About

Econophysics, Sociophysics & Other Multidisciplinary Sciences Journal (ESMSJ) provides a resource of the most important developments in the rapidly evolving area of Econophysics, Sociophysics & other new multidisciplinary sciences. The journal contains articles from Physics, Econophysics, Sociophysics, Demographysics, Socioeconomics, Quantum Economics, Econooperations Research, or many other transdisciplinary, multidisciplinary and modern sciences and related fundamental methods and concepts.

CONTENTS

MIRCEA GLIGOR

IN MEMORIAM

Profesorul Mircea Gligor s-a născut pe 13 mai 1963, în localitatea Sărmaş, judeţul Mureş. A absolvit Facultatea de Fizică din cadrul Universităţii "Babeş-Bolyai" din Cluj-Napoca, ca şef de promoţie, în anul 1986, devenind pentru 28 de ani profesor de fizică la Liceul "Roman-Vodă" din Roman. În perioada 1997-2003, şi-a pregătit doctoratul în fizică aplicată în economie şi ştiinţele sociale. A susţinut, în 2004, lucrarea "Modele termodinamice şi statistice pentru studiul sistemelor socio-economice disipative", sub îndrumarea profesorului universitar doctor Margareta Ignat, de la Universitatea "Alexandru Ioan Cuza" din Iaşi, obţinând distincţia "Summa Cum Laude".

The late teacher Mircea Gligor was born on 13 May 1963, in Sărmaş, Mureş county. He graduated in Physics from the "Babes-Bolyai" University in Cluj-Napoca, as to topmost-ranking student of the year 1986, becoming a teacher of physics – his job for 28 years at the "Roman-Vodă" high school in Roman. Between 1997 and 2003, he prepared a doctorate in applied physics (with relation to economics and social sciences). In 2004 he defended his thesis, entitled "Thermodynamic and statistical models for the study of socio-economic dissipative systems", under the guidance of Professor Margareta Ignat, Ph.D., of the University "Alexandru Ioan Cuza" in Iaşi, being awarded the distinction "Summa Cum Laude".

În 2003, a fos trecompensat de către Academia Română cu Premiul "ŞtefanProcopiu".Teza sa de doctorat a fost prima teză dedicată Econofizicii şi Sociofizicii la noi, de către un spirit viu cu o mentalitate de învingător, a unui autor român care beneficiat pentru meritele sale deosebite de o bursă postdoctorală la Universitatea din Liège (Belgia), sub îndrumarea profesorului Marcel Ausloos. A participat la conferinţe naţionale şi internaţionale, aşa cum pot fi amintite "Econophysics and Complexity", în 2005, în SUA, şi, din 2008, la "Workshop International EDEN – Exploratory Domains of Econophysics News", la Piteşti, al carui suflet a fost, este şi va dăinui... A murit tot aşa cum a trăit, printre aceia carre şi-au dorit mereu să cunoască şi să înţeleagă!

In 2003, he was given the "Ştefan Procopiu" award of the Romanian Academy. His was the first thesis devoted to Econophysics and Sociophysics in this country, by a man animated by a lively spirit, with a winner's frame of mind, a Romanian author of merit who received a postdoctoral scholarship at the University of Liège (Belgium), under the guidance of Professor Marcel Ausloos. He participated in national and international conferences, such as "Econophysics and Complexity" in 2005, in the US, and from 2008 to 2014, in the "International Workshop EDEN – Exploratory Domains of Econophysics News" in Piteşti, whose very formative spirit he actually was – and he will endure as such… He died just as he lived, among the people like him, who wanted always to know and understand!

EDEN I

Abstract

"More and more systems studied in the social sciences were found to bedescribed by power law statistical distributions. This class of distributions is fascinating forthe physicist. The reason is that the most complex, collective phenomena do give rise topower-laws, which are universal that is to a large degree independent of the microscopicdetails of the phenomenonn. The power-laws emerge from the collective action and transcendindividual specificities".

(Mircea Gligor, February 29th, 2008)

 e-mail

Nu stiu de ce (probabil in orice institutie) atunci cand cineva face eforturi disperate pentru a-si indeplini sarcinile la timp, cei din jur simt nevoia sa i le dubleze. Poate este si asta o lege (neinvestigata inca) a sociofizicii...

I do not know why (perhaps in any organization or institution), when someone makes desperate efforts to accomplish their tasks on time, some of the others feel the need to duplicate them. Perhaps this is also a (yet uninvestigated) law of sociophysics.

(Mircea Gligor, September 21st, 2008)

EDEN II

Abstract

During the last decade, some theoretical physics models turned out to be useful for describing not only the financial and economic interactions but also more complicated problems of the social psychology (extending in this way the traditional field of 'econophysics'). The emerging field of 'sociophysics' uses with predilection non-equilibrium statistical physics tools as the random cluster models, the diffusion-limited aggregation formalism, the percolation theory and the evolving networks analysis. The social phenomena that may be modelled by these tools pertain to a large sphere, including the spontaneous social coalition's formation and breakdown, the fashion and advertising fluctuations, the dynamics of individual specialization and global diversification in communities and the fear and rumour spreading.

(Mircea Gligor, February 8th, 2009)

e-mail

Mi-a luat ceva timp elaborarea versiunii in limba romana, in special datorita necesitatii de a gasi (in premiera) echivalentul romanesc al unor termeni uzuali din fizica retelelor complexe si teoria grafurilor

Drafting and developing the Romanian version took me a lot of time, in particular due to the necessity of finding (for the first time) the Romanian equivalent of some common terms specific to the physics of complex networks and graph theory.

(Mircea Gligor, March 4th, 2009)

EDEN III

e-mail

Many thanks for the very good news concerning the book. This is a powerful incentive to continue work in this field.

Multumesc mult pentru stirile foarte bune legate de carte. Este un imbold puternic pentru a continua lucrarile in domeniu.

(Mircea Gligor, February 3th, 2010)

Abstract

The properties of the weighted networks are investigated using some statistical physics tools, taking into account the statistical ensemble of the networks with fixed numberof vertices. As application, the correlations between GDP/capita time series are investigatedin various time windows, over the time interval 1993-2008… Particularly, the concept of entropy, based on the probability of one particular realisation from the statistical ensemble,may yield some more information about the structure, stability and evolution of the EU country clusters. **(Mircea Gligor, May 9th, 2010)**

EDEN IV

Abstract. Today (September, 2011) in Romania there are 320 towns. In the present paper, we demonstrate that using the updated dataset, the basic features of distributions remain essentially the same… The Central Places Theory, the diffusion-limited aggregation and the self-organized criticality mechanisms are investigated by means of some numericalsimulations and the last two are found to fit better the urban perimeter growth. (Mircea Gligor, Ocotber 15th, 2011)

Din pacate, cei de sus se pare ca nu au altceva mai bun de facut decat sa inventeze noi si noi mijloace de a ne ocupa timpul cu inutilitati, iar ca sef de catedra resimt toate astea in plin. De vina mai sunt si fostii mei dascali de la universitate care m-au invatat sa ma achit de toate obligatiile, pe cat posibil fara rabat de la calitate (formatie? sau malformatie!?) Evident, EDEN IV ar fi o oaza de aer curat care ne-ar incuraja sa inotam cu mai mult spor prin rutina zilnica spre o destinatie mai interesanta. Mai ramane ca Cel de Sus sa aranjeze putin lucrurile in matca lor, incat macar de acum incolo sa ne bucuram de ceva mai mult timp la dispozitie pentru a scrie articole incitante si de calitate.

Unfortunately, our betters seem to have nothing better to do than inventing renewed ways to occupy our time with useless concerns, and, as head of the department, I am fully aware of that. Maybe some of the fault lies with my former university teachers, who have taught me to achieve all my obligations, if possible without sacrificing quality (does is have anything to do with my intellectual background, or is it a malformation!?)… Obviously, EDEN IV can be seen as an oasis of fresh air, which could encourage us to swim faster against the current of our daily routine for a more interesting destination. Let us hope that the Lord above pleases to arrangethings in their usual frame, so that, at least from now on, we could enjoy more time available to write exciting, quality papers.

(Mircea Gligor, October19th, 2011)

EDEN V

Gligor jr. uses much of my time – before we can learn together how to study in secondary school. My memories from EDEN will remain the most beautiful this summer. (Mircea Gligor, 3 July 2012) My way of working, for many years now, has consisted, when I start to revise a paper, in not interrupting the process, because otherwise I find it hard to resume work (it often cost me completely sleepless nights, and this means more than simply going to bed at small hours).

Gligor jr. imi rapeste mult timp - pana ne deprindem cu modul de a invata la gimnaziu. Amintirile de la EDEN vor ramane, pentru mine, printre cele mai frumoase din vara aceasta. (Mircea Gligor, July 3th, 2012) Modul meu de lucru de multi ani incoace este ca atunci cand incep revizia unei lucrari sa incerc sa nu ma intrerup, pentru ca imi vine greu pe urma sa o reiau (asta m-a costat de multe ori nopti complet albe si nu numai culcatul la o ora tarzie).

(Mircea Gligor, September 9th, 2012)

Abstract. Some of the most significant points in the study of the „small world" (SW) effect are brieflyreviewed in the first section of the paper, starting from the Milgram's sociological experiment,the paradigm of the „six degrees of separation", and the Watts and Strogatz' model.The problem is important taking into account that the spread of news, jokes, fashions, rumour, aswell as epidemics, all take place by contact between individuals, far faster over a socialnetwork in which the averaage degree of separation is small than it can over one in which theaverage degree is e.g. 25.

 (Mircea Gligor, May 4th, 2013)

EDEN VI

Abstract

Some methods taken from the statistical thermodynamics may be applied in order to model several social phenomena for which, at the time being, we have qualitative descriptions only (e.g. the fear/rumour propagation process in the stock market space). The speculative bubbles are seen as non-equilibrium patterns resulted from the reaction-diffusion mechanism. The fashion fluctuation could be seen as noise induced transitions in a system in which the interaction among individuals is described by means of the classical Ising-spin model.
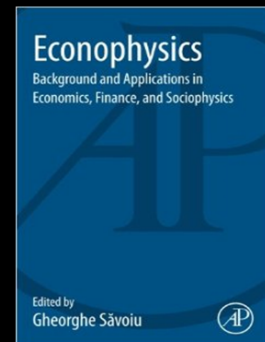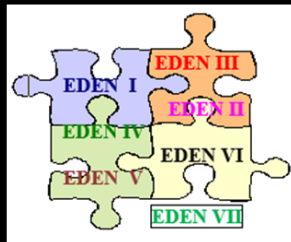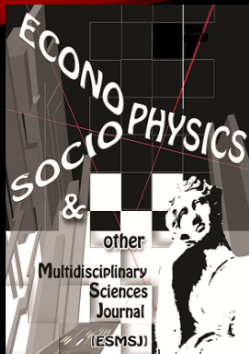
(Mircea Gligor, April 29th, 2014)

Ultima intalnire de suflet cu prietenul nostru drag Mircea Gligor...

Our last meeting with our dearest friend Mircea Gligor

EDEN VII

MIRCEA GLIGOR
IN MEMORIAM

Mircea Gligor, the man and the teacher, is no more with us, but his spirit and courage, his gentleness and the depth of his knowledge of sociophysics and econophysics will be immortalized in EDEN! Our dear friend, you left, and you paradoxically and peerlessly remain with every one of us!

Mircea Gligor nu mai este, dar spiritul și curajul lui, blândețea și profunzimea cunoașterii sale econo si socio-fizice vor eterniza in EDEN! Prieten drag, ai plecat și ai rămas paradoxal și inegalabil în fiecare dintre noi !

26 FEBRUARY 2015, ORA 13…
INFORMATIA SOSESTE FULGERATOR PRIN INTERNET, DE PESTE OCEAN, DIN SUA, DE LA UNUL DIN PRIETENII LUI SI AI EDEN-ULUI, THIMS LIBB: PROFESORUL MIRCEA GLIGOR A MURIT!

26 February 2015, at 13.00… The information comes like a thunderbolt via the Internet, from overseas, i.e. from the US, sent by one of his and EDEN's friends, Thims Libb: Professor Mircea Gligor has died!

Our ancestors complained to the birth of a child and enjoyed each death as a real celebration for a high character of a good and brave man…According to Herodotus, Zalmoxis character has two halves: the first was Chthon (infernal) and the second was Uranian (heavenly) and he was a slave of one of the wisest of the Greeks - Pythagoras ... Mnaseas of Patrae identified Zalmoxis with Cronos...Contemporary scientists and friends from EDEN believe that Mircea Gligor was EDEN Cronos and consider him the first creator of Econophysics and Sociophysics here in Romania, like Cython and Uranian inside the same spirit… For all of us his living friends from EDEN, Mircea Gligor means the first holistic thinker based on Physics model. As Plato had written in the Charmides Dialogue about Zalmoxis as one of the first visionary thinker in a holistic manner I consider him the first econophysicist and sociophysicist who took a holistic approach to modelling the human activities, including what a human being is thinking, writing and acting... Please allow me to say that Mircea Gligor was our holistic thinker! In today Romania, the commemoration remains or is a party among friends called POMANA (as noun) from the ancient Romanian verb POMENI (I can not translate this sense of POMANA as verb, this is somewhere between remember and reborn, celebrate and laugh, mock and love, drink for him and speak about him etc.) ... This EDEN VII and the final party are more important like knowing him for the first time to EDEN I (this could be the seventh day…), and here everyone who really meet him, comes to mention the character, passions, actions, loves, gestures of the person who died as I have done especially to remember the good thoughts and facts of our commemorated and beloved Mircea…God bless you Mircea! You are and you will remain the spirit of our EDEN workshops (Gheorghe Savoiu)

Our colleague Mircea Gligor was one of those wonderful teachers who has revived and maintained alive the brilliant tradition of the top high schools in Romania in entangling teaching with scientific research, he approaching topics of highest social interest by using new mathematics and physics tools to get frequently quoted, valuable, original results. May he rest in peace! (Radu Chisleag)

I could ascertain, from the various experiences of my life, that there are few people whom I can become attached to quickly and unconditionally – as was the case of the late Mircea Gligor. Personally, his figure has remained in my heart for life, as a true intellectual figure, and moreover, like a true friend. And there are equally few people working in the field of the sciences called *hard sciences*, who are ready to understand the representatives of the so-called humanistic field as thoroughly as Mircea did. He was a generous, fond man, whose interests were not limited to just ideas and the fruits of the garden of spirit. He was deeply passionate about what he did – and he did it very well, too. A good communicator, and consequently a very good teacher, but not exactly a keen conversationalist, he was also an excellent companion and debater, a rare wit. What he actually did was harmonize science and communication, humanizing the former and instilling substantial consistency into the latter. (Constantin Manea)

Discreet and a great family man, Mircea Gligor was a decent, soft-spoken, equanimous Transylvanian adopted by what Moldavia has best and profoundest. Therefore, his soul and culture were impregnated by the *spiritus loci* of arguably the deepest Romanian provinces.

