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SOCIAL, CULTURAL AND WORKING CONDITIONS DETERMINANTS OF OCCUPATIONAL ACCIDENTS IN EUROPE

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Abstract

The determinants of occupational accidents from a social, cultural and a working conditions combined perspective are investigated. Fatal and non-fatal work accidents in 2014, collected and provided by Eurostat, are correlated with country by country results of the 7th European Social Survey (ESS) (2014 data). This informs on social determinants of work accidents. National Dimensions of Culture proposed by Gert Hofstede are correlated results of the ESS informing on cultural determinants of social dimensions. Moreover, considering data from the 6th European Working Conditions Survey (2015 data), working conditions are further considered and analyzed from the perspective of fatal and non-fatal accidents and social and cultural dimensions. The findings shed light on the interconnectedness of the distinct domains under study, as well as informing policy development towards creating tailor made approaches suiting each country reality within the European countries encompassed in the analysis.

Keywords*: social dimensions, culture, occupational accidents, international analysis*

1. INTRODUCTION

Humanitarian and economic considerations alike prompt the need to improve working conditions, which is a collective concern. A safe and healthy working environment is an essential element of the quality of work. European Union institutions have been carrying out themselves, and, or, sponsoring academic institutions to do the analysis and monitoring of a great set of indicators across the continent, including social dimensions, working conditions and fatal and non-fatal work injuries.
This study aims to characterize association of social factors and working conditions with work accidents, to unveil determinants of fatal and non-fatal accidents at work, at the nation level. EUROSTAT statistics of accidents at work are associated (using IBM SPSSS v.23) with country by country results of the 7th European Social Survey [1]. National Dimensions of Culture are correlated with results of the ESS7. Additionally, considering data from the 6th European Working Conditions Survey [2], selected aspects of working conditions are considered as determinants of accidents at work.

2. ACCIDENTS AT WORK

Non-fatal and fatal accidents at work in the European Union (EU) are collected within the framework of the European statistics on accidents at work (ESAW) administrative data collection. In ESAW methodology an accident at work is defined as a discrete occurrence during the course of work which leads to physical or mental harm. Fatal accidents at work are those that lead to the death of the victim within one year. Non-fatal accidents at work collected within ESAW are those that imply at least four full calendar days of absence from work (they are sometimes also called 'serious accidents at work'). Non-fatal accidents at work often involve considerable harm for the workers concerned and their families and they have the potential to force people, for example, to live with a permanent disability, to leave the labor market, or to change job; indeed, they result in a considerable number of days of work being lost [3] (EUROSTAT, 2017).

The most recent statistics of EU fatal and non-fatal accidents at work available from EUROSTAT are shown for selected countries on Table 1 (actual data collected for 29 countries). They are depicted both in absolute terms and as per capita values, considering the total population of the country (as of January 1st 2015, according to EUROSTAT [4](2017b).

Table 1: Fatal and non-fatal per capita accidents at work data from 2014 for selected European countries [3, 5, 5].

Country	Fatal accidents at work per capita [/million]	Non-fatal work accidents per capita [/thousand]
Belgium	4.6	5.9
Croatia	6.2	2.8
Germany	6.2	10.4
Italy	8.6	5.2
Portugal	15.4	12.5

3. SELECTED DIMENSIONS OF THE EUROPEAN SOCIAL SURVEY

The ESS [1] is an academically driven cross-national survey that has been conducted across Europe since 2001. Every two years, face-to-face interviews are conducted with newly selected, cross-sectional samples. The survey measures the attitudes, beliefs and behavior patterns of diverse populations in more than thirty nations.

For the purpose of the analysis reported on this paper, a selection was made of 16 indicators extracted from the ESS round 7 2014 data, using as criteria to extract no more than two questions from each of the core section themes (media and social trust, politics, subjective well-being, gender and household, socio demographics and human values), with the exception of human values, where more variables were extracted, in order to match them with the cultural dimensions presented in section 2. Table 2 depicts the result of the selection. The selection was subjectively carried out by the researcher, based on the perception of the most impactful themes covered in the ESS7 regarding working conditions.

Table 2: Variables of the ESS round 7 [1] questionnaire selected for analysis.

Theme	Selected Variables
Media and Social Trust	ppltrst: Most people can be trusted or you can't be too careful
	pplhlp: Most of the time people helpful or mostly looking out for themselves
Politics	trstlgl: Trust in the legal system
	stflife: How satisfied with life as a whole
Subjective Well-Being	sclmeet: How often socially meet with friends, relatives or colleagues
	health: Subjective general health
Socio-demographics	gndr: gender
	edulvlb: Highest level of education
Human Values	ipeqopt: Important that people are treated equally and have equal opportunities
	ipshabt: Important to show abilities and be admired
	ipfrule: Important to do what is told and follow rules
	impfree: Important to make own decisions and be free
	ipadvnt: Important to seek adventures and have an exciting life
	imptrad: Important to follow traditions and customs

Selected average scores per country were obtained from the dataset (ESS round 7) and are shown for 5 randomly selected countries (out of 21) in Tables 3 and 4. In this process, the response scale items were considered in a question by question approach.

Table 3: Part 1 of 2 of selected average social scores per country examples

Country	ppltrst	pplhlp	trstlgl	stflife	sclmeet	health
Austria	4.968	5.081	5.638	7.380	4.867	1.979
Estonia	5.574	5.015	5.215	6.401	4.180	2.563
Ireland	5.128	5.847	5.291	6.943	4.526	1.859
Spain	4.828	4.351	4.018	6.965	5.222	2.314
United Kingdom	5.376	5.920	5.548	7.163	4.808	2.140

Legend: ppltrst: 0-You can't be too careful--10-Most People can be trusted; pplhlp: 0-People mostly look out for themselves--10-People mostly try to be helpful; trstlgl: 0-no trust at all--10-complete trust; stflife: 0-extremely dissatisfied--10-extremely satisfied; sclmeet: 1-never--7-every day; health: 1-very good--5-very bad) [1].

