	2.23

Table 5. Conjectural dimension scores

Equipment components were recognised as very important, with high scores, showing one more time that the students are reliant on material support for creative design, in spite of conceptualisation and initiative (Table 6).

Equipment	Median values
Quality of the research equipment	4.43
Research premises	5.23
Access to information	5.65
Support to access materials, consumables or special equipment	4.85

Table 6. Equipment dimension scores

In what concerns the creativity components, they were strongly correlated with the personal experience, in the first place, followed by interpersonal and conjectural components. The ability to question and doubt was correlated ($r = 0.5713$, $P < 0.0001$) to the experience of having a mentor in any filed and with the theoretical/ scientific knowledge ($r = 0.3801$, $P < 0.0001$). The ability to make associations was correlated with any previous experience in arts ($r = 0.39801$, $P < 0.0001$) and not being afraid to take risks is correlated at the 0.01 level (two-tailed), with the awareness of personal development goals sub-item ($r = 0.4302$, $P < 0.0001$), with the visibility of the results ($r = 0.5608$, $P < 0.0001$) and with any kind of benefit, rewarding ($r = 0.3907$, $P < 0.0001$). During the interviews, this was confirmed, as respondents linked their

http://dx.doi.org/10.5772/65421

boldness in approaching risky design or management alternatives with the incentives or recognition of their work.

6. Conclusions

The correlations revealed a strong liaison between creativity components showed during student group work sessions and personal, alternate experiences. This might bring, once more, the need of more flexible curriculum, where students should be able to benefit from alternative activities.

Even sophomore students and master students are strongly dependent on directions given by tutors or supervisors, and hesitate to challenge them. One of the issues in student's creative groups is the balance between the creative thinking and critical thinking within the group. The tension created at the frontier of those two is the source for advancement in solving inventive problems. Due to the lack of information on the objectives of the groups, as a whole, the critical thinking is not paid enough attention in common educational approaches and is often perceived as destructive when applied during group meetings. Overall, good communication within the team and team support were appreciated as very important but few interviewees knew how they could be accomplished. The need for efficient communication strategies activities in the curriculum might fill-in this obvious gap.

The students supervised during this research seem to perceive creative effort as a supplementary one, somehow extracurricular, and rather few of them engage voluntarily in creative endeavours. Even if most of them agree that creativity is important, and recognise the intrinsic value creativity brings to artefacts and technologies, they are, at the beginning, reluctant to manifest components of creativity, and remain attached, for learning, expressing their contribution and examination, to standardised engineering calculus described step-by-step in design guides. This inertia is identified as an important barrier in learning with and for creativity and origins much far backwards in the education flowline. In exchange, they perceive up-to-date lab endowments as crucial for a creative design.

A general conclusion of this study is that flexible thinking, autonomous thinking and self-criticism are the key creativity components that need to be paid special attention to in technical, scientific higher education.

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Chapter 12

Structuralist and Heuristic Convergence between Architecture and Music

Ruxandra Mirea

Additional information is available at the end of the chapter

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Abstract

The convergence between the two fields, music and architecture, through structuralism and heuristics is explained by the very principles demonstrated in the evolution of this orientation of ideological, philosophical and artistic nature. The gradual abandonment of the decorative and demonstrative art of the bel-canto of Classicist patterns is akin to the Realism in architecture, more prominent and persistent with the passing of nineteenth century decades. The tension of librettos, with obvious psychological connotations, marked by the expansion of vocality is congruent with rational directions in architecture, which bypass and occult the balanced and symmetrical beauty, suggesting atypical, slightly abstract volumes.

Keywords: Architecture, music, heuristic, structuralism, Romanticism, The Romantic Opera, lied, bel-canto, volumes, timbrality

1. Introduction

Notions such as structuralism and heuristics need to be explained for a better understanding of the convergence of both subjects: music and architecture.