By his way of working in the extended domain of science – and also by his very way of being, by the manner he used in questioning various exciting issues of interdisciplinary and multi-disciplinary research, our late friend and collaborator helped to undermine the would-be wall, or rather that myth, which apparently separates the world of sciences and the area of the humanities.

The most beautiful, convincingly true tribute that we can pay him is to continue, with the same sense of responsibility, the initiative we started together, a modest, but authentic and genuinely cultural approach to the challenges of today's world. (Constantin Manea)

„*Atunci când majoritatea se simte bine, când are sentimentul că i se oferă ceea ce își dorește, câțiva se retrag, stabilindu-și propriul orizont de așteptare, propriul cerc în care își refac lumea interioară, departe de agitația și normele impuse de exterior.*" *- Principiul Vieții trăite. (Mircea Gligor)*

Prin flexiunea si fluența gândirii proprii, a demonstrat ca fizica este un poem al viziunii divine asupra universului. Intuia felul în care te poți adresa ,vorbea despre limbajul universal al fizicii și despre dimensiunea ei reală în spațiul mental intelectual al fiecăruia. Mircea Gligor? O prezență discretă, o fire deschisă, atent la ce e în jur, nici măcar nu a crezut vreodată ca este primul Econofizician din Romania, iar premiul Academiei Romane nu este pe măsura valorii lui. (Ion Iorga Simăn)

"*When the majority feel good, when they feel they are given what they want, some retire and establish their own expectation horizon, their own circle where they rebuild their inner world, far from the bustle and rules imposed from outside.*" *– the Principle of Life lived. (Mircea Gligor)*

By the flexibility and fluency of his own thinking, he demonstrated that physics is a poem of the divine vision of the universe. He intuitively understood the way you can address it, he spoke about the universal language of physics and its real dimension in of each individual's intellectual, mental space. Mircea Gligor? A discrete presence, an open mind, a man who paid attention to what was around; he didn't even think he was the first econophysicist in Romania, and the Romanian Academy Award is not up to his value. (Ion Iorga Simăn)

MIRCEA GLIGOR
IN MEMORIAM

Editor in chief
Gheorghe Săvoiu

DEVELOPMENT OF VERBAL ANALYSIS OF PATHOPHYSIOLOGY

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Abstract. *Since 1999, the author has been engaged in the research and development of a quantitative measurement of emotion and stress. He has built an emotion model derived from emotions and biological substances in physiological tests. He has analysed emotional speech based on fMRI and people's subjective views (their own/a third person's), and has built a system that visualises the type and intensity of emotion in real time based on voice data. This is known as Sensibility Technology (ST). This article outlines the structure of the emotion measurement technique in ST, and compares the measurements with emotion-related brain activity, as well as with "voice, emotion, and stress" on the basis of recent reporting on stress detection.*

1. INTRODUCTION

After the Great East Japan Earthquake, there was an increase in mental illnesses such as anxiety disorder and depression, caused by mental and physical fatigue and stress. The prevalence of suicide as a result of these mental illness issues also increased. I was requested by the Self-Defense Forces to propose countermeasures for this. A technique was sought which allowed for the simple, quantitative measurement of stress and emotional change. I therefore studied the possibility of simply measuring stress and emotional states using vocal emotion recognition technology [1].

2. VOCAL EMOTION RECOGNITION

I examined simple techniques for measuring a person's emotions. This revealed that it is relatively difficult for people with inborn impaired hearing to understand emotions based solely on facial expressions and textual information. Moreover, I also found that Japanese people have a strong tendency to suppress emotions, and that in Japan's cultural environment emotions are particularly unlikely to be apparent in a person's attitude or expression. Therefore, I decided to study techniques to identify emotions from voice, and to create language-independent vocal emotion recognition. First, the colour representation in the aforementioned emotion model (green, red, blue, yellow, orange) was used to collect people's subjectively coded speech, eliminating as much language dependency and language impact as possible. Using the collected voice samples, I built a software tool that can classify emotions automatically and in real time, similar to people's subjective views (with colour denoting the attribute, and quantity scored on a scale of 1–10). This is the vocal emotion analysis technique, known as Sensibility Technology (ST). Furthermore, I compared this against emotion-related activity in the brain and physiological responses.

2.1. Structure of emotional utterances

I studied how emotion-related activity in the brain affects vocal utterances. The following general theory is important here: [1] Processed results for emotion-related information in the amygdala are first transmitted to the hypothalamus, which is the centre for autonomic nervous function and hormone secretion, causing an autonomic nervous response that increases the heartbeat and alters gastrointestinal motion. [2] When subjected to an impulse such as fear, information is simultaneously transmitted from the amygdala to the midbrain, causing freezing behaviour. [3] Furthermore, the amygdala transmits stimuli to the limbic system including the cingulate gyrus and the hippocampus in the brain, significantly impacting long-term memory [2]. The following general theory on the causes of vocal cord disorders due to recurrent laryngeal nerve palsy in the relationship between vocal cord disorders and the recurrent laryngeal nerve is also important: [4] Disorders due to a ruptured vagus nerve to the vocal folds or the branched recurrent laryngeal nerve in traffic accidents or after surgery. [5] In nerve compression, disorders when the recurrent laryngeal nerve, which descends to near the heart then ascends, is also subject to compression through the enlargement of the heart and the nearby aorta (e.g. raised heartbeat). Disorders when the nerve is subject to compression due to e.g. malignant tumours, or after intubation during general anaesthesia. [6] Disorders due to acute infections, medication, or neurological disease (including emotional disorders). [7] Other disorders for which the cause is unknown, termed "sudden (idiopathic) recurrent laryngeal nerve palsy". Unlike [4], [5], and [6], this occurs suddenly, and sometimes also heals spontaneously [3].

Based on these two general theories, namely "the emotional mechanisms of brain and nerves [1], [2], [3]" and "the link between nerves and vocal cord disorders [4], [5], [6], [7]", I hypothesised that "the vocal folds are impacted by heartbeat changes and nerve status associated with recurrent laryngeal

nerve activity which is affected by emotion-related brain activity". This relation is outlined as follows.

Based on the link between voice and emotion, ST argues that "emotion-related brain activity will at least be apparent in the voice", and "through this, the state of emotion-related activity in the body and the brain is communicated through the circuitry connected to the vocal folds".

A system was built by comparing ST with subjective voice data evaluation results and brain function activity, and its accuracy was verified.

matter	excite	stress	anxiety	disgust	agonism	fear	depression	Pleasure/un	stability	euphoria	expectation	hart	pupill	sympathetic	swetat	temp	bloodpress	cycle	immune
CRH	arousal	○ACTH○	◎		◎		◎				○	◎					◎	biorhythms	
NPY	calm	○CRH◎	○×	NA×															
Cortisol		○																	
VP		○homeos			◎	◎								active			◎	biorhythms	
ACTH		○			◎×											×			
CCK-4	F◎		○ ◎S			○ ◎strong	○								◎				
CCK-8	A◎SF								◎										
Melatonin		○×						hap	○			×		forget				season	active
endorphin	calm		NA×			NA×		pleasure		○				motion-pie					NKact
βEnd		CRH×										◎					◎		
ACh		CRH◎				◎													
NA	◎	CRH◎△	◎	◎	◎	◎	◎					◎	expan	Tension memo					
Adrenaline		CRH◎△	◎		◎	J◎						◎	expan	tention					
DA	◎	CRH◎			◎	low◎								memory					
5-HT		CRH◎	◎×		low◎	◎	◎												
Ang-		CRH◎																	
Garanin		CRH◎	×																
SRIF		CRH×																	
α—MSH		CRH×														×			
GABA		CRH×	NA×			NA×													
BZD		×	◎																
Diazepam			NA×			NA×				○									
Ethanol			NA×			NA×													
cnk																			
β-carboline			○◎																
Isoprenaline			◎																
Yohimbine			◎																
Fenfluramine			◎																
Sodium lactate			◎																
CO2			◎strong			◎strong													
Caffeine	arousal		◎																
Galanin			×?																
Oxytocin	×	×	×?															matetnal	
FMRF Amide			×		◎?														
Testosterone			×		◎strong														
Androgen			×		◎														
Estrogen			×		×														
Progesterone					×														
Corticoid						○													

Table 1. The research of relation between Emotional response / Physical reaction and materials.

○ shows synthesis/secretion, ○× shows secretion and suppression, ◎ shows acceleration, CRH ◎ is CRH synthesis/secretion acceleration, front ◎ is acceleration in the prefrontal cortex, all ◎ is acceleration in the entire brain, front × is suppression in the prefrontal cortex, low ◎ is decrease then acceleration, × is suppression, ○ homeostatic is maintaining homeostasis through secretion, CRH × is CRH synthesis/secretion suppression, ◎× is control, △ is adjustment, NK is natural killer cells, ? is reported information, - is not indicated in literature [9].As seen in the Table, the many '-' signs show that many of the relations among the mind, feelings, and secretory substancesremain unknown. The CCK system, 5-HT, GABA, and DA interact in complex ways and seem to act to emotions. Additionally,sex hormones seem to have a close relation with attack. These secretions and substances are controlled by cranialnerve activity, and the limbic system, emotions, and memory work together intimately.
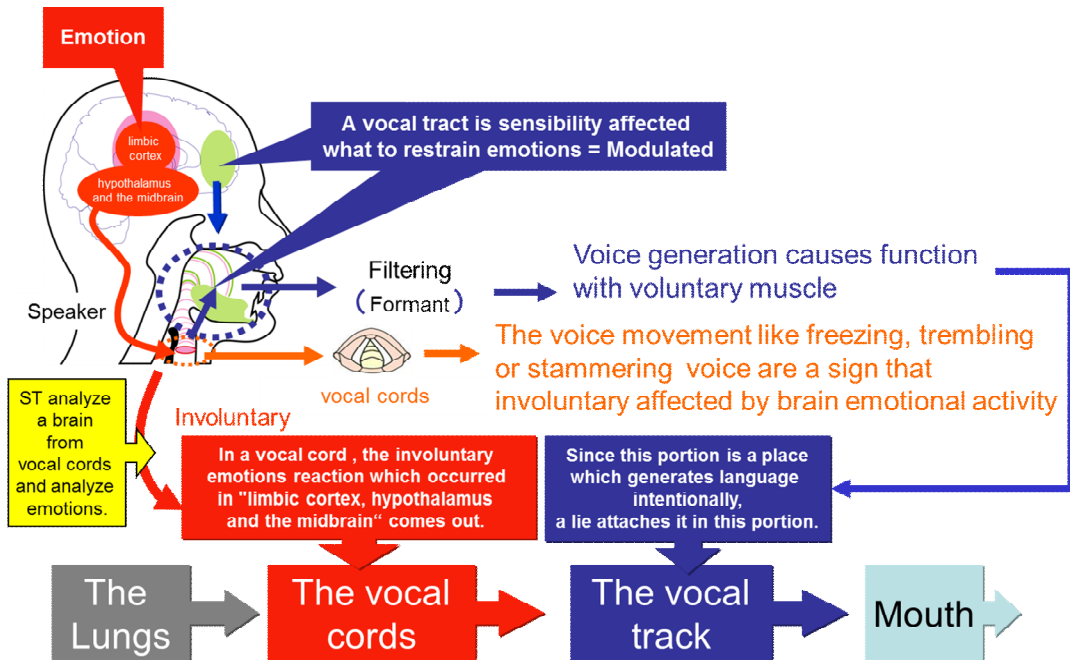
Fig. 1 Body structure: A short-term effect on brain emotion activity. Human has a strong emotion, it is usually under control of intelligence. This is human emotion. Usually humans modulate emotions well in social life.
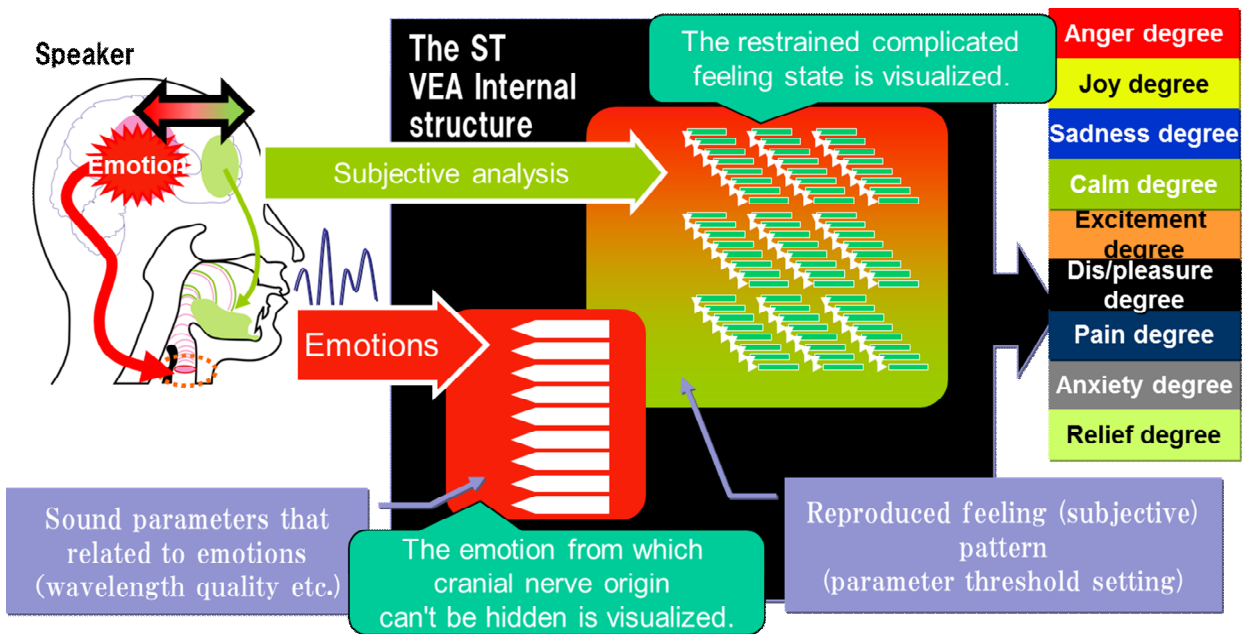
Fig. 2 ST structure and its output: Emotions and respiration are both related. VEA enables us to analyze emotions at utterance interval between a breath and the next breath. The strongest emotion will be selected by majority decision on judgment logic and display as classified colors and strength. Other emotions will also list following the first chosen.