Table 4: Part 2 of 2 of selected average social scores per country examples

Country	ipeqopt	ipshabt	ipfrule	impfree	ipadvnt	imptrad
Austria	1.952	2.967	3.141	1.933	3.903	2.565
Estonia	2.364	3.573	3.328	2.266	4.106	2.926
Ireland	2.075	2.884	3.122	2.212	3.666	2.581
Spain	1.622	3.451	3.264	2.104	4.026	2.703
United Kingdom	2.022	3.228	3.350	2.136	3.837	2.874

Legend: scale: 1-Very much like me--6-Not like me at all [1].

4. HOFSTEDE'S NATIONAL DIMENSIONS OF CULTURE

The six measures of national cultures, initially identified by Hofstede [6, 7, 8], are numerically depicted for selected countries in Table 5 and summarized as follows, according to Coelho [9, 10, 11] and to Barata and Coelho [12]:

1. Power Distance Index (pdi) - Power distance is the extent to which less powerful members of organizations expect power to be equally distributed [6]. In low power distance countries there is limited dependence of sub-ordinates on their bosses. Power is very decentralized as well as decision-making. In contrast, in high power distance countries, hierarchy is the fundamental principle on which all relationships are based. Power is centralized as well as deci-sion-making, leading to more emphasis on formal methods for gathering and analyzing external information [13].

2. Individualism versus Collectivism (idv) - Individualism is the degree to which people are oriented towards acting as individuals as opposed to acting as a group [6]. In individualist countries people tend to value individual success and achievement. Members of individualist countries are autonomous and confident, tending to rely primarily on their own ideas [14]. In collectivist countries, people are bound in groups such as the extended family or village and are more likely to rely on information provided by others in formulating their opinions [14]).

3. Masculinity versus Femininity (mas) - Masculinity is the extent to which success and aggressiveness are valued [6]. In high masculinity countries, high earnings, advancement through opportunities and challenging work are mostly emphasized. Use of information to support decision-making is dependent on its expected effectiveness in gaining advantage over competitors [13]. In high femininity countries, relationships, concern for the others, inclusiveness and society's best interest are valued. The use of information to support decision-making is typical of a feminine national culture [15].

4. Uncertainty Avoidance Index (uai) - Uncertainty avoidance is the degree to which people feel confident about the future [8]. National cultures that score high in uncertainty avoidance have an emotional need for rules. Vice versa, national cultures that score low in uncertainty avoidance dislike formal rules, setting them only when it is necessary [13].

5. Long Term Orientation versus Short Term Normative Orientation (ltowvs) – Long term orientation stands for the fostering of virtues oriented towards future rewards, in particular perseverance and thrift. It's opposite pole, short term orientation, stands for the fostering of virtues related to the past and present, in particular, respect for tradition, preservation of 'face' and fulfilling social obligations.

6. Indulgence versus Restraint (ivr) - Indulgence stands for a society that allows relatively free gratification of basic and natural human drives related to enjoying life and having fun. Restraint stands for a society that suppresses gratification of needs and regulates it by means of strict social norms.

Table 5: Hofstede's national dimensions of culture for selected European countries

Country	pdi	idv	mas	uai	ltowvs	ivr
Bulgaria	70	30	40	85	69	16
Croatia	73	33	40	80	58	33
Finland	33	63	26	59	38	57
Norway	31	69	8	50	35	55
Switzerland	34	68	70	58	74	66

Source: http://www.geerthofstede.com/research—vsm, accessed February 2015 (legend of headings given in main text in the current section).

5. EUROPEAN WORKING CONDITIONS SURVEY

Since its launch in 1990, the European Working Conditions Survey (EWCS) has provided an overview of working conditions in Europe [16]. Themes covered today include employment status, working time duration and organization, work organization, learning and training, physical and psychosocial risk factors, health and safety, work-life balance, worker participation, earnings and financial security, as well as work and health. For the purpose of the analysis reported on this paper, a selection was made of indicators extracted from the 6th EWCS 2015 data. Tables 6 and 7 depict the result of the selection regarding physical and psychosocial exposures. The selection was subjectively carried out by the researcher, based on the perception of the most impactful themes covered in the 6th EWCS 2015 data. Selected average scores per country were obtained from the dataset (Tables 8 and 9). In this process, the response scale items were considered in a question by question approach (answer ranges shown to survey respondents are given in the Tables captions).

Table 6: Selected physical variables of the EWCS [2].

Variable	[are you exposed at work to…? does your main job involve…?]
Q29a	Vibrations from hand tools, machinery etc.
Q29b	Noise so loud that you would have to raise your voice to talk to people
Q29c	High temperatures which make you perspire even when not working
Q29d	Low temperatures whether indoors or outdoors
Q29e	Breathing in smoke, fumes (such as welding or exhaust fumes), powder or dust (such as wood dust or mineral dust) etc.
Q29g	Handling or being in skin contact with chemical products or substances
Q29i	Handling or being in direct contact with materials which can be infectious, such as waste, bodily fluids, laboratory materials, etc.
Q30a	Tiring or painful positions
Q30b	Lifting or moving people
Q30c	Carrying or moving heavy loads
Q30e	Repetitive hand or arm movements
Q30g	Handling angry clients, customers, patients, pupils etc.
Q30h	Being in situations that are emotionally disturbing for you
Q30i	Working with computers, laptops, smartphones etc.

Table 7: Selected psychosocial variables of the EWCS [2].

Variable	[to what extent do you agree with the following statements about your job…?]
Q89c	I receive the recognition I deserve for my work
Q89d	I generally get on well with my work colleagues
Q89e	The organization I work for motivates me to give my best job performance
Q89f	I get on better with my children because I have a job
Q89g	I might lose my job in the next 6 months
Q89h	If I were to lose or quit my current job, it would be easy for me to find a job of similar salary

Table 8: Part 1 of 2 of selected EWCS average scores per country.

Country	Q29a	Q29e	Q29i	Q30a	Q30b	Q30i
Czech Republic	6.27	6.40	6.61	5.86	6.69	4.98
France	6.11	6.29	6.41	5.16	6.54	4.51
Hungary	5.95	6.23	6.40	5.27	6.51	5.06
Portugal	6.08	6.55	6.68	5.01	6.56	5.24
Sweden	6.32	6.44	6.33	5.34	6.38	3.59

Legend: headings in Table 6; scale: 1-All of the time--7-Never [2].