The structuralism is an option, a method of analysis, emerged in psychology. "The aim of the structuralism, considered the first major school in psychology, was to understand the structure (the configuration of elements) of the psyche and its perceptions through the analysis of them, starting from its components" [1] Extrapolating the term, the relation between music and architecture can also be approached in a structuralist manner, because there is, as we shall see in our study, a concord between the elements of the two fields, through the evolution of human consciousness and the very psychic characteristics with which they both operate, sensations and emotional images.

The heuristics is determinative for any human activity which starts from imagination and approximation; it aims content and is omnipresent. In DEX (Romanian Explanatory Dictionary), we decode this notion as "a part of science aiming to discover new facts" [2]. The sense thus decelated signifies "a novel idea in composition, a research theme originally designed differently than currently contemplated……an unconventional interpretive requirement" [3].

Thus, we try with modest initiative to build bridges, similarity tracks, to find areas in which architecture and music converge. "The artistic beauty penetrates and floods the entire structure of the psyche with vitality—strengthening it" [3].

2. Convergence between architecture and music

We shall see that this time too, in the paradise of Romanticism, ties between the two arts and sciences are woven. They are so different in expression, the architecture from the concrete, material towards the symbolic level and music on vibrational level, from weightlessness and evanescence towards the materialization level.

Both subjects operate with archetypes. Carl Jung, who has defined the archetype, enough so that we can stop thinking of our existence outside the patterns, suggests the following definition: "a matrix which influences human conduct, both in terms of ideas and those of moral, ethics and conduct in general" [4]. Artistic archetypes of music and architecture belong to "the universally unconscious dimension. Being sediment of the experiments of the species..." [5]. There lays the custodian of models, Jung outlining that the archetypes operate with symbols and suggesting that all archetypal markings are symbols. Thus, in the dimension of the two subjects, the symbols ever so present are projections of archetypes, with direct lineage from the collective unconsciousness.

The convergence between the two fields, music and architecture, through structuralism and heuristics is explained by the very principles demonstrated in the evolution of this orientation of ideological, philosophical and artistic nature.

The esthetical categories decisive for this period would shape the thinking of the creators, effectively regulating the balance between the Gothic past, the Romantic present and modern future for Romanticism: humour with its nuances, satire, sarcasm, irony, tragedy, sublime, grotesque and fantastic.

Romanticism, an aesthetic of the end of eighteenth century and the entire nineteenth century, proved to be a custodian of several tendencies, values and renewals. The tumult of the French Revolution (1789) has triggered the voluntary effort of a nation, then through mimesis and of others, to free itself from any constraints. Liberté, Egalité, Fraternité was the impulse which drove a generation and others in the future, towards a new dimension of consciousness, of the power which needed to be removed. It was followed by independence wars of nations, which entailed the break-up of Feudal and the imminence of Capitalist relations. The undetermined potential of consciousness, accountable for the evolution of mankind "provides, at the same time, a pragmatic map of the obstacles which need to be overcome in order to reach the optimal

http://dx.doi.org/10.5772/65422

and more beneficial levels of consciousness" [6]. The obstacle of that time was the aesthetic of Classicism, one of the most important orientations of universal culture, which has promoted righteousness, rigor, balance and harmony. These characteristics have become redundant, inflexible for a Romantic hero animated by feelings, restlessness, imagination, bucolic, endless, Thanatos and transfiguration.

2.1. Elements of language

In architecture, in the nineteenth century, there is an overlaying of tendencies, which meet and complete each other in their temporal rush to aesthetically settle the volumes: Romanticism and Neoclassicism. The tendencies are contemporary, they are both linked to the past but the manner in which they relate to it is much different. The Romanticism in architecture is more than a style; it is a human state of mind, a contemplative and nostalgic attitude which denies the Neoclassicism. It denies it because of the excessive canonization, since the creative spirit of a Romantic architect cannot obey a set of strict rules, him being at the same time a demiurge which imagines and constructs an entire universe. The artist, the Romantic architect, is the creative genius, who is guided by his own sensitivity and the created ambiance is addressed to the soul and human sensitivity, not the mind or reason. The beauty is not a wish, but rather the expressiveness and capability of a building, of a landscape or interior decoration to carry you to a different universe. The state of reverie, of contemplation, of escapism from the present is due to the social, economic and political context of the time (the demographic boom, industrialization), but also the much easier travelling in this period, which has allowed people to come in contact with civilizations and cultures of the past or long gone, with the role to ignite imagination or even nostalgia.