2.2. Technique for measuring emotion in the voice

Based on the aforementioned structural link between emotion-related brain activity and utterances, I created ST, which was structured into acoustic parameters relating to emotion (acoustic elements such as prosody) and people's subjective reproduction logic (set of parameter thresholds for the assessment of emotion based on acoustic parameters, similarly to people's subjective views).

The structural diagram for this is as Fig. 2.

Because two assessment techniques have been obtained, i.e. acoustic parameters and subjective reproduction logic, this technique allows for a comparison of biological emotional responses and neurological disorders against acoustic parameters, and enables long-term dispositions to be compared with psychogenic depressive states using subjective reproduction logic.

2.3. Technique for measuring emotion in the voice

An experiment was performed to ascertain whether ST is consistent with people's own subjective views.

Standard evaluation: The utterer listens to their speech after uttering, and their evaluation of their emotional state is set as the standard.

Experimental method: Subjects are asked to listen to the standard voice data and provide intuitive, subjective evaluations of utterance units in a randomised order. The concordance rates with the standard voice data evaluations are checked.

Subjects: a) Twenty-six utterers (re-evaluated after some time had elapsed); b) six third-person evaluators, also Japanese speakers; c) six third-person evaluators, foreigners who do not speak Japanese; d) ST evaluation results for which emotions were measured from voice data.

Results: a) 73%, b) 60%, c) 55%, and d) 70%.

As a) and d) are approximately the same, the results suggest that ST is broadly equivalent to the utterers' subjective views. However, since the utterers' re-evaluation of the standard speech after some time had elapsed resulted in close to 30% inconsistency, it is difficult to study emotion recognition rates in comparative experiments for subjective views alone. This is because Japanese speech has little undulation in its intonation, and is rather flat. Additionally, the subjective evaluation of speech samples which had been segmented into utterance units and presented in a randomised order was difficult for the speakers themselves.

2.4. ST and emotion-related brain activity

A performance evaluation of the reproduction of the subjective views of the utterers themselves using ST revealed a number of obstacles, such as changes in subjective views due to complex cognitive influences and the passing of time, and Japanese speech characteristics such as flatness. A performance evaluation exceeding 70% accuracy turned out to be impossible. It was therefore necessary to conduct a comparison with biological responses, which are the origin of emotions. The results from a comparative experiment with emotion-related brain activity are described below.

2.4.1. Study of emotion-related brain communication

This experiment used 3T fMRI (Siemens) to measure brain function. The provision of this machine and the experimental work formed part of a three-year scheme funded by the National Institute of Information and Communications Technology (NICT).

2.4.2. Measurements of emotion-related brain activity

It is well known that MRI creates 130 classes of digital noise when running, and it is impossible to obtain speech without noise inside an MRI gantry. Using a mouth-covering dust mask to improve the seal, I manufactured a mask using fibre-reinforced plastic (FRP). By plugging silicone of high specific gravity around the mouth, noise levels were cut and the noise problem was solved. Next, to prevent suffocation by this sealed mask, and to prevent muffling the sound in this narrow space, a thick sound-proof silicone hose was manufactured. By connecting this to the mask, I used the air convection (created by circulating fresh air using an air compressor and working the shape of the mask) to prevent muffled sound and echoes, thus allowing for clean MRI speech recordings. For the experiment, the utterer's head was secured in the MRI machine. A total of six subjects took part, and each had a conversation partner (a close relative) that was familiar with episodes that would evoke emotion in the subject. All conversations were recorded, and measurements of brain activity, heartbeat, eye blinking, body temperature, blood pressure, and eye movement were recorded. Apart from brain activity, no significant physiological differences were observed. Thus, this paper describes the comparison of ST with brain activity.

2.4.3. Comparison with emotion-related brain activity

Experiment: using the aforementioned technique, I examined the difference between brain activity during conversation when ST could confirm negative emotion, and when it could not (using t-test, critical region for both 0.1%, non-corrected). The focus was on negative emotion-related brain activity, because at the time there were extremely few study outcomes for brain activity related to positive emotion.

Results: The most frequent components of conversation in the ST analysis during brain activity measurements were excitement and tranquillity. Conversation components were extracted in the fMRI analysis, firstly through block design.

Results showed activation of Brodmann areas 4, 6 (subject TO, p < 0.001), and 46 (subject TN, p < 0.001). Brodmann area 46 is the so-called Brodmann language area.

When the subjects were in conversation, activation was observed in the left prefrontal area (DLPFC, Brodmann areas

45, 47) and the base of the frontal lobe (Brodmann area 10) (subjects TO, SM).

In subject SM, activity was also seen in the amygdala. In the ST analysis, times of excitement and times of tranquillity produced different activity in the left angular gyrus (Brodmann area 39, Wernicke's area) [4].
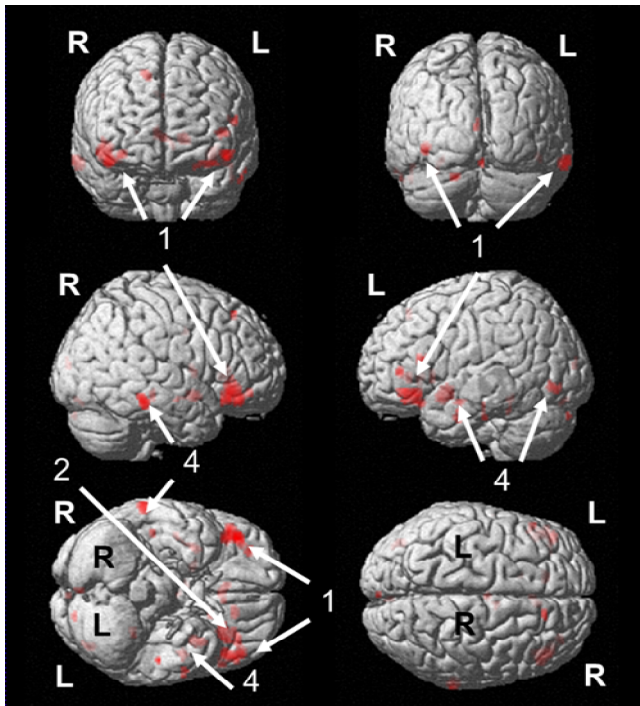
Fig. 3 This is a proof which ST had judged to be a negative emotion only when brain activity was a negative emotion.

1. Left and right frontal BA44,45 - L:speech generation, R: sympathy
2. Left dorsofrontal BA12 - hormonal control, suppressive emotion
3. Left amygdalate complex - negative emotion
4. L/R inferotemporal - visual imagery, body image

3. ST AND STRESS

It is well known that mental and physical stress is related to depression and anxiety disorders. In collaboration with the National Defense Medical College, we verified whether ST was superior in detecting stress from states of emotional change.

3.1. Voice and stress comparison

Having established that the overseas deployment corps of the Self-Defense Forces suffers the maximum mental and physical stress, a comparative verification was conducted for ST and stress. Stress levels were established by the period of local deployment. A comparison of long-term and short-term deployment cohorts showed a tendency for the happiness component to decrease and the sadness component to increase. Furthermore, no changes were seen in the anger and tranquillity components. This suggests that it is possible to detect stress from states of emotional change in ST [5].

4. MEASUREING STRESS THROUGH VOICE

A joint research project with the Faculty of Engineering, University of Tokyo [6], has seen the construction of a subjective reproduction logic, and tests have been performed for large-scale subjective evaluations of the basic feelings of pleasure/displeasure and six emotions. The results suggest that, as stated in Section 2.4, it is not possible to achieve accuracy in excess of 70–80%, which is the limit of subjective evaluation by the utterers themselves. This stands to reason, as it is the limit of people's subjective view. However, the addition of "pleasure/displeasure, pain, anxiety, tranquillity" to "anger, happiness, sadness, excitement, tranquillity" makes the ST structure robust. On the other hand, solving the noise issue enabled the successful acquisition of voice data in the difficult fMRI gantry environment. Additionally, results concerning the consistency of emotion-related brain activity and ST showed that solid brain activity measurements can be obtained for at least the excitatory response, and brain function mapping for individual emotional responses (e.g. anger) in line with subjects' perceived intensity has also become possible. Furthermore, in collaborative research with the National Defense Medical College, a comparison of ST and stress response voice data suggested the possibility of detecting stress from states of emotional change in ST, and voice data samples could be collected for the purpose of larger-scale verification and improving accuracy. A collaborative project involving a large-scale field trial with members of the general public is scheduled to take place, whereby the mental status of utterers will be routinely estimated. Deviations in the frequency of emotions over the long term will be detected, with those trends taken to denote a person's level of health. For this, a robust ST will be compared with people's subjective views, and changes in emotion, which are an important element of one's mental state, will be analysed based on voice data. This has the potential to play a supporting role in psychoanalysis and diagnosis by physicians, based on early detection of pathology.

5. CONCLUSION

ST has become the current medical technology of PST (Pathologic condition analysis and Sensibility Technology), and a Social Collaboration Lecture titled "Verbal analysis of pathophysiology" has been established at the Faculty of Medicine, University of Tokyo, by MAZDA and MKI. Softbank's emotional robot Pepper is also used. Regarding preventative medicine, Finland, Romania, the US armed forces, and Japanese medical institutions, as well as the Japanese government, have expressed strong interest. In Japan, it has been designated as a National Strategic Special Zone technology, and the University of Tokyo and the Ministry of Education, Culture, Sports, Science and Technology have

designated it as advanced and innovative research. However, even if the significance of stress in emotional change has become apparent, classifying its causes (psychogenetic, neurogenic, physical) is difficult based on subjective views. Therefore, if, in physician-led intervention experiments, the link between acoustic parameters and neural/biological responses can be derived, and if neurogenic and physical symptoms and pathology can be defined, there is a possibility of pathological analysis and simple and routine visualization of brain and neural activity in real time, as "X-rays of the mind".

7. TERMINOLOGY

Utterance unit: One utterance unit is continued speech uttered in one breath, and indicates speech uttered between consecutive breaths.

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SOCIAL COMMITMENTS OF THE SCIENTISTS, PHYSICS AND CORRUPTION

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Abstract. *Physics may offer powerful tools to be used by socially committed scientists to model social, political and economic phenomena, among them corruption. The word corruption was used in Physics and Philosophy, in Antiquity, to describe an alteration of the actual motion (behaviour) of a body, with respect to that expected to be, due to the physical law applicable. The alterations of the actual motions of bodies have been explained by physicists by using Physics models. The authors have used Physics models to find characteristics of social corruption, characteristics which are exposed in the paper. A few simple Classical Physics models are introduced in the paper - the three Newton laws, conservation laws, dimensional homogeneity, and the basics of the processing of data. These models are being used by the authors to explain some classical or contemporary examples of social and economic corruption, and may be used by socially committed scientists to identify and understood corruption, possibly suggesting how to fight and forecast concrete cases of corruption, models being applicable to explain many other everyday life phenomena.*

Key words: *Corruption, fraud on law, physics models, action and reaction, inertia, proportionality, conservation principles, dimensional calculus, dimensional homogeneity, error estimation, sociophysics, sociooptics.*

Introduction

Following the financial crisis of 1720 (known also as ''South Sea Company bubble''), some governments decided to encourage research, development and engineering.

Scientists have been at the origin of the later progress due to the enormous social impact of science and of technology which have lead to: the industrial revolutions, the discovery of radioactivity, of nuclear reactions and of the structure of matter, the revolution in information technology.

This progress has also significant ecological impacts, a positive one but also a negative one. It generates the necessity of a new kind of "intelligent" growth, to which socially committed scientists are to play an important role. That may be helped if research and its applications be based on interdisciplinary education, so preventing specialists from being inhibited by a lack of general scientific overview.

Particularly, because Physics has large spectra of models and it is studied from the school age as a component of scientific literacy, Physics is called on to suggest scientists and to help them to apply laws, principles, methods, structures, models and ways to understand, identify, describe, manage and control social and economic phenomena, by analogy with physical natural phenomena.

The authors have make use of such models to investigate corruption, an alteration from a lawful behaviour, comparatively, in Physics and in society. They have drawn, by analogy, a few conclusions on the characteristics of the social corruption. These characteristics are presented in the paper to assist socially committed scientists to deal with corruption, by using simple models relying upon: the Newton's laws of Mechanics, the conservation principles, the dimensional analysis, the processing of experimental data.

Quantum mechanical types of behaviour of ensembles of human individuals previously developed by authors are not introduced in this paper.

The authors give a few examples of modelling recently described concrete situations of social corruption, analysed using the introduced in the paper Classical Physics models, to suggest how to fight and even, forecast and prevent some types of corruption when considering different world sceneries for different social and economic phenomena at different levels, thematic, space and time horizons.

Definitions of corruption

The word "Corruption" comes from Latin **corruptio**.

In contemporary dictionaries, "corrupt" (L corruptus) means: broken in pieces, destroyed; corrupted (ptp. of corrumpere), equiv. to **cor-** + rup- (var. s. of rumpereto break) + -tus ptp. Suffix; when used as an adverb corrupt literally means "utterly broken"

In modern English usage, the words corruption and corrupt have many specific meanings, like:

- **Political corruption**: the abuse of public power, office or resources by government officials or employees for personal or group gain, e.g. by extortion, soliciting or offering bribes (including Electoral fraud, slush funds).
- Nepotism, cronyism, favoritism. ·
- **Bribery** in politics, administration, management, justice, army or sport (including **match fixing**).
- Baksheesh.
- **Police corruption**.
- **Corporate corruption**: corporate criminality and the abuse of power by corporation officials, either internally or externally.
- **Putrefaction**: the natural process of decomposition in the human or animal body or of plant body following death.
- **Linguistic corruption**: the change in meaning to a language or a text introduced by cumulative errors in transcription as changes in the language speakers' comprehension.
- **Data corruption**: an unintended change to data in storage or in transit in a system of processing information.