Table 9: Part 2 of 2 of selected EWCS average scores per country.

Country	Q89c	Q89d	Q89e	Q89f	Q89g	Q89h
Czech Republic	2.30	1.74	2.39	2.56	3.62	3.37
France	2.33	1.60	2.44	2.84	4.18	3.20
Hungary	2.42	1.82	2.36	2.30	3.79	3.37
Portugal	2.27	1.49	2.24	2.73	3.57	3.88
Sweden	2.27	1.46	2.34	2.45	4.21	2.69

Legend: headings in Table 7; scale: 1-Strongly Agree--5-Strongly disagree [2].

6. ANALYSIS OF ASSOCIATION AND DISCUSSION

Association between the fatal and non-fatal accidents at work statistics (in per capita formulation) and selected social dimensions was made based on data from 20 countries that were matched. Pairs of variables with Pearson correlation factors above 0.45 were singled out. Both dimensions of accidents at work statistics are equally salient in this analysis. The social dimensions that are more salient are those of satisfaction with life as a whole, frequency of social meetings and importance given to equally of treatment and opportunities as well as of following rules. This suggests that countries where people report a lower average degree of satisfaction with life as a whole (e.g. Portugal, Lithuania, Hungary) are bound to incur higher number of per capita fatal accidents at work. The moderate correlation found between the latter and the importance of equal treatment and equal opportunities, suggests that countries where people on average give more relative importance to this issue (e.g. Spain, Slovenia) show a moderate tendency to display higher numbers of per capita fatal accidents at work than countries where this issue is given lower importance (e.g. Czech Republic, Lithuania). However, other factors seem to be at play, including the aforementioned degree of satisfaction with life as a whole and the working conditions dimensions discussed in the following paragraph.

Association between the national dimensions of culture and the selected social dimensions was made based on data from 20 countries that were matched. The pairs of variables where Pearson correlation factors were above 0.5 were emphasized. The dimensions of culture that are more salient in this analysis are power distance, uncertainty avoidance and indulgence versus restraint. The social dimensions that are more salient in this analysis are those of trust in other people and trust in the legal system. The greatest absolute value of correlation found in the study was 0.879 between uncertainty avoidance and people's perceived helpfulness. Hence, people from countries with a low degree of uncertainty avoidance (e.g. Denmark, Sweden, Norway) are bound to perceive others as helpful, while people from countries with a high degree of uncertainty avoidance (e.g. Portugal, Belgium) are bound to perceive others around them as mostly looking out for themselves.

Association between the national dimensions of culture and the selected working conditions dimensions was made based on data from 20 countries. The pairs of variables where Pearson correlation factors were above 0.5 were singled out. The dimensions of culture that are more salient in this analysis are indulgence versus restraint and uncertainty avoidance. Physical working dimensions more salient in this analysis of association are those of 'Handling or being in direct contact with materials which can be infectious, such as waste, bodily fluids, laboratory materials, etc.' as well as 'Tiring or painful positions'. The psychosocial working dimensions that display a great number of associations with the cultural dimensions are those concerned with job insecurity, recognition for work, ease of working with colleagues and prospects of finding a new job if needed. National dimensions of culture strongly associated to physical exposures were uncertainty avoidance and indulgence versus restraint. More tiring and painful positions on average were associated to higher uncertainty avoidance cultures, and relatively high indulgence cultures (e.g. Sweden, Denmark, Great Britain) were on average associated with lower exposure to vibrations from hand tools and machinery and more work with computers than high restraint cultures (e.g. Estonia, Czech Republic). Higher uncertainty avoidance cultures were associated to greater perceived difficulty in finding a new job, while relatively higher indulgent cultures associated to higher perception of work recognition, relationship with colleagues and organization motivated performance and lower prospects of job loss than restraining cultures.

Associations of physical exposures with self-perceived health were negative for vibrations, breathing in some and fumes, experiencing tiring or painful positions and performing repetitive hand or arm movements. Job security correlated very notably with trust in the legal system and recognition for work.

Analysis of correlation between fatal accidents at work and physical job exposures yielded a moderate correlation for vibrations from hand tools and machinery, indicating that countries where on average more people are subjected to this physical exposure at work (e.g. Poland, Hungary, Estonia) show a moderate tendency to suffer a relatively higher rate of fatal accidents per capita. The single psychosocial factor that correlated with accidents at work was 'getting on better with own children because of having a job' which associated strongly with non-fatal work accidents. Countries where people on average show higher levels of agreement with the aforementioned EWCS survey item (e.g. Slovenia, Ireland, Finland, Norway) tend to have relatively lower per capita rates of non-fatal accidents at work. Associations of physical exposures with self-perceived health were negative for vibrations, breathing in some and fumes, experiencing tiring or painful positions and performing repetitive hand or arm movements. Job security correlated very

notably with trust in the legal system and recognition for work. The greatest absolute value of correlation found in the study was 0.879 and it was achieved between job insecurity and trust in the legal system.

There are limitations in this study. Given the breadth of the ESS and ECWS surveys, a selection of variables was made, which carries a level of subjectivity. Moreover, the size of the level of analysis in this study (country level) precludes fine grained differences which are inherently present in any big population group, such as a nation. European countries included in each of the three datasets considered were not the same intersection of the datasets yielded a sample of twenty countries. Hence, the scope of analysis is not completely encompassing.

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ADVANTAGES OF EDUCATION AND PROFESSIONAL CERTIFICATION OF ERGONOMISTS

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Abstract

Since 1994 the Centre for Registration of European Ergonomics (CREE) has been certifying qualified and experienced people as European Ergonomists (Eur.Erg). The requirements are based on IEA minimum standards and the IEA promotes harmonization of the certification systems around the world. A university degree or diploma called ergonomics is offered only in a few countries and for this reason, certification by professional societies is particularly important. It guarantees to government bodies and private companies that the person who is mandated to undertake the design or redesign of a workplace, tool or working environment has sufficient knowledge and experience to produce high quality results. In some countries, ergonomics work can only be undertaken by certified ergonomists and some large international companies require such certification for leading positions. This system allows flexibility and facilitates movement of professionals between areas.