The period perhaps most focused upon by the Romantics is the Middle Ages, therefore we also encounter the term Neogothic architecture, being a source of inspiration for the ecclesiastical architecture, such as the façade of Church Santa Maria Novella or that of Church Santa Croce (1853–1863), both in Florence. Expressing the human individuality coincides with the will and deeds of nations in the Middle Age period, all the more reason to look upon those times with nostalgia.

The countries where Romanticism was widespread were England, which has left the English picturesque garden as legacy, Germany which turns towards its glorious past and the architectural and not only drive of Gothic and France which after the Revolution of 1790 was compelled to find solutions of restoration and conservation of monuments, the tragedy being the trigger of breaking new grounds with beneficial effects for what was to become the architectural heritage.

The Gothic is the undeniable source of inspiration in this period, both from ideological and structural and architectural point of view, but the nineteenth century signals an original building material which allows openings that seem to defy gravity and heights which aim to the sky: metal. Thus, the Trinity Church and Brooklyn Bridge, both in New York are designed and built which proves the drive of Romanticism, not only in Europe but also on other continents. In the south of Germany, in Bavaria, the Neuschwanstein, the castle of Ludwig II, was built and would serve as inspiration for the world of Disney's fairy tales. In England, the

Parliament (1839–1888) and Tower Bridge (1886–1894) were both built in Neo-gothic style and became some of the landmarks of London and the nation.

The technique would be the foundation of the architectural aesthetic ambiance. The reality of the end of eighteenth century shall be guarded by a novel repertoire, that of the mechanic, physics and mathematical inventics. The discoveries of Isaac Newton (1687), Robert Hook (1687) and James Watt (1782) are decisive. The cognitive transformation from the field of exact sciences shall support that from the field of arts, each following an alchemical track, worthy of the leap of an aesthetic orientation.

In music, the Romanticism signifies mind-blowing universe dominated by fantasy, imagination, feelings, liberty, anxiety, national history, specific folklore, conflict and retreat towards mythical themes. The return to the distant past of the Middle Ages, at the expense and to the discrediting of the Classicism is a global approach in all arts. Musical languages, conditioned by the expressive implications and Romantic impulses, have responded to some social needs, themselves conditioned by the emancipation of thought, caused by the elevation of human consciousness. The early Romanticism, the first blossoming of national schools, Post-romanticism, are just as many dimensions generated by the thought of creators determined to alter the symmetry and formal balance of classical creations, of tonal functions which imprint a sound much too balanced, much too delicate for the passionate experience of the Romantic hero, of a predictable timbrality.

The melody, conspicuous in the first part of the orientation, is increasingly evanescent towards the Post-romanticism. The chromatic insertions would alter its recognized melodiousness, translating a dynamic melodic track, with interval leaps which bring about restlessness, disturbances and even anxieties generating sound intermittences into the level of consciousness. The harmony, in its expressiveness, through the increasingly atypical, indefinite successions, opposable to Classicist rules, joins the characteristics of the melody, so conspicuous, clear and transparent in the past aesthetics.

Both of them combined would shape the vibrant Romantic sound images. The timbrality is the bold renewal of Romanticism, in the sense of its activation after a few centuries of instrumentalism, in which composers have neglected this quality of sound. In Romanticism, melody, harmony and timbrality would be sustained, being integrated into the aesthetic and philosophical principles of the time.