Legally, corruption is an occult disregard of the law, the violation of legal provisions in their meaning and spirit**.**

This disregard of the law may be or may be not relying upon other laws. Frequently, in legal courts, the corruption is connected with fraud on law.

There is reckoned fraud in law, when certain legal rules are not used for the purpose for which they were enacted, but to circumvent other mandatory legal rules.

The interest in corruption is continuously increasing with the increase in societies' diversification, interaction, informatisation and with the progress of globalization.

Institutions dealing with corruption

The contemporary corruption is so important that, there are being frequently founded institutions dealing with political and economic corruption, from world to local levels.

Transparency International, since 1995, has published an annual Corruption Perceptions Index (CPI) listing and ranking the countries of the world according to "the degree to which corruption is perceived to exist among public officials and politicians, as determined by expert assessments and opinion

surveys". The organization defines **corruption** as "the abuse of entrusted power for private gain" or "the misuse of public power for private benefit".

The CPI draws on 13 different surveys and assessments from 10 independent institutions: the African Development Bank, the Asian Development Bank, the Bertelsmann Foundation, the Economist Intelligence Unit, Freedom House, Global Insight, International Institute for Management Development, Political and Economic Risk Consultancy, the World Economic Forum, and the World Bank. Countries must be assessed by at least three sources to appear in the CPI.

As of 2010, the CPI ranks 192 countries "on a scale from 10 (very clean) to 0 (highly corrupt)."

In 2011, India ranks 95th, with 3.1 pt, Romania 75th with 3.4 pt.

The CPI measures perception of corruption only, due to the difficulty of measuring absolute levels of corruption.

There are to be mentioned and other important institutions: the ''Grouped'Etatscontre la Corruption'' (**Group of States Against Corruption**), a body established under the **Council of Europe** to monitor the implementation of instruments adopted by member states to combat political corruption;

D. N. A. National Anti-corruption Directorate (a prosecution entity) in Romania, with national headquarters and 15+3 local branches; India Against Corruption, a movement created by a group of citizens from a variety of professions and statuses to work against corruption in India, currently headed by Anna Hazare; local Indian NGOs, like Association for Social Transparency, Rights and Action (ASTRA) in Karnataka; the LokSatta Movement which has transformed itself from a civil organization to a fully-fledged political party - the LokSatta Party, visible in Andhra Pradesh, Tamil Nadu, and Bangalore.

"Corruption" has been firstly described in Physics

In dictionaries, in social studies and in media, there is not even an allusion about the Physics' origin of the word „corruption".

But, the word „corruption" was firstly used in Physics, since Antiquity, to describe an alteration of the actual motion (behaviour) of a (celestial) body, with respect to the expected motion, subject to the physical law applicable.

Along History, physicists have measured and explained corruption in Physics, starting with the irregularities in planets' motions, have modelled them and have found ways to deal with, to master, to reduce or sometimes to eliminate apparent corruption. By studying corruption, physicists have found unknown macro- and micro- bodies, new laws of behaviour, new structures, new forces a. s. o. Sometimes, the fight for eliminating apparent corruption led to unsuspected results: for example, to the discovery of the planets of Earth, Neptune (1846) and Pluto (1930).

Because Physics has large spectra of models able to describe social, political, economic, human, psychical, biological, chemical and engineering phenomena, not only physical, ones, by analogy with Physics models, Physics seems convenient to be applied to study and deal with corruption, being called to suggest and/or develop models, laws, principles, methods, structures and ways to understand, to control, to forecast or to fight and even prevent corruption.

A few characteristics of corruption in society

By their comparative approach of corruption in Physics and in society, using Physics models, the authors have drawn a few conclusions about corruption in society:

- Corruption has cosmic studies origins and the term designating it has been continuously used in Physics since Antiquity;
- Corruption means alteration of a lawful behaviour because of an external influence, (disregarded when the law of supposed behaviour had been formulated);
- Corruption has its rules;
- Corruption may be generated by an external individual influence, a tandem or a group (family, ethnic group, tribe) influence, which have particular interests opposing the general ones or by another influence (environmental, climatic a. s. o.);
- The external influence at the origin of corrupted behaviours is also subjected to rules;
- The rules governing corruption may be known and by a refined, extended or diversified research, the path might open a new perception of the structure and future evolution of the corrupted phenomenon;
- An approach at a higher level of understanding might describe simultaneously both the basic law and the rules giving rise to previously „corrupted" behaviour as regards the basic laws;
- The new more general law may describe „corrupted" behaviours until a new kind of corruption (or a refined one, or an inter-disciplinary one or a far range one) is discovered and the cycle: applied corruption, theoretical explanation and unification of corruption rules and basic laws, restarts;
- In society, the basic social laws or regulations may be infringed by "the legal corruption", by existing valid laws covering „corrupted" behaviour as regards the basic law, through "fraud on law";
- Laws permitting corruption generate system (society) structures, organized, managed, run and acting (at least, partially) subject to corruption rules, eventually by fraud on law;
- Corruption is facilitated by a superior norm (law) and/or higher level structural (institutional) frame permitting corrupts to regulate or promote corruption at lower levels, facilitating that one subsystem of a system make profit on the loss of other subsystems, for example financial and industrial ones; army and civil ones, private or state ones;
- Corruption propagates legally and structurally from universal to local levels and is financially supported reversely, by the black money collected by corruption and by a culture of bribing, favouritism and nepotism;
- Corruption is making profit of the incompetence and/or corruption and/or subordination to corruption interested groups or individuals of the members of the society who normally are in charge of fighting corruption;
- Inequalities in socio-economic status as a result of corruption generate corruption and are expanding by corruption;
- Corruption is stimulated by existence of social segments having Quantum Physics type behaviours - parliament, justice, other state institutions managing society's power (police, army a. s. o.) and take advantage from the competition between such groups and groups where there are valid Classical Mechanics type rules of behaviour (as for the society at large);
- Applied corruption (directly seen by media and laymen) is ensured and operated by networks, self interested closed cliques, old boys networks, structures extended horizontally and vertically;
- Corruption is self-sustainable in the absence of a strong, permanent, general, sustained society's will to fight it, when there is illiteracy and lack of education among population;

- The social corruption may be more versatile, refined, deep, extended, interdisciplinary, than the physical corruption;

- Corruption is not inexorable, because it is subject to social laws which are subjective, being generating by human groups or individuals on behalf of the whole society referred; these chosen laws, have a local in space, in time and domain validity; they may be changed by the society, in opposition to Physics, where laws are natural ones, time and space independent, objective ones, not dependent of humans;

- The result on human control of social laws may be not only a decrease of corruption but, also, an increase, an enlargement, a deepening, a diversification, a flourishing of corruption if those groups or individuals subjectively generating social, political or economic laws and regulations are corrupted themselves as individuals or as a group or are incompetent or are obeying to orders from persons or groups (lobbyists) interested in generating a given kind of corruption, for a given period of time, in a given region, concerning a given activity.

Physics, by its models, may suggest: how, where, when, in connection with what, to find corruption, depending of the type of the law to be broken by corruption and may identify corruption which breaks laws; may show how to find the corruption rules; which kind of laws are contributing to infringe the main law; what is the mechanism and the hierarchy of the laws and of the structures (institutions, networks) implied in facilitating visible corruption; analyze different explanations for the given social findings.

The fraud on law might be diminished by proper competence in applying Physics tools (f. e., by showing how by fraud on law are infringed the action-reaction and/or proportionality postulates, deriving from the laws of Mechanics, the dimensional homogeneity) to prevent fraudsters for using their rights to elude their obligations.

Socially, too, it is convenient to find general laws to include both basic laws and laws considered responsible for corruption, by fraud on law. This path might open a new perception of the structure and future evolution of the corrupt phenomenon, an approach at a higher horizon and level of understanding, like to the discovery of new satellites in Physics when the motion of planets appeared as being corrupted.

To reduce social corruption, the Parliaments and Governments have to amend those laws and rules and regulations facilitating corruption by infringing, by fraud on law, provisions of the Constitution and of other organic laws.

There seems necessary, as regards legislative procedures, to improve the legislative regulations leading to the passage of laws in Parliament or of adopting Government's ordinances or of issuing institutional advices and reports as well as to increase the responsibility of all legislators, which must decide in the favour of public interest but not in the private interests of some individuals or lobbying groups, deeply seeking to be favoured.

The legislators are protected when taken their decisions, even in their own advantage, by immunity. and as well as judges (who, more, are nominated for life) and because for them are valid Quantum Mechanics type behaviour rules, which eventually, may hide and favour corruption, there is necessary a social control of their behaviour (of statistical type, f. e.), made possible by encouraging a large transparency and by the monitoring of their decisions.

A few Classical Physics models for social corruption
These characteristics of corruption and simple Physics models may be used, by socially committed scientists and not only, to improve social environment by recognizing, measuring, modelling, forecasting and fighting corruption.

When applied to society, relationships might have some characteristics a little different from those of the Physics laws. Social laws and the definitions or the conditions for space, time, objects, and interactions are relatively less rigorous than in Physics. We shall consider social laws, when possible, as being postulates (acceptable, based upon partial check) and less rigorous.

There are two complementary approaches useful for socially committed scientists:
- to find a Physics model to explain a chosen type of social, politic or economic corruption or
- to start from an existing Physics model and to find social, political, economic phenomena where this Physics model may, eventually, fit successfully - like in the next part of this paper.

Here following are described a few simple Physics models to be used by any scientist, in the everyday life.

Newton's laws of motion
The three laws of motion were first compiled by **Sir Isaac Newton** in his work *PhilosophiæNaturalis Principia Mathematica*, first published on July 5, 1687.

Newton used these 3 laws to explain and investigate the motion of many physical objects and systems.

These laws describe the relationship between the **forces** acting on a body and the **motion** of that body due to those forces.

These laws have been expressed in several ways over more than three centuries and may be summarized as follows:

First law: Everybody persists in its state of being at rest or of moving uniformly straight forward, except insofar as it is compelled to change its state by the force impressed.

If the **resultant force** (the **vector sum** of all forces acting on an object) is zero, then the **velocity** of the object is constant:

$$\sum F = 0 \Rightarrow \frac{dv}{dt} = 0 \qquad (1)$$

Consequently, an object that is at rest will stay at rest unless an unbalanced force acts upon it; an object that is in motion will not change its velocity unless an unbalanced force acts upon it.

Newton's first law is often referred to as the **law of *inertia***. It is a restatement of the law of inertia which **Galileo** had had already described. It permits the introduction of inertial reference frames.

Second law: The **net force** acting on a particle is equal to the time rate of change of its **linear momentump,** in an **inertial reference frame**:

$$F = \frac{dp}{dt} = \frac{d(mv)}{dt} \qquad (2)$$

where, for constant-mass systems, the mass can be taken outside the **differentiation** operator by the **constant factor rule in differentiation**; thus, for constant-mass systems:

$$F = m\frac{dv}{dt} = ma \qquad (3)$$

where **F** is the net force applied, m is the mass of the body, and **a** is the body's acceleration. Thus, the net force applied to a body produces a proportional acceleration.

Any mass that is gained or lost by the system will cause a change in momentum that is not the result of an external force. A different equation is necessary for variable-mass systems.

Consistent with the **first law**, the time derivative of the momentum is non-zero when the momentum changes direction, even if there is no change in its magnitude; such is the case with **uniform circular motion**.

The relationship also implies the **conservation of momentum**: when the net force on the body is zero, the momentum of the body is constant. Any net force is equal to the rate of change of the momentum (as a vector, in magnitude or in direction).

Third Law: To every action there is always an equal and opposite reaction; or the forces of two bodies on each other are always co-linear, equal in magnitude and are directed in opposite directions.

The Third Law means that all forces are interactions between different bodies and thus that there is no such thing as a unidirectional force or a force that acts on only one body.

Whenever a first body exerts a force **F** on a second body, the second body exerts a force −**F** on the first body. **F** and −**F** are equal in magnitude and opposite in direction. This law is sometimes referred to as the **action-reaction law**, with **F** called the "*action*" and −**F** the "*reaction*". The action and the reaction in Physics are simultaneous.

A force means an interaction; it acts between a pair of objects, and not on a single object. So, each and every force has two ends. Each of the two ends is the same except for being opposite in direction. The ends of a force might be considered as mirror images of each other.

Newton's third law may be stated, more generally, as:

Given two objects A and B, each exerting a force on the other,

$$\sum F_{a,b} = -\sum F_{b,a} \qquad (4)$$

where **F**$_{a,b}$ are the forces from B acting on A, and **F**$_{b,a}$ are the forces from A acting on B.

Newton used the third law to derive the law of **conservation of momentum**; however from a deeper perspective, the conservation of momentum is the fundamental idea.

Laws of conservation

In modern Physics, the **laws of conservation** of **momentum**, of **angular momentum** and of **energy** are of more general validity than Newton's motion laws, since they apply to both light and matter, waves and particles and to both classical and non-classical physics. This can be stated simply, "Momentum, energy and angular momentum can neither be created nor destroyed."

Conservation of energy was discovered nearly two centuries after Newton's lifetime, the long delay occurring because of the difficulty in understanding the role of microscopic and invisible forms of energy such as, that time, heat and infra-red light.

A few examples of classical social applications of Newton's Laws

To Newton Laws (in social applications is better to be called "Postulates") correspond causality, which is the relationship between an event (the cause) and a second event (the **effect**), where the second event is a consequence of the first, in the special situation when antecedence is reduced to simultaneity, understood as for social phenomena (as having a much larger time constant).

The previous equations observe the order cause – effect of their terms.

Though cause and effect are typically related to **events**, candidate quantities in social life may include: **objects**, resources, **processes**, **properties**, variables, **facts**, rights, actions. The quantitative analysis of causes and effects of a process, based on these three Laws (social Postulates) may stay at the basement of any social analysis.

"Status quo antem" corresponds to 1st Postulate: "no action leads to any change in motion".

To the 2nd Postulate may correspond principles and rules of proportionality: - "the variable cost is proportional with volume of the goods or services of the same nature (considered within defined limits)"; - "the value added tax is proportional with the added value"; - "the number of seats for the representatives of a state in the federal parliament is proportional with the number of inhabitants", - "the penalty is proportional with the damage". Alterations in applying such rules or laws suggest searching for corruption.