Keywords*: professional, certification, quality, education*

1. HISTORICAL BACKGROUND

Ergonomics is a relatively new scientific discipline, although the basic concept of enhancing the well-being of people at work goes back several hundred years (if not thousands). During the beginnings of the industrial age, there was a shift toward the employment of people in factories and by the nineteenth century, political bodies were introducing laws in many countries to protect the health and safety of employees. This has now extended to most countries of the world, although the degree of protection varies widely. Particularly during the Second World War, scientists in Europe and America began to study the effects of working conditions on humans and to try to determine parameters that could be used to design tasks and equipment such that health and safety were not endangered. These studies took place within a wide variety of scientific disciplines from sociology to medicine and engineering. During the middle of the last century, scientists began to club together into associations to pool this knowledge and enhance its transfer into national policies, laws and practice. With this development, the idea of a profession for people who are expert in the scientific knowledge about the well-being of people at work and how to optimize their performance began to emerge. In some countries, this was called ergonomics, whereas, in others, it was called human factors (engineering), although there were also differences in emphasis between regions:

Whether the scientists were more concerned with physical loads and mechanisms, or with cognitive and organizational issues.

With the growing interest in workplace well-being, members of ergonomics societies were not the only people who started to offer services to companies and advise administrative organisations and lawmakers. Sometimes these people are affiliated with other professions, such as occupational hygiene, safety engineering, medicine, psychology, physiotherapy, etc. These people may have had a thorough scientific training in specific aspects of health protection in a workplace setting, but little awareness of the knowledge that was available in other disciplines. They therefore rarely had a holistic view of all the solutions that were possible for particular problems, and they only rarely worked proactively to use scientific principles to design workplaces and tools to enhance worker well-being and performance. More troublesome, was the fact that many people worked in the field who had little or no scientific training. This development prompted the ergonomics and human factors societies in several countries to introduce certification systems for professional ergonomists.

Several ergonomics societies limited membership from their beginning to people with specific educational backgrounds, but other societies operated as interest groups, open to anyone who was active in the field. The Centre for Registration of European Ergonomists (CREE) was the first internationally active certification body, limiting certification to people with at least four years of scientific training and three years of professional experience. The Board of Certification of Professional Ergonomists (BCPE) in the USA followed shortly afterwards, and similar certification boards were established in Japan, Australia and New Zealand. Around the turn of this century, the IEA, wishing to promote the profession, introduced a system to endorse these certification bodies and encourage the coordination of their activities. Today there are certification systems in Brazil, Mexico and Canada, and others are under development in South Africa, Israel, Chile, Malaysia and India, amongst others.

The International Ergonomics Association (IEA) works in collaboration with the established certification boards and it has produced guidelines for the establishment and conduct of certification systems [1]. These guidelines are based on international standards for such organisations to ensure that the governance is sustainable, not subject to unprofessional bias or open to corruption [2].

2. EDUCATION OF PROFESSIONAL ERGONOMISTS

The IEA has defined the educational requirements for professional ergonomists: Called the Core Competencies [3]. It is still actively promoting the endorsement of certification systems to promote harmonization at an international level, with the Core Competencies as the required professional standard. Its challenge is to do this without restricting the development of profession, which is changing as it adapts to changes in the working world. Currently a review of the Core Competencies is underway. The aim is to update them to reflect the changes that have occurred since their introduction, almost twenty years ago, particularly in line with the recommendations in an IEA policy paper on the future of the profession [4] and the growing need to recognize that many practitioners are specialized in their fields of activity.

The Core Competencies describe what ergonomists should be able to do, rather than what they know. However, an ergonomist needs basic knowledge over a wide field of scientific disciplines, such that they can identify issues and respond appropriately, even if they are

not specialized in all areas equally. The multidisciplinary nature of the profession is part of its added value to its clients, however it also poses problems for educational institutions, as it does not fit neatly into any particular faculty. Very few countries offer training programs specifically designed for ergonomists (or human factors specialists). In most countries interested people must undertake courses from various faculties to ensure that they are competent to deal appropriately with physical, cognitive or organizational issues and identify the most economical and effective area of intervention. In reality, most will only do interventions within their area of most expertise, which often depends on their original training, e.g. psychology, engineering, etc.

Defining an adequate level of basic knowledge in the component disciplines is a challenge to all the certification boards and the IEA, and there is a great deal of variance between countries, even within Europe. An analysis of the backgrounds of the CREE certified ergonomists from five member countries undertaken in 2013 (Fig.1) shows that the most common original training is in physical therapy but it also demonstrates the marked differences between countries and the multitude of different backgrounds of the ergonomists. Very few ergonomists have ergonomics as their basic training, e.g., as a Bachelor of Ergonomics. Because of missing data or small sample sizes, this analysis was not done for the other member countries.