2.1.1. Romantic musical genres

Romantic musical genres are akin to the principles of architecture, of generous proportions, with innovative solutions which stir troublesome affects and images.

The lied—centuries old emanation of the German culture, embodying various forms, which have unveiled the lapse of time and determined a constantly different processing of the sound material. It is the genre corresponding to the cultural dimension of the Middle Ages, fitting exactly the pattern of a Romantic genre which feeds on the Gothic era. The poetic images unveiled by the sensitive verses, with frequent temporal tracings in the past, create the expressive Romantic background. We refer to the verses of the poets J.W. Goethe, F. von

http://dx.doi.org/10.5772/65422

Schiller, J.P. Richter, Novalis and F. Holderlin. Yet the music is like the verses, with a surplus of vibration which provides ineffable suggestions of magic idealism. Following the trace of the Romantic lied of the nineteenth century, the more than 600 lieder of Franz Schubert (the cycles The Beautiful Miller Girl, Lady of the Lake, Winter Journey, Swan Song) allow us the understanding of an animated style, with interval volutes, with unexpected contrasts, with rhythmic cascades, with involvements of the piano in the spirit of the convincing vocality and dynamic endings of voice and backing.

Franz Schubert was followed by Felix Mendelssohn Bartholdy, Robert Schumann (A Woman's Love), Franz Liszt with a creation of more than 70 lieder, Richard Wagner with his love story Wesendonk-Lieder and Johannes Brahms with the 11 vibrant lieder volumes.

Post-romanticism is a distinctive school of composition, through the initiatives of its representatives to explore the innovative timbral combinations by Hugo Wolf (Morike-Lieder) or by replacing piano with orchestra by Gustav Mahler (Songs of the Death of Children) or to exceed the limits of the intonational tonal system in the creation of Arnold Schonberg (Gurre-Lieder), Alban Berg (Altenberglieder) and Richard Strauss (Last Four Lieder).

The miniaturist genres of Romanticism are clear-cut playing which creates unity in diversity, in the animated landscape. The small size of studies, waltzes, barcarolles, nocturnes, mazurkas, impromptus, scherzos, ballads, in contrast to the size of symphonic works, are manifestations of instrumental virtuosities which evolve in parallel to the grandiose sounds, with multiplied timbrality and the commanding orchestral dynamics. Composers such as N. Paganini, F. Chopin, F. Schubert, F. Mendelssohn Bartholdy, R. Schumann, J. Brahms and F. Liszt have built a literature of considerable musical imagination.

The symphonic genre. The Romantic symphony has perpetuated in the first part of Romanticism, though its string of creators of the time, F. Schubert, F. Mendelssohn Bartholdy, R. Schumann, J. Brahms and F. Liszt, a range of elements which emphasized the classical form of the genre, through the intonational system and architecture. Then, the ideological changes have reconfigured the genre and the programmatic music has exceeded tradition, allowing the prosody to lead the musical thought. H. Berlioz (Fantastic Symphony) and F. Liszt (Faust, Dante) are composers who would evoke the torment and conflicting ideas of the Romantic hero through the size of the sections, timbral combinations and ardent dynamics which uncovers the literary libretto the works are based upon. Then, the last part of the Romantic symphonism, similar to the constant struggle of the creator for the fulfilment of ideals, many times defeated and abandoned, on the verge of the fantastic, grotesque and tragic: G. Mahler, A. Bruckner and C. Franck.

The pragmatism is a tendency of the Romanticism generated by the polyvalent comprehension of this orientation and music is joined by literature in a new vision, differently than in vocal music. A literary theme, written by the composer or undertaken, is the resistance structure of the musical work on which the musical grid is woven. The genres subjected to such transformation can be small or large in size, depending on the creator's inspiration: sonata, quartet, concerto and symphony. An illustrious work in music history, the Fantastic Symphony by H.

Berlioz (1830) makes up an incipit of this tendency. It was followed throughout the twentieth century by other creations adjusted to other genres, original architectures of Romanticism.