For example, to quote Indian sources: there have been several cases of collusion of officials of the income tax department of India for a favorable tax treatment in return for bribes; preferential award of public resources, iIlegal mining in India favoured by local authorities; public land in areas with short supply of water awarded to private concerns at negligible rates; (black) money removed from the official economy (via corruption, bribery, tax evasion, etc.) and stored outside of the country; corruption involving senior armed forces officers.

Proportionality is a principle in law ('second Postulate') which covers two distinct (although related) concepts: within Criminal Law (at national levels) and International. Law.

In Criminal Law, the punishment of a certain crime should be in proportion to the severity of the crime itself. In practice, systems of law differ greatly on the application of this principle. In some systems, this was interpreted as lextalionis, (an eye for an eye). In others, it has led to a more restrictive manner of sentencing. For example, all European Union countries have accepted as a treaty obligation that no crime warrants the death penalty, whereas some other countries in the world do use it.

The proportionality principle, moreover, is regarded as a fundamental element of regulatory policy and public administration. In this context, the principle is considered to find its origins in German constitutional and administrative jurisprudence. Over the past fifty years, however, it has become a preferred procedure for managing disputes involving an alleged conflict between two rights claims, or between a rights provision and a legitimate state or public interest.

From its German origins, the proportionality analysis spread across Europe and into Commonwealth system.

In International Law: the incidental (i.e., unintended) harm caused to civilians or civilian property must be proportionate and not excessive in relation to the concrete and direct military advantage anticipated by an attack on a military objective.

The principle of proportionality has played an important role in preventing undue invasions of basic rights for the purposes of countering terrorism.

The characterizing of the causal relationship may be the subject of much debate in each case.

Contiguity, implied in causality (Max Born), postulating that cause and effect must be in spatial contact or connected by a chain of intermediate things in contact is always implied.

The Physics action-reaction Law, as an *action-reaction postulate* (ARP), may model many non physical phenomena. These phenomena might have some characteristics different from those of the physics law of action–reaction, but not, essentially, affecting it. The time constant might be different, for example, the nature of the reaction might be also different.

The *action-reaction postulate* has analogies in many non physical issues:

- Vedas "if one sows **goodness**, one will reap goodness; if one sows **evil**, one will reap evil".

- Karma in **Indian religions**, treated in **Hindu**, **Jain**, **Buddhist** and **Sikh** philosophies, is the belief that a person's actions cause certain effects in the current life and/or in future **life**, positively or negatively.

- Hegel's dialectic principle of "unity and conflict of opposites (contraries)".

- In Economics, the demand and the offer act reversely; or if the action means expenses, the reaction would mean income.

- In the theories on Law, the rights are always accompanied and conditioned by obligations. If the action means more rights, the reaction would mean more obligations. The reverse allegation is also valid.

- A civic principle asks that one should take responsibility for all his own actions.

Complying with the action reaction postulate (rights vs. obligations) is a requirement at the basement of judges' reasoning.

The observation of the action-reaction postulate is evident in the major part of provisions of national Constitutions: „national citizens, foreign citizens, and stateless persons shall exercise their constitutional rights and freedoms in good faith, without any infringement of the rights and liberties of others"; „no budget expenditure shall be approved unless its financing source has been established".

Typical examples of breaking action-reaction postulate (ARP) are offered: by media campaigns, by the official names chosen for some organizations, by barristers who usually stress only action or the reaction component, by many of those making petitions or complaints to authorities.

Other typical examples of breaking action-reaction law are offered by the requests of the representatives of some groups on behalf of those groups to gain financial and other gains without offering society nothing in return for their demands or at least by indicating where from to take the supplementary required resources,. One could mention, f. e., some trade unions, which ask increased salaries without indicating the source of the new demanded funds (where to diminish spending) or what they offer to increase revenues of the patronage (including the State) – for example, the unions do not ensure the upgrading of the training of their union members with regards the use of IT technologies or of the contemporary standards of quality or of learning international languages.

Sometimes, politicians do not evaluate the possible reactions to their declarations, consequently suffering severe consequences.

The same is valid for political parties which, during electoral extended campaigns, to gain votes, do pass laws in Parliament providing for uncovered budgetary future expenses, which shall lead to future chronic State Budget Deficits.

But, in spite of constitutional provisions („no budget expenditure shall be approved unless its financing source has been established"), the State Budget Deficits of many countries have continuously increased in the last years, some Governments being obliged to implement them, not being possible to infringe previously passed laws which have been providing for unsustainable social expenses and salaries. Some constitutional provisions may be infringed by other laws, previously passed by Parliaments, by „fraud on law".

The solutions for the Governments would be to identify and amend those laws generating corruption, through the infringement of the provisions of the national constitutions.

This refers to the reduction of opportunities for corruption created in the past.

For the future, there seems necessary, as regards legislation procedures, to improve the legislation regulations leading to the passage of laws in Parliament or of adopting Ordinances by the Government or of issuing institutional advices and reports and to increase the responsibility of all legislators, including the Parliament members which, must decide in the favour of public interest: "In the exercise of their mandate Deputies and Senators shall be in the service of the people"(Constitution of Romania), but not in the private interests of some individuals or groups, deeply interested to be favoured, as have been accused, sometimes.

The European Union is in course of implementing constitutional changes to limit the breaking of the 3rd postulate in dealing with the national budgets.

An analysis of the Constitutional content, at the next Revisions of Constitution, by considering the mentioned Postulates (of proportionality and of rights and obligations) seems necessary.

When educating people, the action-reaction postulate is introduced very early, even before hearing about Physics, for example, when a mother is conditioning the feeding of a baby by a certain behaviour of the baby (by generating a conditional reflex); later on, in earlier childhood, f. e., when a baby is told not to knock or to kick hardly because this will result in hurting himself. The ARP is applicable everywhere, every time, in every interaction, subjected to conditions of stability of the implied system, mentioned above.

A typical example of breaking action-reaction postulate in early school education is offered by a pupil who is wishing a higher mark without doing more work for reaching it, but by cheating.

Corresponding to the ARP, the pupil is to be trained to have a proactive approach in expecting an increase in his compensation by the reaction of the environment, that meaning to perform a more intense action or a longer time one or a better one.

Some canonical rules, taught early to pupils, may also be explained and modelled by the action-reaction postulate, f. e.: not to take other's goods without paying for them and other commandments.

For educating a responsible citizen, there is important to teach pupils to try to be inventive, creative in *observing* the action-reaction postulate, not in finding ways to infringe it.

The observation of the action–reaction postulate is essential in ecological education of pupils, by showing them the possible negative consequences of their bad ecological actions, as a result of the reaction of the environment to their unhappy actions, starting from simple actions as not keeping their body and their close neighbourhood clean, as wasting water or throwing plastic foils and bottles and even home waste everywhere.

The "problem solving" and "solution oriented" approaches might be introduced in teaching Physics and other topics by applying ARP, through emphasizing the gains of such approaches as the results of reaction to the pupil's actions.

Changing the signs of some of the data in a statement of a problem could demonstrate the role of reaction in the studied phenomenon.

It is useful to ask the student to every time think, also, to non Physics applications of the physical law, tool, method used, to suggest ways for judging the different approaches in those non physics applications and for improving the precision of the physics model used. There are to be mentioned here the unhappy titles of some important international treaties like ''Human Rights Charter'' or names like ''Court of Human Rights'' titles which, without intent, may encourage the abuse of requiring more rights by those who do not observe their correspondent obligations.

But, his infringement of the Action-Reaction Postulate is not seen for the name of the new Indian "citizen's charter" or at classic thinkers.

F. e., on the tomb of Voltaire (François-Marie Arouet, 21 November 1694 – 30 May 1778), a great French Enlightment writer, there is mentioned that ''he fought for the human rights against the feudal abusive obligations''. "He fought the fanatics" may be interpreted as to refer to Voltaire's observing the second postulate – of proportionality, not observed by the fanatic people.

Fig. 1. Voltaire's tomb in the Pantheon in Paris (since 1791)

Some applications of Conservation Laws (as social Postulates)

Newton's laws are the result of conservation laws of the quantities non regenerative and non perishable in a conservative system (referring, in Mechanics, to the total energy, the total linear or/and circular momenta), to ensure the stability of the system in its stationary evolution. But, conservation laws are acting in all fields.

In biology the concept of "areal" is used (i.e. minimum surviving area for an individual animal of given specie, in a given environment), the size of an areal being determined by conservation laws, subject to the speed of regeneration of renewable resources.

Conservation laws are present, too, in social life of humans, when having a limited resource for a defined social group, under specified conditions, subject to defined space and time horizons and the conservation postulates might limit the social development, particularly, in the present time of globalization, at global level (industry, agriculture, tourism) mainly due to the consumption of limited, non-renewable world resources (fossil fuels, gold, f. e.).

May be, the conservation laws impose that a further development of developed countries observing traditional patterns is not a solution, on the actual pattern, if we consider a worldwide homogenizing of the level of development. Some world finite resources may limit the world development to a couple of years, only.

Maybe, it is the case to speak of ''re-development'' and of other ''intelligent'' ways of development.

If a sustainable increase of known resources is possible, the speed of this possible increase of available resources put limits to a sustainable rhythm of development. Of course, progress in science, technology and management in replacing limited resources with others, renewable or less scarce ones, make a sustainable development possible on a longer run, on a larger human and geographical scale.

The conservation laws may require redistribution of world resources or of their rhythms of consumption and these requirements may generate conflicts.

A debt on the future is not an unlimited resource as it is seen by some governments, but it is leading to a spiral of debts, taxation, discouraging business but promoting corruption and regress in the middle run and more, in the long run. These debts generated by an egocentric generation are to be paid by future generations.

Dimensional Analysis

Dimensional Analysis (D. A.), largely used not only by physicists but by almost all scientists, is easy to be understood and applied, allows and stimulates creative approach, may be largely used almost everywhere and may be introduced into the curriculum of any undergraduate Science program.

In the following, there are exposed basics of D. A., how to find dimensional equations, examples of their applications in different fields.

The basic principle of Dimensional Analysis was known to **Isaac Newton** (1686) who referred to it as the "Great Principle of Similitude". Important contributions were made by the 19th century French mathematician **Joseph Fourier**, based on the idea that the physical laws (like $F = ma$) should be independent of the units employed to measure the physical variables.

This led to the conclusion that meaningful laws must be formulated as homogeneous equations in their various systems of units of measurement.

In Physics, D. A. refers to the operations with dimensional equations and with units, describing the nature of physical quantities. In other sciences D. A. operates with other specific quantities.

The value of a dimensional physical quantity **X** is written, within the dimension **[X]**, as the product of a unit **{X}** and of magnitude, **x,** a dimensionless numerical factor:

$$\mathbf{X = x \{X\}} \qquad (5)$$

Because a physical quantity **X** has not to depend of what unit, **{X₁}**, it is expressed one may write:

$$X = x_1 \{X_1\} = x_2 \{X_2\}, \qquad (6)$$

where x_1 and x_2 are the magnitudes (values) of the same quantity **X** expressed with the units **{X₁}** and respectively **{X₂}** and consequently, all the commonly used systems of units in physical science have the property that the number representing the magnitude of any quantity (other than purely numerical ratios) varies inversely with the size of the unit chosen.

This universal property of unit systems, often known as the ''absolute significance of relative magnitude'', determines the structure of all dimensional formulas.

Because physical quantities may be connected, in many ways, there is necessary to select a set of physical quantities to be considered a fundamental (basic, primitive or primary) set, from which all others physical quantities, the derived (secondary) quantities, could be defined.

The choice of the basic set of dimensions is, thus, partly a convention, but cannot be arbitrary, because the dimensions must form a basis: they must **span** in a multi-dimensional space and be **linearly independent**.

Basic units are defined for fundamental quantities, possibly in different ways, in different fields, in different historic periods.

The fundamental quantities (and their symbols) and their units (and symbols), currently agreed in Physics, established by international convention, form the International System of units (SI) and are:

length, **L** (m, meter); *time*, **T** (s, second); *mass*, **M** (kg, kilogram); *electric current*, **I** (A, ampere); *thermodynamic temperature*, **θ** (K, kelvin); *amount of substance*, **M** (kmol, mol); *luminous intensity*, **J** (cd, candela)**.** They form a set of **fundamental dimensions** and may be seen as a vector space over rational numbers.

Dimensions

It can be proved that every secondary quantity which satisfies the condition of the absolute significance of relative magnitude is expressible as a product of powers of the fundamental quantities:

$$X = C * L^{\alpha} * T^{\beta} * M^{\gamma} * I^{\delta} * \theta^{\varepsilon} * \mu^{\zeta} * J^{\eta} \qquad (7)$$

where **C** is a dimensionless constant. There are no conversion factors between dimensional symbols.

The magnitude **x** being a dimensionless constant (a real number), like **C** is, one may introduce **[X]** - the dimensional expression (equation) of **X**, as:

$$[X] = L^{\alpha} * T^{\beta} * M^{\gamma} * I^{\delta} * \theta^{\varepsilon} * \mu^{\zeta} * J^{\eta} \qquad (8)$$

The form (4) of the dimensional expression **[X]** of **X** (equation, formula) is valid for every physical quantity, primary or secondary one.

Percentages are dimensionless quantities, since they are ratios of two quantities with the same dimensions.

Therefore, besides unit **{X}** and magnitude **x,** each physical quantity, **X**, may be characterized by a dimensional expression (equation) **[X],** as an algebraic product of basic quantities at whole numbers or fractional powers, basic quantities

expressed by their dimensional equations represented in S. I., simply, by their symbols: **L; T; M; I; θ, μ** and **J**.

The exponents $\alpha, \beta, \gamma, \delta, \varepsilon, \zeta, \eta$ of the symbols of the basic quantities **L; T; M; I; θ,μ** and **J** (in S. I.), in the dimensional equation **[X]** of the derived quantity **X,** are called the „dimensions of the derived quantity **X** in S. I.".

For example, the physical quantity, speed, may be measured in Mechanics, in units of meters per second, miles per hour etc; but regardless of the units used, speed is always a length divided by a time, so we say that the dimensions of speed are length divided by time, or simply **[v] = L/T**.

The choice of the dimensions or even the number of dimensions to be used in different fields of physics (and not only) is to some extent arbitrary, but consistency in use and ease of communications are very important.

The most basic consequence of dimensional analysis is that *only commensurable quantities (quantities with the same dimensions) may be compared, equated, added, or subtracted.*

This conclusion is valid in any domain of knowledge.