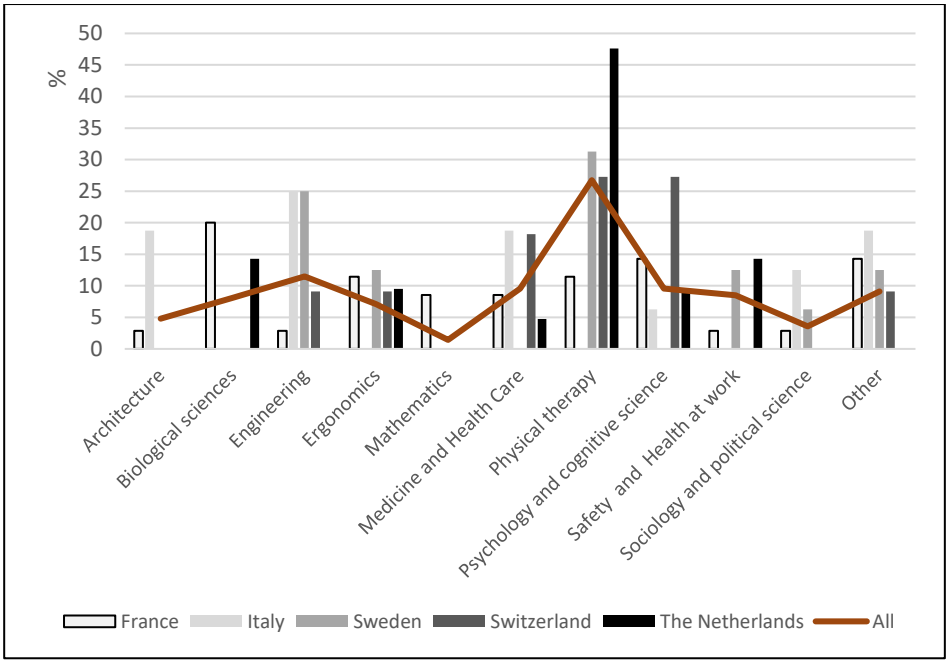

Figure 1: Original university level training of certified European Ergonomists in five member countries

Source: Data compiled from accepted applications for certification (CREE; 1994-2013)

3. EMPLOYMENT OF PROFESSIONAL ERGONOMISTS

There is also a wide degree of variability in the way that European Ergonomists are employed, which also depends on the country (Fig.2). In Germany, most certified ergonomists are employed in educational and research institutions, which is relatively rare in the other countries that have been analysed. In the other analysed countries, most ergonomists are employed in consultancy companies. Switzerland and Italy have the most diverse mixtures, whereas Italy and France have the most ergonomists running their own consultancies. These differences may have to do with how the European Framework Directive on Safety and Health at Work (Directive 89/391 EEC) [5] has been applied in the countries. A Directive is a legal act provided for in the EU Treaty. It is binding in its entirety and obliges Member States to transpose it into national law within a set deadline. This particular Directive requires companies within the European Union to provide occupational health and safety services to their employees. However, countries can specify for themselves the composition of these services in terms of the qualifications of their employees. If ergonomists are specifically mentioned in the national laws regarding occupational health services, it appears to substantially increases the proportion of ergonomists working in consultancy companies.

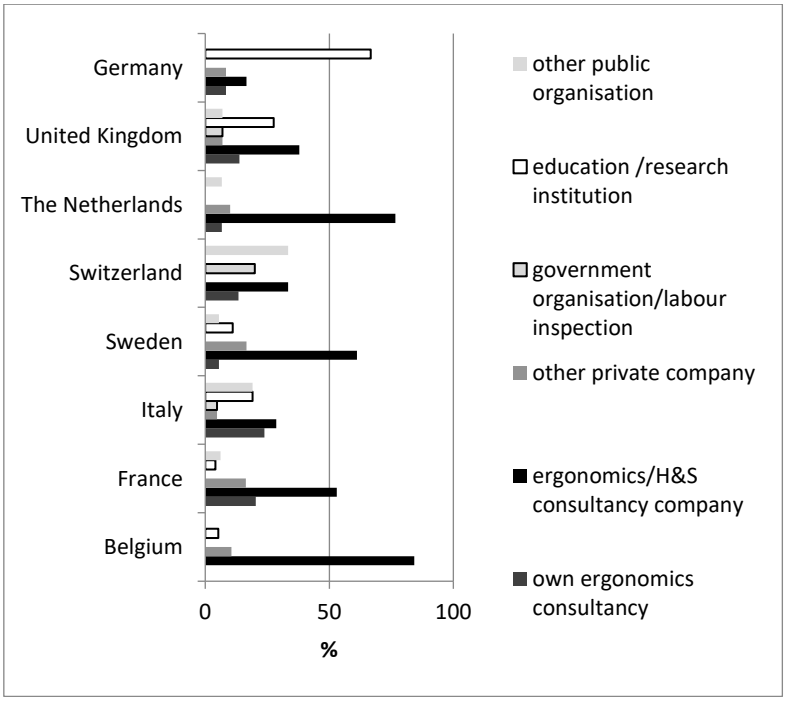

Figure 2: Type of employment of European Ergonomists (2013)
Source: Data compiled from accepted applications for certification (CREE; 1994-2013)

Certified European Ergonomists are also employed in a wide range of industries; however, the automobile industry is markedly the most frequent, followed by hospital and care services. Again, there is a lot of variability between countries.

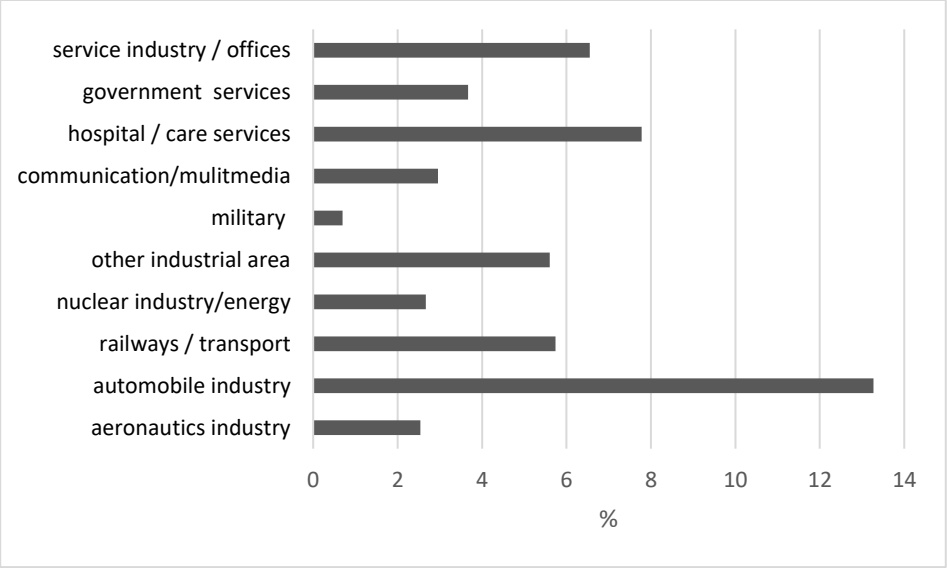

Figure 3: Sector of employment of European Ergonomists (2013)
Source: Data compiled from accepted applications for certification (CREE; 1994-2013)

4. ADVANTAGES OF PROFESSIONAL CERTIFICATION

Professional certification is a win-win for industry and ergonomists. This section explains some of the more frequently noted advantages.