The symphonic poem is the most important among those works and What is Heard on the Mountain (1849) by F. Liszt, after V. Hugo, became the genre's pattern. It has an obvious logic, being designed for symphony orchestra in an extensive display, in a single part which may include several sections, shaped, however, after different types of lied, sonata and rondo or in composite form. The melodic naturalness and harmonic richness are characteristics of those works which "the composers of Central Europe and Russia would practice in order to praise the native land and its originality, in relation to the established musical powers (Italy, Germany and France)" [7].

Researching the wide range of Romantic genre creation we mention a few important titles: Mazeppa, Preludes, Hungaria by F. Liszt, Night on the Bald Mountain by M. Musorgski, the cycle My Fatherland by B. Smetana, The Sorcerer's Wizzard Apprentice by P. Dukas, The Sea by C. Debussy, Don Juan, Till Eulenspiegel, Thus Spoke Zarathustra by R. Strauss, etc.

The Romantic Opera becomes the Romantic drama, the national opera. The genre of lyrical theatre remains prominent in the creation of Romantic composers through its complexity and the complementarity of aspects with regards to music, literature, scenography, choreography and makeup. This genre, designed according to the Baroque pattern, includes the overture, two–three or four acts, soloist moments, choral and ensemble moments with soloists, choir and orchestra, follows the stylistic adjusted on the modulating and transforming stages of this orientation: early Romanticism, middle Romanticism, the first blossoming of national schools and late Romanticism. Thus, we shall gradually emphasize the emergence of several interpretation styles in this composite orientation, the musical Romanticism. The large concerto range is the pivot of the show, the extension of that of Baroque Aria da Capo. The recitative, constant in the first period, would undertake alterations, being amplified from secco to espressivo recitative, when the orchestral development would achieve an additional stage.

The first stage, that of the seraphic and translucid Carl Maria von Weber (Freischütz, Euryanthe, Oberon), amplifies the genre of German lied through orchestration and vocality. In Italy of the same period, the triad G. Rossini, V. Bellini and G. Donizetti makes proof of the craftsmanship of bel canto, the technique of vocal agility and virtuosity, which overshadows the importance of text through cavalcades. A few achievements of the time become unique moments, a combination between ideal, expressiveness, virtuosity, cheerfulness and lyrism: The Barber of Seville, Cinderella (G. Rossini), The Elixir of Love, The Daughter of The Regiment (G. Donizetti), Norma, The Puritans (V. Bellini). The era of G. Verdi would mean engaging on a track of musicality, lyrism, of high-pitched female and male voices, of the subtle capitalization of Italic melody and rhythm. It was the undertaking of another stage that of the vocality sustained by the presence of dramatic timbre.

"The dramatic soprano—whose richly nuanced Italian type is entirely the result of the Romantic theatre—dominates the famous musical scores, from Norma by Bellini to Leonora from The Power of Destiny, Aida or Desdemona from Othello by Verdi" [7]. The deliberate

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passion of the characters, the vocal generosity, the rhetoric of tragic intent, the dramatic peaks, sustained by a melodic musicality on harmonic unfolding are attributed to this period.

Then, the original fantasy of the folk melody would be instilled into the meaningful cultivated musical language, fulfilling the works of the Eastern European lyrical theatre through melodic freshness and rhythmic vitality. The modal principle would support the melodic expressiveness, reconfiguring the harmonic relations. We encounter an original aura in the Russian opera creation where "the signs of harmonic-melodic innovation orientated on the track of modalism are much more obvious" [7]. Grigore Constantinescu suggests to us that there are two directions of modal thought which converge with the cultivated music through the penetration of Oriental elements (Glinka – Ruslan and Ludmila, Rimsky-Korsakov – Sadko, Borodin – Prince Igor) and Russian essence in the Slavic songs and dances (S. Musorgski – Boris Godunov, Hovanscina). The choir, which signifies the people, is invested with attitudes and affects, it would revitalize the genre, bestowing it with authenticity and picturesque.