Thus, dimensional analysis may be used as a **sanity check** of physical equations: *any equation must be ''dimensionally homogeneous'', for all fundamental dimensions.*

Scalar arguments to **transcendental functions** such as **exponential**, **trigonometric** and **logarithmic** functions, or to **inhomogeneous polynomials**, must be **dimensionless quantities**.

The dimensionless constants could not be computed by D. A.

Dimensional equations

The deduction of the form of unknown dimensional equations may be done by using Rayleigh's method or by **π** theorem.

The application of dimensional analysis to the derivation of unknown relations depends upon the concept of completeness of equations: an expression which remains formally true no matter how the sizes of the fundamental units are changed is said to be complete.

The Rayleigh's method involves the following steps:

a. Gather all the **independent variables** that are likely to influence the **dependent variable**.

b. If **X** is a variable that depends upon **n** independent variables $X_1, X_2, X_3, ..., X_n$, then the **functional equation** can be written as

$$X = F(X_1, X_2, X_3, ..., X_n). \qquad (9)$$

c. Write the above equation in the form:

$$X = CX_1^a X_2^b X_3^c \cdots X_n^m \qquad (10)$$

where **C** is a **dimensionless constant** and where **a, b, c, ..., m** are unknown exponents, to be found.

d. Express each of the quantities in the equation in some **fundamental units** in which the solution is required, by considering (in S. I.) the dimensions of each quantity X_i ,$\alpha_i, \beta_i, \gamma_i, \delta_i, \varepsilon_i, \zeta_i, \eta_i$, of the symbols of the basic quantities **L; T; M; I; θ,μ,** and **J** .

e. By applying **dimensional homogeneity**, obtain a **set** of **simultaneous equations** involving the exponents **a, b, c, ..., m**.

f. **Solve** these equations to obtain the value of exponents **a, b, c, ..., m**.

g. **Substitute** the values of exponents **a, b, c, ..., m**. in the main equation and eventually form the **non-**

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dimensionalparameters by **grouping** the variables with like exponents.

Units

Dimension is a more abstract concept than scale**unit**: mass is a dimension, while **kilogram** is a scale unit (choice of standard) in the mass dimension.

The units of chosen fundamental quantities in a system of units are also chosen by convention (f. e.: **m, s, kg, A, K, mol, cd**, in S. I.) but the units for the derived quantities are to be established as to be able to eliminate parasite factors of conversion between the units for the same quantity and to preserve simultaneously valid the equations (5), (8), (9).

Such a system of units is called a coherent system of units.

The coherence of a system of units is the result of recognizing the existence of essential relationships among physical quantities.

When using units belonging to a coherent system, the functional equation for magnitudes:

$$x = F(x_1, x_2, x_3, ..., x_n) \qquad (11)$$

would be of the same form as the functional equation for the physical quantities (9).

Strictly, when like dimensioned quantities are added or subtracted or compared, these dimensioned quantities must be expressed in coherent units so that the numerical values of these quantities may be directly added or subtracted, the equations connecting the magnitudes only, being exactly like the physical equations (11) are resembling (9).
Therefore, all conversion factors have to be equal to 1 and could be disregarded in practical work.

Conceptually, there is not a huge difficulty to add quantities of the same dimension expressed in different units. But, in such cases there are to be used the appropriate conversion factors between the different units used and paid deep attention.

Operations with dimensional equations; observing dimensional homogeneity

The dimensional expression of a physical quantity **X** neitherdepends of the magnitudes of the units through which it is expressed (because the magnitudes are numbers – dimensionless quantities) nor of the operations of addition and subtraction between the physical quantities of the same physical nature which are connected in the considered equation.

Only terms whose dimensions are the same may be equated.

F. e., the equation: **60 kg = 60 m/s !?** makes no sense, in spite of the implied magnitudes being equal (60 = 60, but what 60?).

A necessary condition for the correctness of any equation is that the two sides have the same dimensions, are measured in the same units, within the same system of units.

There is always compulsory to observe in each case (for products, powers), the equalities of the exponents (dimensions) of each basic physical quantity which enters in any term and in each member of a dimensional equation as well as any relationship among dimensional expressions be homogenous, relatively to all fundamental physical quantities.

Any physical equation:

$$X_1 = X_2 \qquad (12)$$

may be true when and only when the corresponding dimensional expressions of the members of the equation are identical:

$$[X_1] = [X_2], \qquad (13)$$

therefore, when:

$$\alpha_1 = \alpha_2; \beta_1 = \beta_2; ...; \eta_1 = \eta_2, \qquad (10_1\text{-}10_7)$$

that meaning that the equation may be true only when there is observed the propriety of homogeneity of the equation with respect to all fundamental physical quantities.

This homogeneity check may be easily done by expressing each of the quantities in the equation (13) in the **fundamental units** in which the solution is required, too.

For social modelling there be necessary to introduce specific dimensions for specific fields.

Some Applications of Dimensional Analysis

Dimensional analysis is mostly often used in Physics, Chemistry, Engineering - and in the Mathematics thereof - but finds applications largely outside of these fields as well.

D. A. analysis is a tool to understand the properties of physical (or other specific) quantities, independently of the **units** used to measure them.

Dimensional formulae provide a convenient shorthand notation for representing the definitions of secondary quantities and are helpful to define units and find relations between units, to change units from one system to another and to categorize types of physical or other quantities and units based on their relations to or dependence on other units, or their "dimensions", or the lack thereof.

D. A. may be always used to check the dimensional homogeneity of physical equations and not only. It is a help in the check of complicated analytic expressions. It affords a convenient means of checking equations used in other sciences.

Dimensional analysis is routinely used to check if **derived** equations and computations are plausible, in the deduction of the form of unknown relations, to derive relationships between the physical or social quantities that are involved in a particular phenomenon that one wishes to understand and characterize, to find new dependencies not so evident from experiments.

D. A. may be approached as a primary tool for obtaining information about physical (and other) systems, too complicated for full mathematical solutions being feasible.

D. A is also used to form reasonable hypotheses about complex physical situations that can lately be tested by experiment or by more developed theories of the phenomena.

Dimensional analysis is often the basis of mathematical models of real situations and generally of models design. It can allow one to make calculations about the phenomenon of interest and therefore be able to more efficiently design experiments to measure phenomenon features or to judge whether it is important.

D. A. enables one to predict the behaviour of large systems from a study of small-scale models, at a great saving in cost.

D. A. facilitates the study of interrelationships of systems (or models of systems) and their properties.

In Law, D. A. is essential to understand principles and to design legal norms.

In Finance, Economics, and Accounting, Dimensional Analysis, as a part of Econophysics, is most commonly used in

interpreting various **financial,** economics and accounting ratios.

D. A. applied in Sociology leads to solutions of problems that have not been solved before in regard to decisions, intentions, emotions, cognition.

Of course, the help of D. A. could not replace human decision-makers. A manager's domain expertise and tacit knowledge cannot be replaced by an automated algorithm. However, Dimensional Analysis can support and augment decision-makers' instincts and reasoning abilities.

Applying Dimensional Analysis to check the correctness of economic indices

F. e., D. A. when applied to appreciate the fairness of the formulae currently used for calculating State Budget Deficit, may indicate a few possible frequent errors introduced to corrupt public opinion perception about the state of the Budget Deficit.

In defining of the State Budget Deficit, D, there are being used the following quantities: government revenues, R and government spending, E, frequently and the gross domestic product, GDP, here, shortly denoted by P.

Defined as an absolute quantity (expressed in the chosen currency), the absolute deficit, D_a is equal to:

$$D_a = E - R, \qquad (14)$$

The quantities R, E, D_a are expressed as absolute (not relative) quantities, having the identical dimensional expressions:

$$[R] = [E] = [D_a] = C/T, \qquad (15)$$

where C and T the symbols of the dimensions of the chosen currency and of time, for example dollar and respectively, year.

The condition of dimensional homogeneity has to be observed for each equation, for each side and for each term. The mentioned quantities have the same dimensional equation, the revenue, the spending and the deficit, are referring to the same State Budget components. Therefore, for the same economic system, they must be expressed in the same currency unit, per the same time interval, i.e. in Euro/year, dollar/semester, RON/trimester, Rupee/month including the same components (for whole Romania or India, i.e.).

Generally, there must be used the same units and be valid the unit's equations:

$$\{R\} = \{E\} = \{D_a\}, \qquad (16)$$

A frequent error may be not to keep the unit $\{C\}$ of the currency C, of dimension $[C]$ as a constant and to compare the values r, e, d_a of each one of these quantities R or E or D_a, for different equal periods of time, but by using different, currencies, at different instants, f. e Euro/y at the end of 2010 compared with Rupee/y at the end of 2009, without mentioning the chosen currencies and the evolution of their exchange rate (I. e. Euro/Rupee), during the interval of time implied.

Another dimensional error would be to compare each one of these quantities R or E or D_a, as absolute values but for different time intervals, even when using the same currency.

For example, there is compared the absolute State Budget Deficit on the first semester of 2011 with D_a for the whole

2010, with a false optimistic conclusion for politicians and media, unaware of the trick.

Another possible dimensional error is to compare the quantities R, E, D_a, for different periods, by using different methodology of computing them, for different periods, not the same one.

The State Budget Deficit may be defined, besides absolutely, D_a, also as a relative quantity, D_R, expressed as the percentage of D_a from the revenue, R:

$$D_R = D_a / R \qquad (17)$$

More frequently, but dimensionally incorrect, the relative deficit is expressed as D_P, a percentage D_a of the gross domestic product, P :

$$D_P = D_a / P \qquad (18)$$

Another dimensional error in operating with relative State Budget Deficit, D_R, is that dividing the absolute State Budget Deficit D_a for a trimester to the gross domestic product, P, for the whole year, D_{tPa}. In this case the relative deficit seems to be, relatively, 4 times smaller than the actual correct figure relative to P when observing the condition of homogeneity in Dimensional Calculus, which may ensure correct conclusions.

The definition of the Relative State Budget Deficit with respect to Gross Domestic Product, D_P, is preferred by politicians and by some international institutions like International Monetary Fund, World Bank, but, from a dimensional point of view, it is a rather unhappy definition and practice because the quantities: government revenue, R, government spending E, on one side and respectively the gross domestic product P, on the other side, dimensionally represent different types of economical quantities. Simply speaking, the whole State Revenue R may be spent by the government, but not the whole domestic product, P.

To better realize this essential dimensional distinction between the definitions (17) and respectively (18) of the relative deficit, let exemplify by the situation in Romania, reported (provisionally) for the whole year 2009.

The „Budget State Deficit" was then reported as being equal to ~ 8.3 %.

Looking at the detailed economical figures one may see that the report was about:
- a relative deficit, not about the absolute deficit $D_a = E - R$ (14);
- a relative deficit computed by dividing absolute deficit $D_a = E - R$, to P, that means as percentage of the gross domestic product, P: $D_P = D_a / P$ (18)

From this definition it would result, by ignoring dimensional requirements, that there would had been enough to splash state spending with 8.3 % to escape of the State Budget Deficit. The correct dimensional approach had would been to use D_R, the relative State Budget Deficit, as a percentage of D_a from the government revenue, R, quantities which have the same dimension and may be divided to offer a correct percentage (17): $D_R = D_a / R$,

D_R is larger than D_P, as much as P is larger than R.

The figures for the R/P vary between 31% and 32% (with or respectively, without, progressive taxes). Considering as acceptable, for the computations done here, an R/P value of approximately 1/3 (the revenue R being approximately only one third of the gross domestic product, P), the relative State Budget Deficit expressed as percentage of R, D_R, is equal to:

$D_R = \sim 3 * 8.3 \% = \sim 25 \%$.

Therefore, D_P, the relative state budget deficit expressed as percentage of P, seems to uneducated people 3 times smaller

than D_R and possibly, that is why D_P is preferred by politicians, because D_P is not so impressive for the media and laymen.

This figure of 25% of the relative deficit being equal approximately to a quarter of the revenue is the significant one by itself and exactly it has been used by the Romanian Government and the I. M. F., World Bank and E. U. when actualizing the loan agreement for the second semester of 2010.

The payments have been done on condition that Romania slashes public spending and boosts tax revenue to reach a $D_R = \sim 25\%$, which had be happen by diminishing all payments from the public budget by a quarter, with 25% .

This partially happened, only salaries being reduced, but had not been enough as shown by our dimensional reasoning. It would had been necessary to reduce all kinds of expenses with 25 %, including all pensions, all social aid, all bonuses, all spending on goods and services and all investment spending of the Government. This has not been possible, may be, because of possible political consequences of the social unhappiness generated by such an action.

Therefore, to comply with the law of action-reaction, the Government has had to try to increase, on the spot, its revenues, to cover the failed proposed slash of expenses.

As a consequence, the Government has decided to increase its revenues, by increasing the Value Added Tax from 19 % to 24 % from the added value tax in economy. That means, again by increasing VAT relatively with itself, with approximately a quarter (with 5%, from 19% of the added value, that meaning, roughly a quarter 5/19 = 26.3% of the initial value of 19%).

Again, this increase of revenue is not enough as required by the action-reaction law. It was necessary to: further drastically reduce expenses on goods and services and of the number of state employees but these partially implemented reductions had not been enough (because social expenses $\sim 46\%$ of the State revenue were not diminished).

There seems necessary to more boost revenues, by: cracking down on tax evasion and austerity measures including rising the retirement age and ending public sector bonuses.

In a case of another state, having a sovereign debt of 200% of GDP, reasoning correctly from a dimensional point of view, the debt is as large as the revenues of the state for ~ 6 years. Considering, a 25% reduction in State Spending, there would be necessary two dozen years to reach the budget balance (if all other parameters be preserved).

It is clear that this debt cannot be paid in a reasonable perspective.

Seeking a large profit from high premiums, some people lent to the Greek government. As it turns out, they made miscalculations. In the process of promising gifts to voters, the Greek government has increased its financial obligations so far beyond what it can cover from its tax revenues that, now, no-one is willing to lend it any more.

Without borrowing more, however, the Greek government cannot repay the debts that are coming. Its current creditors are going to lose part of their deposits.

The exact steps are to be choosing following numerical simulations of different possible measures be taken, by modelling their correlations, too.

There is to be avoided that the harsh measures trigger series of public sector strikes and eventually violence on the streets (like it has happened in Greece), by governments taking gradual measures to allow social acceptance.