4.1. A guarantee of professional quality

For prospective clients of ergonomists, such as employers, contracting companies, government agencies, etc., certification offers a guarantee that the practitioner has the necessary knowledge and experience to do the work that they require. In some instances, this may be legally required. Most professional organisations have established procedures to classify their members according to competence, and the establishment of such a system by the ergonomics societies is a sign of the maturity of the profession. An important aspect of certification by professional societies is its regulation by peer-review. The professionals themselves determine the qualification criteria and assess applicants. The criteria must be available to anyone who wishes to enquire, and the processes for certification must be independent of the financial interests of the providers of the qualifications (the training establishments). Additionally, certified professionals are generally required to sign a Code of Conduct. The certification system of CREE meets these requirements [6] and the certification criteria were agreed by the founding member societies in the early 1990s.

4.2. Flexibilty to allow change

In a few countries, government regulations define the educational criteria of ergonomists. Although this removes the responsibility for the task from the professional societies and appears to promote ergonomics, experience has shown that it comes at a price. As laws are drafted with particular fields of application in mind (generally occupational health and safety in the case of ergonomics), other aspects of the education of ergonomists are ignored, such as cognitive loads and product design. Often the standard is well below that which would be recommended by the professional societies. It may restrict the work of ergonomists to assessing the anthropometric quality of workplaces or the set-up of office furniture. To some extent, this results from poor public understanding of the competence of professional ergonomists. It results in an erosion of the profession, such that employment possibilities are limited rather than enhanced. Development of the profession into other areas is hampered. Furthermore, discussions between FEES and European Commission representatives have made it clear that the lawmakers in Europe are moving away from the regulation of professions, as they also see that government regulation restricts development and adaption. It is not easy to get laws revised, even when conditions change.

4.3. Building up a professional identity

In the previous section it was emphasized that certification is an activity of professional organisations. Examples are engineers, physicians, psychologists, etc. Sometimes these certification systems become legally endorsed within a country. For example, the Swiss government obliges all medical professionals to be registered with the Red Cross, which has traditionally checked their qualifications and ensured that they maintain logbooks of their continuing professional education. In the United Kingdom, the national ergonomics society became a chartered society several years ago. This is an official recognition of their certification system and effectively prohibits people from calling themselves an ergonomist, if they are not certified by the society. The certified members are called Chartered Ergonomists. This type of professional recognition is not known in most countries, nevertheless, having a professional certification system that allows people to put letters after their name (e.g. Eur.Erg.) raises public awareness of the profession and encourages people to identify with the profession. It is a badge of honor, to be used with pride.

4.4. Promoting professional exchange and continual professional development

An important aspect of professional certification is that it ensures that the certified people keep up to date with scientific findings and practice developments. Generally, certification is limited to a specific period and further certification is contingent on the submission of adequate proof of professional development. The CREE certification expires after five years and will only be renewed if the ergonomist is continuing to be active in the profession and has attended further courses in ergonomics, attended scientific conferences and otherwise engages in knowledge exchange with other ergonomists. For some companies that employ ergonomists, this is an essential aspect. For example, Airbus requires certification to be maintained, as it ensures that their ergonomists are at the cutting edge of professional knowledge.

4.5. Privileged access to jobs and contracts

There are a number of large companies in Europe who only employ ergonomists with the European Ergonomist title, even when these people are largely active outside Europe, e.g., Shell, Johnson & Johnson, Safran. Even when the title is not mandatory, having such a title can be a deciding argument in the contest for contracts and employment. In this regard CREE has observed, that ergonomics is most well known and accepted in countries where certification has been actively promoted for ergonomists in industry and commerce, such as France, the United Kingdom and the Benelux countries. The certified ergonomists themselves become the best ambassadors for the profession.

4.6. Ease of movement between countries

Qualifications are often specific to countries, even with the Bologne Agreement within Europe. In a profession such as ergonomics/human factors, where academic qualifications rarely contain the word „ergonomics“, it can be difficult to get employers in another country to accept the equivalence of titles to their own systems. In such cases, the certification is a proof that qualifications obtained abroad are equivalent to their own standards. Certification therefore eases the flow of professionals between countries. With the IEA endorsement of certification systems, there is an intercontinental guarantee of the quality of professional competance. For example, a CREE certified European Ergonomist can work in the USA as the IEA guarantees that this title is equivalent to the local BCPE certificaiton, even thought the assessment system is different.

5. CONCLUSION

A certified professional ergonomist is able to analyse a working situation, task or a tool to assess the aspects that are important to the well-being of the worker (or user). Their approach is holistic, system oriented and design driven. Their recommendations should ensure a solution that is compatible with the physical, cognitive and organizational limitations and abilities of the worker or user, such that productivity is enhanced. To do this they require basic knowledge from a large range of scientific fields. They have the necessary knowledge and experience to integrate this knowledge and are bound by a Code of Conduct that prevents them from working outside their areas of competence. They are trained to work with others to develop solutions that have a high level of acceptance by users. These competencies require a minimum of at least a year of university level education dedicated to ergonomics and several years of experience to develop. They also require continual professional development through contact with fellow professionals and ongoing education, for example, by participation at scientific conferences.
Certification offers guarantees to employers of this competence and ensures that the reputation of the profession is not damaged by poorly qualified service providers. There are therefore advantages to both industry and the ergonomists in promoting certification. For government and legal agencies, a society that offers professional certification can be officially endorsed. This enhances the recognition of the profession by companies.