In the last mentioned period, the main element of the musical language, the melody, would have a track oriented towards the dissolution of expressiveness for the purpose of harmonic and timbral configurations. The avalanche of chromatic scales which would construct the melodic notes foreign of tonal chords, the uncommon modulations towards remote tonalities would shape unexpected harmonic colours. The harmonic-melodic substance changes with the Wagnerian creation, leaving the lyrical and inspired limits becoming more incandescent and more nonconformist. The voices, imprints of human typology, are distinguished through dramatism as the extreme pitches of all types of voices are increasingly preferred. Thus, a particularized stylistic of the Wagnerian interpretation outlines through rhetoric unusual interval leaps and abundant chromatic scales unveil the passionate experiences of legendary heroes: Tristan and Isolde, Lohengrin, The Ring of the Nibelung (Valkyrie, Siegfried), Parsifal. The orchestral background is under permanent watch with the same volcanic outbursts, translated into twisted harmonies and grandiose sound.

Then, the verismo delights us with the vocal maturity of a late Romanticism. The wide unfolding of the musical moments, with minimal pauses, the symphonization of the opera work and instrumentalization of voices because of the psychological profiles anchored in the ruthless social-cultural context describe a new stage in the history of the lyrical theatre. R. Leoncavallo (Pagliacci), P. Mascagni (Cavalleria Rusticana) and G. Puccini (Tosca, La Boheme, Madame Butterfly, Turandot) emphasize the novelty of harmonic language prefigured from R. Wagner.

A century of lyrical theatre, almost with the genre's most important works, depicts us the engaging on a different orbit which combines different stylistics, deep, poetical vocality, sustained and capitalized by the orchestra, through the gradual emphasizing of the elements: melody, timbrality, agogics and rhythm.

3. Conclusions

The congruence between elements of Romantic language and architecture is obvious.

The stylistic quests of both converge towards the unveiling of creativity, through languages with additional visual and audible spectacularity and the willingness to appreciate and capitalize a certain part of the past. The lyrical theatre, the most important and majestic genre of Romanticism and the Romantic symphony, the symphonic poem, the lied and the genres and miniature forms construct the uneven, yet fiery image of Romanticism. The vocality, the art of vocal sustaining in the generous dimension of the lyrical theatre, the instrumental virtuosity, the timbrality and agogics in symphonism are language elements proving the spark of genius of the Romantic creators, namely, the gradual waiver of symmetries and consonances in favour of the unsymmetrical melodic arch forms, of the harmonic capriciousness by inflaming chromatic scales.

The gradual abandonment of the decorative and demonstrative art of the bel-canto of Classicist patterns is akin to the Realism in architecture, more prominent and persistent with the passing of nineteenth century decades. The tension of librettos, with obvious psychological connotations, marked by the expansion of vocality is congruent with rational directions in architecture which bypass and occult the balanced and symmetrical beauty, suggesting atypical, slightly abstract volumes. Traditional materials are added by unconventional ones for that period, such as glass and metal. The accumulated science overlapped on the overflowing creativity initiated the expansion at the end of nineteenth century, when the Romantic architecture would promote the eclectic style that of regrouping some elements, symbols of past aesthetics, on the burning dimension of nineteenth century aesthetics. It is the period when the South-Eastern European cultures mature and express in their own language, accessing that folkloric heritage, symbols and archetypes. The blossoming of national cultures was the certain manner of an artistic expression of essences, both in music and architecture.

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Interdisciplinarity is a sine qua non condition for any modern endeavour, a reason for the International Conference on Interdisciplinary Studies (ICIS 2016) to promote new and emerging research topics and interdisciplinary collaborations. During the event experiences about how interdisciplinary research is carried out were summarized and the demand for interdisciplinary research and innovation was investigated.

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