By its success in getting the IMF loan and by observing its engagements, Romania has gained a vote of confidence for the measures taken by the Government.

Romania has an open window to exit crisis, which may influence financial markets and this has to be honoured.

Measures to encourage development by attracting investment local, foreign and E. U. funds, accessible to Romania (insufficiently applied for until now) are to be taken.

Exactly measuring corruption statistically is difficult if not impossible, due to the illicit nature of the transactions and imprecise definitions of corruption. While "corruption" indices first appeared in 1995 with the Corruption Perceptions Index, all of these metrics only address different proxies for corruption, such as public perceptions of the extent of the problem.

Below some simple applications of D. A., connected with evaluating corruption are given.

The leverage when investing in bribing
D. A. has been suggesting the authors to quantitatively measure different social phenomena by using relative ratios of specific pairs of quantities which have the same dimensional values.

F. e., to relatively measure the absolute gain by corruption, G, one may deduce from the profit, P, generated with bribing the paid bribe B. .The relative gain through bribery, G_r;

$G_r = (P - B) / B = (I - E - B) / B$,

where P is the amount expected to be gained on the investment when bribing, B is the bribe, I is the expected income generated by the contract and E are the normal expenses to implement the contract (the investment).

A recent concrete example from a municipality of Romania: a contract of 72,000,000 of Euro has been preferentially allotted to a company who paid a bribe of 45,000 Euro to the Mayor of the town (now imprisoned for criminal investigations). In the contract, the computations were based on a declared 15 % relative profit P_r:

$P_r = (I - E) / I$

That meant that the profit would have been $P = P_r * I = 10.800.000$ Euro and the absolute gain is $G = P - B = 10.755.000$ Euro.

Finally, $G_r = 10,755,000:45,000 = 239 = 23,900\%$!

Let us relatively compare with a recent case related by media as being discovered in Argentina, where a bribe of 100,000,000 $ has favoured a contract of 1000,000,000 $, contract with an estimated relative profit of 40 % (media allegations).

The result computed for this Argentina case is that a relative gain by bribing, here equal to 300 %, is relatively, ~79 times less that computed for the Romanian previous example, but also much more than values accepted in some countries; 200% (a profit of 10 % expected by considering a commission of 5 % on the contract).

Responsibility of the members of Parliament (MP)
The responsibility of the members of Parliamentis expected to be high, but it is difficult to be measured.

To measure it, at least, relatively, let us compare it with the responsibility of a citizen. .   Because responsibility covers many aspects, let us consider only financial responsibility.

We need to compare their behaviours in the same situation, at similar operations, based on objectively found quantities.

Let choose, f. e., the double voting.

Here following there are presented two recent examples from Romania:

1. the Judicial Commission of the Camera of Deputies has established, based on multiple proofs, that in the autumn session 2011, 8 MP (from all 3 main parties) have voted at least doubly and it sent its report to the Board of the Camera, with the proposal that those MP be penalized at the maximum: 15 days not to receive emoluments, that meaning about 10% of the monthly income of an average income of a MP.

If this maximum penalty for MP double voting is compared with the maximum penalty provided for double voting by the electoral law for the electors (laymen) in the local, general (national or European) poles, 5 years of prison it results that an elector of a MP has a loss in the salary corresponding to 60 months, that meaning a financial penalty 600 times relatively larger that one of a MP penalized for double voting.

Therefore we may conclude that the maximum financial responsibility of a MP for a double vote in specific similar activities, is 600 smaller that that of an elector of that MP.

Actually, those 8 MPs have actually been penalized, at December 22, 2012 at minimum: 1 day loss of emoluments for each MP, the minimum possible, by the regulations established by the Parliament.

2. Previously, on November 18, 2012, the Romanian citizen Marian Amza, has been arrested in Italia (Viareggio), subject to an European warrant, he being convicted to 4 y of prison (1461 days) for his double voting in the euro parliamentary elections of June 7, 2009, in Romania.

The actual ratio of financial penalties: voter/MP, in the mentioned two recent cases, is 14610. It results an elector is 14610 times more financially responsible than a MP.

The frequency of such infringements of the law, by double voting is, also much higher for MP then for their voters.

D. A. may help to operate with the risk on investment

If an investor chooses to invest in some sovereign bonds of a certain state, state which is offering a high premium, say of 8-10/%/y, instead of investing in to bonds of another Government which is offering a premium of only 1.5 – 2 %/y, there is to expect, considering the dimensional homogeneity which require here to compare chances of loss, that the chances of losing the investment are much higher (eventually considering the Gauss normal distribution for the premium and the relative frequencies) for the investor looking for the highest efficient investments That means that the chances to loose at least a part of the lent sum are much higher for the greedy investors.

Taxation of financial activities

From a D. A. point of view, taxation of purely financial activities is to be done at the same rate on operation than any other taxation on income. For example, in Romania, for small enterprises: a tax is of 3% of the total amount of the income due to each operation on the instant of the transfer of rights of propriety (or of equivalent ones).

If Government be applying such a 3% tax per each financial operation, the Government would discourage money short term speculations (some obligations being sometimes exchanged a few times a day) and significantly increase its revenue.

Of course, such an agreement might be universal (also required by the D.A. condition of homogeneity), not to favour some financial centres which are not applying such a taxation, on the loss of the governments and other financial centres where there is applied such a taxation per financial operation.

The social savings by diminishing bureaucracy (rather than by firing public officers, only)

Some analyses have shown that, in some places, about 80 % of the certificates required to citizens from state and local authorities, are of no use, these having been introduced by some public institutions to justify the hiring of more officers by nepotism or cronyism.

Let us compare the time lost by a citizen to get such a socially useless certificate - about two halves of a working day missing from the work, with the time used by the officers in charge of receiving and delivering the required certificate (about 20 minutes). The total work time lost per certificate, at the society's level, is not 20 minutes but 8 hours work time, that meaning 480 minutes = 24 times more than the time used by the implied officers for issuing a useless certificate.

That means that by not more asking such kind of certificates and consequently by being able to fire the implied officers in issuing them, there may be saved the working time of 24 working people for each fired officer.

It results a lot of social increase in the society's efficiency.

From this model there is appearing as evident an advice which might be given to the Government: do require the state and local officers to find which documents are useless, keep in office and promote those officers which prove firstly that their jobs are useless, promote them and ask them to act in the same way in their newly got positions.

Processing of errors

Other Physics tools in modelling the socio-economic life are the common procedures in Physics in processing the errors on experimental data.

Such procedures, might be used in improving the control of public expenditures, f. e., when selecting a winner of a public auction for services or goods (highways, mines, army goods a. s. o.) or for public-private partnership investments, by adapting the current regulations, such as to observe common procedures in processing the errors on the physical experimental data as to diminish corruption.

Let us suppose that the price offered at a bid by a company X is P_X and the price offered by the next ranked competing company Y, is P_Y, for the same package of goods and services in their offer, in the bid concerned.

If $P_X < P_Y$

$P_Y - P_X = \Delta P_{YX} > 0$,

the selected company to be the happy winner would be company X and the agreed price, would be P_X.

The corruption in those public authorities when allotting and implementing contracts is favouredbecause there is legally permitted a later increase in the price invoiced to be paid, without a new auction, just by simple mutual agreement of the implied parties. This increase might be higher than the settled price not only with a few percentages but even be a few times larger than the initial price (media examples of 6 time larger final costs than the initially agreed one are quoted!).

Knowing this possibility and based on relatively frequent leakage of information during bid time (information got by bribing), the favoured company X may offer a slightly diminished price than Y company, to be sure that it „legally" gains the auction. Later on, the price P_X, sometimes under the expected market costs, is increased much more over P_Y, by corrupted bilateral agreement only, not being compulsory that the increase of price be subjected to third party control.

Some possible actions to reduce corruption when auctioning public expenses would be:

- to provide for, in the public auctions law or in the auction rules on the individual bids, that the price is firm (for the engaged services or supplies), could not be increased and the risks belong to the company

or at least:

- to provide for in the auction law that following a public auction, the final price invoiced and paid could not be increased with respect with that initially agreed one by a supplementary agreement between the parties, at an amount larger than a fraction of ΔP_{YX}, the difference between the prices demanded by secondly and firstly ranked competitors.

The solution proposed by some Government to impose a limit on the relative increase of the price, during implementation of the contract, limiting the possible increase by direct negotiations, f. e. to 50% of the value of the contract:

$\Delta P_{YX} / P_X < 50\%$,

marks a progress, but also encourage corruption and supposes that the estimated profit of the winner (hidden in its offer) be ~50%.

The authors suggestions to change the current auctions regulations, as to limit the after auction increase in the price invoiced to be paid, possible by the posterior agreement of the implied parties, correlated with the existing high level of corruption in allotting public expenses on goods and services, would allow a ~ 25% reduction on public spending at auctions, by legally introducing the above proposed by the authors limitations. They seem being quite possible in some countries.

Procedures of statistical evaluation and control of averages and errors, might, for example, be used to improve the control of public expenditures when selecting winners of repeated public auctions for acquisition of services or goods.

The quantitative approach for the average values is to be completed with a quantitative estimation of the errors.

This approach may be useful to reduce f. e. corruption in the judicial system, by statistically checking the frequency of decisions taken by judges not validated at superior level,

The mastering of errors in applying physical laws, competence got at the Physics laboratory work together with the developing abilities for measuring, will make easier the process of modelling non physics phenomena, eventually of preparing, passing, granting and implementing the human (judicial) laws.

Usually, the goal is to minimize uncertainty and hence the error to the lowest extent, affordable and acceptable.

Further, there is the important aspect of reporting the measurements. They should be consistent, systematic and revealing in a context of accuracy and precision.

The checking of the dimensional homogeneity of the relationships modelled will help the explanation, the understanding and the interpretation of those modelled relationships.

The authors have used D. A. in developing models to compute the propagation of errors in economic forecasts.

Acknowledgements

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STRESS EVALUATION BY VOICE:
FROM PREVENTION TO TREATMENT IN MENTAL HEALTH CARE

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Abstract. *The implementation of large-scale mental health care requires low-cost, high-accuracy screening methods. Reporting bias cannot be eliminated from the self-administered screening methods that are currently in general use, and screening using biomarkers, which has seen remarkable developments in recent years, remains costly.Mental disorders resulting from stress alter the expression of emotion and cause changes in certain voice qualities. We have therefore attempted to assess stress intensity using vocal emotion recognition technology through a computer programme. In a prior verification comparing our programme with assessments through self-administered questionnaires (GHQ-30) and interview assessments, the proposed technology obtained almost the same detection sensitivity as GHQ-30.The main advantages of the present technology are its ease of implementation and low cost. Its application in preventative medicine is therefore promising, and, if used in combination with the various biomarker-based diagnostic techniques currently in development, better induction to health care specialists will be possible.*

Keywords: *emotion recognition, screening system, mental health, mental stress, depression.*

PACS numbers: 87.19.X-, 87.15.ad, 07.64.+z

1. INTRODUCTION

Many victims and relief workers involved in the Great East Japan Earthquake are said to be affected by post-traumatic stress disorder (PTSD) or depression. In implementing large-scale mental health care for PTSD and depression at times of disasters, it is not possible for specialists to conduct interviews with all subjects. This is similar for mental health care in large corporations. Therefore, a screening technique which is inexpensive, simple, and highly accurate is highly necessary.

Generally, mental health care for major disorders in a population involves counselling or treatment after filtering based on self-administered tests. However, reporting bias (mainly underestimation due to self-consciousness) cannot be eliminated from these self-administered tests. Specifically, it has been reported that, in hierarchical organisations such as the fire services, police, and armed forces, detection rates are significantly reduced [1], [2], [3]. The reasons for this underestimation in self-administered screening are thought to include resistance, prejudice, and discrimination with regards to mental health problems, as well as concern over adverse effect on one's career [1].

To prevent reporting bias, the tests should include indices that subjects are either unaware of or cannot control. In recent years, screening and auxiliary diagnostic techniques based on biomarkers have undergone remarkable developments as a tool for objective evaluations in the field of psychiatry.

As shown in Fig. 1, large numbers of biological substances and physiological indicators are studied as biomarker candidates. Each has its own characteristics, and at this point in time, none have been found that can replace self-administered screening in large-scale mental health care. For instance, cortisol, amylase, chromogranin A, and catecholamine have short response times with respect to stress, which makes the timing of examinations difficult, and individual abnormalities cannot be discerned in most markers if they are not compared with the 'normal' baseline.

Moreover, as indicators such as catecholamine, cortisol, heart rate variability, brain waves (alpha waves), and the acceleration of pulse waveforms also react to factors other than mental stress, it is essential that these are used in conjunction with other findings. Sometimes, special testing equipment is needed, such as for near-infrared spectroscopy (NIRS). Most tests require samples to be obtained, which necessitates an enormous amount of time and manpower in large-scale screening.
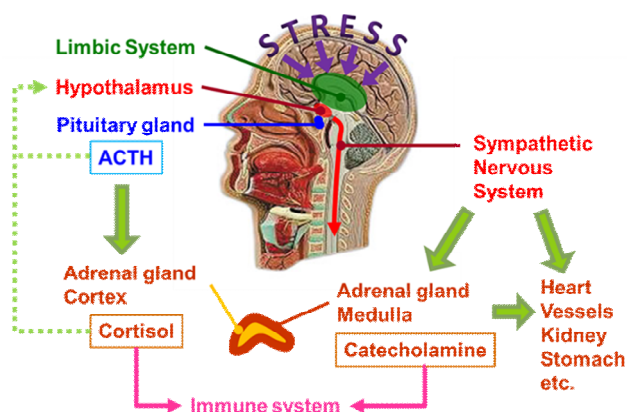
**Fig. 1** The physiological indicators among the biomarkers

When the procurement of reagents and equipment is taken into account, large-scale screening becomes unfeasible from a cost perspective.

Obtaining samples for biomarkers for the purpose of large-scale screening should be easy and require no large equipment or measurement-tailored reagents. We have therefore focused on the physiological indicators among the biomarkers shown in Fig. 1. Most physiological indicators change in reaction to factors other than mental stress, but only speech possesses a qualitative element. Thus, we have explored the potential of using speech in the psychiatric field and for mental stress screening.