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KILLER SMOKE IN KENYA

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Abstract

Millions of poor rural families in Kenya, Africa, depend on biomass for domestic cooking including wood, dried dung, and crop residue that produce high levels of smoke. Exposure to this smoke can lead to serious health hazards including pneumonia, emphysema, and lung cancer leading to premature deaths. The persons most affected by this indoor air pollution are women and their children who spend time in these kitchens. Attempts to reduce this air pollution have focused on the development and use of new and more efficient stoves that produce more heat and less smoke. However, such stoves are not always available and often cost more than rural families can afford. To explore alternatives to the use of new stoves, an indoor air-flow simulation was conducted. Based on the outcome of this study, an architectural design solution was developed that allows smoke to exit the kitchen quickly regardless of the stove type or the fuel used. The design is simple and inexpensive. The design was implemented in Kenya and field observations showed that smoke build-up inside the kitchen was reduced by more than 75%. Application of this new design now has the potential of improving the health and safety of women and children in rural Kenya.

Keywords*: rural kitchens, indoor smoke, ventilation, ergonomic design*

1. BACKGROUND

Rural households in Kenya prepare food over open fires. Firewood, crop waste and dried dung are used for fuel [1]. Incomplete combustion leads to smoke that consists of particulate matter, carbon monoxide and nitrous oxides and many other contaminants [2, 3]. Chronic exposures to these pollutants cause pneumonia, tuberculosis, obstructive pulmonary disease, lung cancer, and premature death [4,5,6,7,8]. These health problems affect mostly women and their young children who spent much time inside the kitchens [9]. Although new types of cook-stoves have been proposed, a practical and universally acceptable design has not emerged [10]. The main reason is that a practical design solution must meet multiple performance requirements simultaneously. This is very difficult to achieve in a single cook-stove design. Ideally, a new cook-stove should reduce fuel use significantly, increase heat production, reduce or eliminate indoor smoke altogether, be affordable and be culturally acceptable. While cook-stove development efforts have focused primarily on engineering solutions, no meaningful effort has been reported on the development of architectural features that could remove indoor smoke by natural means.

2. COOK-STOVES

Traditional cook-stoves range from three-stone open fires to brick-and mortar models. Unfortunately, they are very inefficient at converting energy into heat and, therefore, the amount of biomass fuel needed for cooking is high. Although rural households have been encouraged to switch to more modern cooking fuels such as natural gas or propane, the additional cost of purchasing these gases make such a transition prohibitive. Figure 1 illustrates the inside of a traditional rural kitchen and the collection and transport of firewood by women.

Figure 1. Interior view of a traditional rural kitchen in Kenya and women gathering firewood

2.1 Stove Programs

Developers of new cook-stove designs anticipated that by providing significant improvements in stove efficiency could make stoves attractive to a rural population. This proved to be incorrect. However, the early failures helped stove programmers to identify factors that could determine potential success of future stove programs. It was identified that programs were more successful in areas where firewood was scarce, and people either spend money buying wood or they spend a significant amount of time collecting it. Furthermore, programs that used a "top-down" approach by relying on donor funding to subsidize stoves, were much less successful than programs that were participatory from the beginning and in where funding was used to establish a self-sustaining stove industry [10]. Clearly, programs that take into account the users' needs have been more successful. In addition to stove efficiency, women often value characteristics such as how long a stove takes to heat up, the aesthetics of a stove and the 'social status' that owning an improved cook-stove can offer. Stove programs have shown that superior efficiency is not sufficient alone to guarantee a widespread acceptance and dissemination of new stoves. A new stove must be competitive with the traditional stoves in several ways such as ease of use, safety, as well as time-saving and attractiveness. The users clearly need to perceive benefits that a new stove can offer over a traditional stove. Figure 2 illustrates

a few examples of new stove technologies that have been introduced to rural communities in Kenya.

Figure 2. Some examples of new cook-stove designs introduced to rural communities.

2.2 Cost

Cost has always been an important factor determining the acceptability and adoption of new stoves. Unfortunately, more efficient stoves are typically twice as expensive as the traditional stoves. Although in the long run, improved stoves can save money. The initial cost may prevent poorer families from being able to afford a new stove. By providing training to assist in the manufacturing process, production costs can be decreased and, at the same time, the knowledge acquired can be passed on to the users which can encourage stove maintenance and reduce the chances of stove failure later on.

2.3 Requirements for Success

Successful implementation of new approaches to improving indoor air quality through the use of more fuel efficient stoves and by providing better ventilation features will require the following characteristics:

- The idea must be tailored to individual user preferences and requirements.
- Users must be involved in the design and testing process and must develop a sense of "ownership".
- The solution must have scientifically proven performance capabilities before being introduced to a community.
- The technology must be able to reduce indoor air pollution significantly and must provide basic safety for all of the users.
- The improvements in air quality must be easily recognized by the users.
- The technology must be relatively cheap, durable and require minimal maintenance.

3. INDOOR AIRFLOW

Exploration of possible architectural design solutions that can prevent smoke build-up inside the rural kitchens has not been reported in literature. In the past, foreign advisors proposed specialized roof openings, smoke hoods and larger window openings, but rural families have not adopted these recommendations [11]. To better understand why

ventilation improvement proposals in the past were not implemented, a review of the traditional kitchen designs was undertaken. Scale model smoke simulation tests were performed to better understand the thermodynamics associated with kitchen ventilation. The purpose was to identify a science-based explanation for why families preferred traditional kitchen designs over more "modern" engineering designs. A kitchen in rural Kenya normally consists of a small structure built separately from other units that are used for living and sleeping. Each kitchen has a narrow door and only one small or no window. The open fire used for cooking always creates large amounts of smoke, which rises upwards and then sinks to the floor. The entire kitchen fills with thick smoke after a relatively short period of time. It was determined through model simulations that opening a window reduced the initial upward flow of the smoke through thermal convection. The airflow coming through the window created a cooling effect that subsequently forced the smoke to the floor level. This phenomenon explains why rural kitchens in Kenya do not use window openings to promote ventilation. It was observed that by limiting cool air from entering the kitchen will prevent cooling of the smoke the generated by the open fire.

4. ARCHITECTURAL MODEL

A 1:12 scale model of a traditional Kenyan kitchen was built. The purpose was to evaluate the effectiveness of a new architectural design idea that could reduce smoke accumulation inside a traditional Kenya kitchen. A liquid fuel cell candle was used for producing combustion bi-products associated with basic stove functions. Measurements of CO_2 concentrations were used as a proxy for room ventilation, i.e., high CO_2 concentrations indicated low ventilation while low concentrations indicated good ventilation.

4.1 Simulations

Two design scenarios were tested that included a traditional configuration with an open fire placed inside the kitchen and another configuration with an open fire outside of the kitchen. Figure 3 illustrates the traditional design and Fig. 4 illustrates the new design.

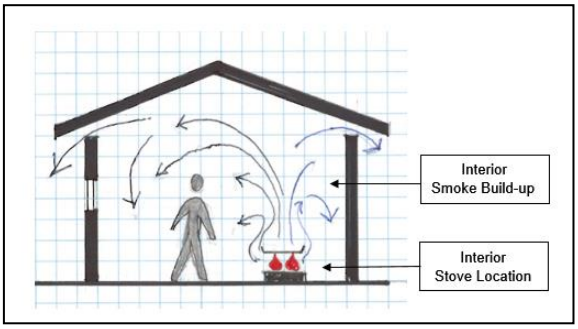

Figure 3. Air circulation associated with a cooking-stove placed inside a traditional kitchen creating high levels of indoor air pollution.

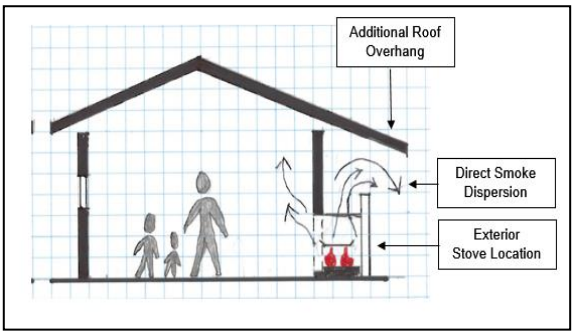

Figure 4. Air circulation associated with a cooking-stove located outside of kitchen resulting in low levels of indoor air pollution.

4.2 Results

Table 1 summarizes the CO_2 concentrations measured inside the scale model with the stove located inside the kitchen, and with the stove placed outside and adjacent to the kitchen. It can be seen that the traditional stove location generated indoor air pollution concentration over 2,000 ppm within two minutes while the new design configuration reached an equilibrium at only 770 ppm. Figure 5 illustrates graphically the difference in CO_2 concentration between the two designs.

Table 1. Summary of CO_2 concentrations observed for a fire located inside the kitchen and a fire located outside of the kitchen

	Fire Inside House	Fire Outside House
Exposure Time (min)	CO_2 (ppm)	CO_2 (ppm)
0	700	700
1	1650	778
2	2143	789
3	2270	792
4	2324	801
5	2355	796
6	2264	783
7	2318	776
8	2322	770
9	2325	766
10	2369	763

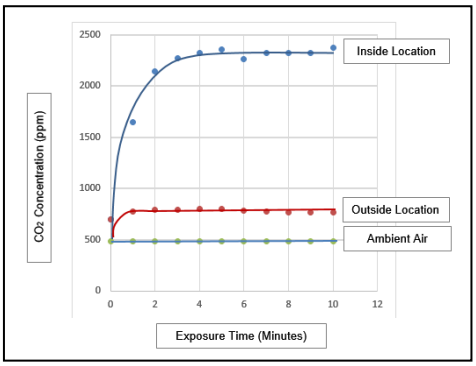

Fig. 5. Illustration of CO_2 concentrations observed for the fire located inside the kitchen and the fire located outside the kitchen.

4.3 Analysis

The high CO_2 concentrations measured for the traditional kitchen design indicates that the majority of air pollution (smoke) created by an open fire will remain inside the kitchen. However, the results show that the alternative design can provide a simple escape for the smoke to the outside of the kitchen. This will result in a minimal smoke exposure and will clearly create a healthier indoor environment for the family.

5. PROTOTYPE STRUCTURE

Based on the results obtained from the 1:12 scale model, a full-scale prototype kitchen was built and tested in Kenya. The design of the prototype is illustrated in Fig. 6 and Fig. 7. Observations during actual use of this kitchen showed that very little smoke entered the kitchen and that the indoor air quality could be maintained at a very high level.

Fig. 6. Prototype kitchen with an exterior placement of the cooking stove. The new design eliminates smoke build-up inside the kitchen almost completely.

Fig. 7. Interior view of prototype kitchen showing easy access to the stoves from the inside of the kitchen.

6. CONCLUSIONS

The model-based ventilation simulation tests revealed that cooler air that is permitted to enter a kitchen through an open window or door will reduce the vertical convection that is created by a fire. This will keep the smoke from rising to the ceiling of the kitchen. This phenomenon was understood by the rural families and, therefore, window openings are not used for ventilation. This helps explain why rural kitchens in Kenya historically did not include window openings. By recognizing the thermodynamic principles exhibited during the scale model simulations, a new ergonomic solution was created which now places the open fire outside but adjacent to the kitchen. The design still provides easy and safe access to the stoves from the inside. Construction and testing of the full-scale prototype confirmed that the new design concept can eliminate indoor smoke build-up significantly which results in a healthier indoor environment for the women and their children. It is envisioned that the new stove location design can be offered to rural families at a low cost as a retrofit option to their existing kitchens.

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TOWARD ULTIMATE ERGONOMICS DESIGN: HONORING THE MOTHER NATURE

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Abstract

"Ergonomics Design" is a human-centered engineering design that focuses on performing an intended function with least physical or/and mental workload by/with human beings. It is increasingly important as the systems becoming more complicated while human nature or capability remains mostly unchanged. In the market, not many designs are really ergonomics designed although many companies claim so.
This presentation is to emphasis that to realize an "ergonomics design", ultimately, one must honor the Mother Nature and thus design to fit the human capability that was determined by the Mother Nature. Cases will be given during the presentation.

Keywords*: Ultimate ergonomics design, Mother Nature, operation, interaction*

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