2. SPEECH AND EMOTION

In a setting of constant diagnoses, it is an oft-repeated experience that the expression of emotion alters when a patient has a mental disorder brought about by stress. People are said to recognise the emotions of another person by judging their expression, voice, or gestures. However, based on the fact that people can also infer another person's emotions over the telephone, it is thought that the voice plays the greatest role in emotion recognition.

When a person is under stress, the limbic system stimulates the hypothalamus, and causes various reactions in the body through the parasympathetic nerves. Increased heart rate, rising blood pressure, and tensioning of muscles are typical, but changes in voice quality are also evident. This is because the vocal folds are innervated by the recurrent laryngeal nerve, a parasympathetic nerve which is susceptible to psychological impact, and a change in heartbeat is similarly caused by the cardiac branches of the recurrent laryngeal nerve (Fig. 2).To avoid the reporting bias outlined in the Introduction, we must focus on the involuntary component which individuals have no awareness of and cannot control.
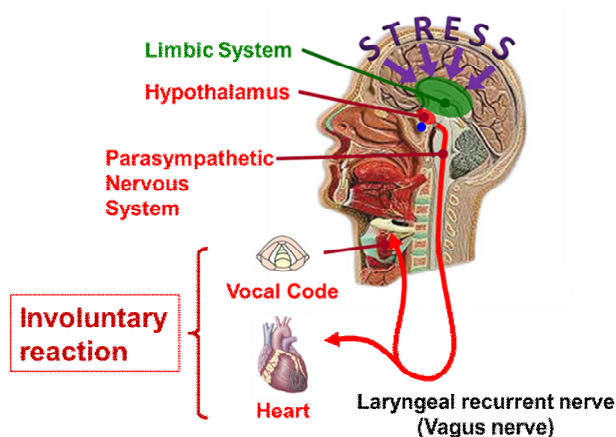
Fig. 2 Changes in voice quality of a person is under stress

3. VOCAL EMOTION RECOGNITION TECHNOLOGY

Many human emotion recognition systems have been developed in the field of engineering [4], [5]. People use linguistic elements (spoken content and vocabulary) and prosody elements (cadence) to recognise emotion in speech. In the past, many studies have reported emotion recognition systems based on linguistic elements that use recognition dictionaries, as in speech recognition. However, because of the difficulty of supporting massive dictionaries, emotion recognition systems based on prosodic information began to be studied. Several studies have been conducted in Japan, and stress and fatigue have been evaluated using speech [6].

The problem in studying vocal emotion recognition is how to define "emotion". To date, most studies have used classification/analysis based on various concepts. These can be broadly divided into the following categories:

1. Methods that screen levels of pleasure/displeasure [7].
2. Methods that classify emotions into a number of feelings, e.g. sadness, anger, surprise, fear, disgust, contempt, joy [8].

Mitsuyoshi suggested there is a relationship between these feelings of pleasure/displeasure and various emotions, and proposed a system to indicate anger, happiness, sadness, and calm, as well as the degree of pleasure/displeasure, which signifies emotional intensity [9].

A technology to identify human emotions from prosodic information in speech has been established by Mitsuyoshi et al.

We have therefore used the vocal emotion recognition software Sensibility Technology (ST) Emotion by AGI Inc., which was developed by Mitsuyoshi et al. This device incorporates a solid fundamental frequency estimation technique and an if/then rule-base derived from a massive emotion-labelled speech database. ST detects over 200 emotion-characteristic parameters from spoken natural utterances and, based on the utterance frequency for these parameters and their speech patterns, displays in real time the percentage of anger, happiness, sadness, and calm contained in a person's speech. Simultaneously, ST displays the emotional intensity of the speech.

Mitsuyoshi's advanced research confirms the link between the emotions obtained from speech and activity in the brain through fMRI [10]. That is, activity in the right amygdala, the prefrontal lower brain (near Brodmann area 12), and the prefrontal area, which are linked to emotion, can be confirmed by fMRI brain activity when the vocal speech recognition output is excitement or anger. Furthermore, simultaneous heartbeat measurements confirmed a causal link between brain, heartbeat, and vocal emotion recognition.
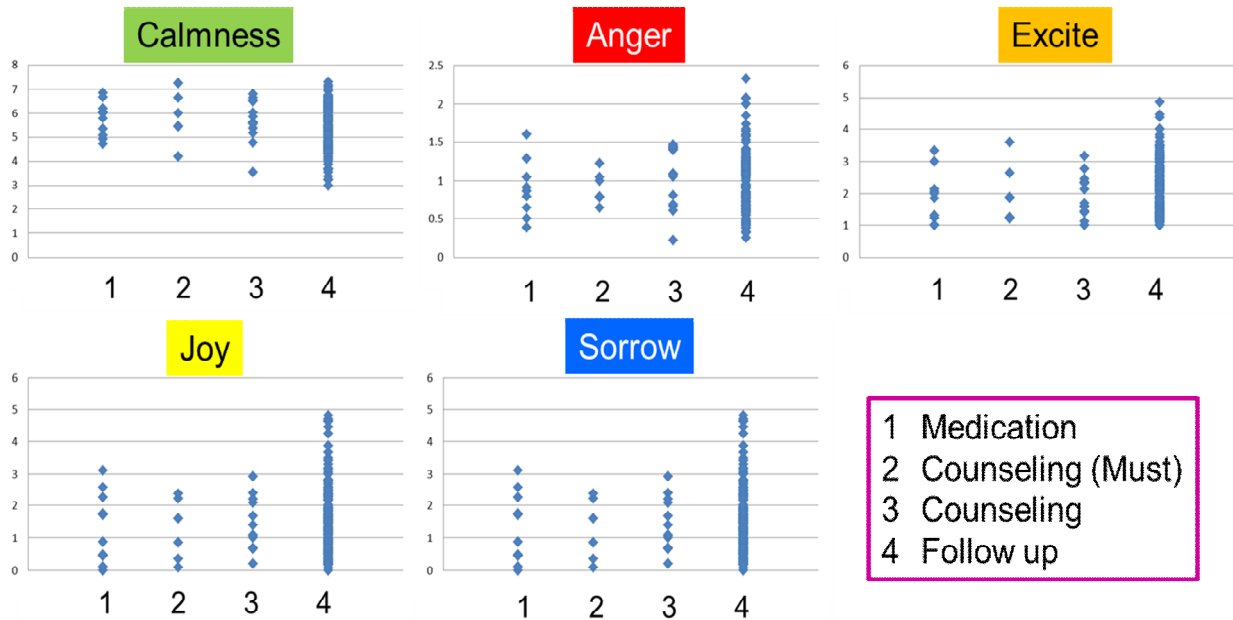
Fig. 3 Identified human emotions

4. EMOTIONAL CHANGES DUE TO STRESS

In prior research, we successfully used the present technology to capture emotional changes due to stress [11]. For nine members of the Self-Defense Forces who were deployed in a disaster relief operation for the Haiti earthquake, we compared the ratio of emotions contained in their speech against the length of deployment periods. Compared to personnel who had been deployed for short periods, the speech of those who had been deployed for long periods tended to exhibit increased sadness components and decreased happiness components.

Motivated by these results, we then conducted a larger-scale survey. Self-administered mental tests (GHQ-30) and speech recordings were conducted for 444 members of the Self-Defense Forces on routine duty and 1,004 members of the Self-Defense Forces who were deployed in the Great East Japan Earthquake. Furthermore, interviews were conducted with 225 personnel. These included people who were considered to have a disorder based on the GHQ-30, and those who wished to or who were recommended by their superior. A comparison of 1,448 subjects with a cut-off score of 7 points in the GHQ-30 found no clear difference in emotions. However, increases in emotional intensity and sadness were observed in subjects deemed, based on their interview results, to have been under a level of stress that required counselling or medical intervention. For subjects who were deemed to have been suffering from stress up to a level that required medical intervention, emotional intensity was decreased, as were anger, happiness, and sadness (Fig. 3). However, although changes in emotion due to levels of stress could be captured, this survey failed to determine the intensity of stress on the basis of changes in emotion [12], [13].

5. DETERMINATION OF STRESS INTENSITY

Using these changes in emotion, we have now developed new software to determine stress intensity based on emotion recognition in speech. In developing this system, we divided the aforementioned data from domestically deployed personnel into two groups matched for age, gender, and assessment. One dataset was used for training the software, and the other set was used for verification. Although an assessment rate of 85% was achieved, we did not attain an assessment accuracy that is satisfactory in a clinical setting in, for example, the high-stress cohort.
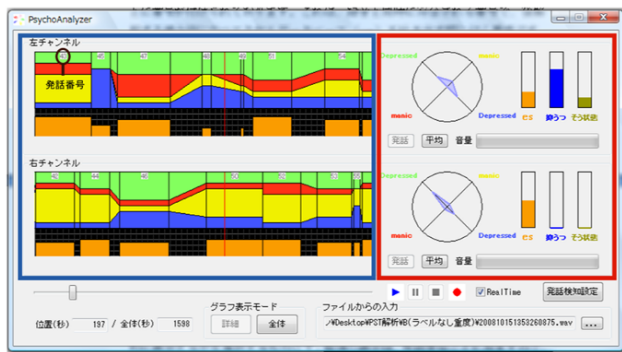
Fig. 4 Some experimental stress intensity parameters that are displayed on the PC screen in real time

We therefore applied empirical coefficients to the parameters used in emotion recognition, and created experimental stress intensity parameters that are displayed on the PC screen in real time (Fig. 4).

This was compared with the aforementioned interview results and the GHQ-30 scores. Compared to GHQ-30 screening, our software exhibited an almost satisfactory detection rate (sensitivity) for those requiring counselling or treatment, but its specificity left room for improvement. However, cases thought to have a reporting bias which could not be detected in GHQ-30 were all recognised, thus overcoming the problem of bias [12], [13] (Fig. 5).
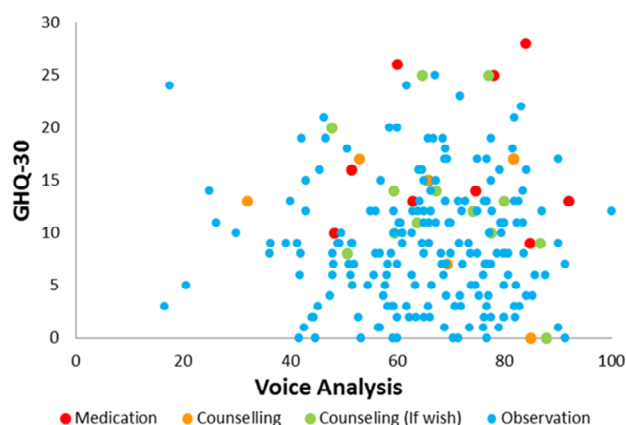
Because the parameters we created were experimental, more scientific and accurate parameters that can be used in statistical analyses need to be developed.

6. BUILDING A JOINT RESEARCH INFRASTRUCTURE

The development of high-accuracy parameters requires a great deal of speech data linked to medical data. For a single institution or company alone to accumulate such speech data would require an enormous amount of time, and is virtually infeasible. For instance, it would be theoretically possible to use the present technology for languages other than Japanese, but no evidence currently exists, and verification for other languages cannot reasonably be done in Japan. The same goes for applications to disorders other than stress, outlined below.

We are therefore currently building a joint research infrastructure using cloud technology to collect a variety of speech data from around the world. In summary, each institution participating in the joint research collects medical information and speech data in line with the various research topics. Once anonymised, these data are uploaded to the cloud. The team developing the parameters (i.e. us) uses these speech data from across the world to create parameters, and uploads the finished material to the cloud as an analytical tool. The joint research institutions use this analytical tool to analyse data in line with the various research topics, and produce various research results. The parameter development team accesses all speech data to create the parameters, but detailed analyses including any medical verification are performed by the respective joint research institutions. However, each institution can only access the speech data that they collected. Separate research agreements are required to be able to access speech data collected by other institutions.

We expect this technology to grow exponentially through this joint research infrastructure.

7. APPLICATION DEVELOPMENT

However good the developed technology, it is of no significance if it cannot be commonly used by companies. We have therefore created an application that runs on smartphones with the objective of popularising the system (Fig. 6). This application allows the level of vitality (the absence of depression) in someone's speech to be monitored without the user being particularly aware of it, simply by using the smartphone as a mobile phone.

We think that using the present application will enable users to become aware of changes in their mental state or condition at an early stage, thus encouraging changes in lifestyle or a visit to a health care facility. A large-scale field trial using this application is currently in preparation in Japan, and we hope to commence this study in the summer of 2015.

8. FUTURE PROSPECTS

The present technology can be incorporated in various devices and, since its main advantages are ease of implementation and low cost, its application in preventative medicine is promising. Using the accumulated technologies to date, new speech analysis algorithms can be developed for stress evaluation or screening for mental disorders, allowing for the construction of ICT-based screening systems. This could prevent non-essential and non-urgent counselling or visits to psychiatric specialists, as well as contributing to specialist health care and prevention for clients requiring intervention in the past. The present technology has a wide range of applications. Besides stress assessment and screening for mental disorders such as

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depression, we believe it could also be applied in the screening of mental disorders such as PTSD (Post Traumatic

biomarkers, better induction to health care specialists will be possible.

Fig. 6 An application that runs on smartphones with the objective of popularising the system

Stress Disorder) and schizophrenia, neurological disorders such as cerebral infarctions or Parkinson's disease, dementia including Alzheimer's, sleep apnoea syndrome, COPD (Chronic Obstructive Pulmonary Disease), respiratory diseases such as asthma, diabetic autonomic neuropathy, and combined disorders such as post-heart attack depression. Moreover, as it allows for continuous, real-time, and objective evaluation, we also think that speech-based emotion recognition can be used to assess treatment results for the disorders outlined above and conduct monitoring at home. We believe that our system may offer objective indicators for the development of drugs for a number of disorders which, to date, have relied on subjective evaluation, allowing for more effective drug development.

9. CONCLUSION

We have introduced a system for stress intensity assessment using emotion recognition technology through speech. This represents an inexpensive, high-accuracy screening method for large-scale mental health care.

A prior verification compared it with assessments using self-administered questionnaires (GHQ-30) and interview-based assessments. This showed that almost equal examination sensitivity was obtained as for the GHQ-30, and that the problem of reporting bias in self-administered surveys was overcome. However, this is still a developing technology, and further improvement is required.

The main advantages of the present technology are its ease of implementation and low cost. Its application in preventative medicine is therefore promising, and, if combined with diagnostic technologies using various

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