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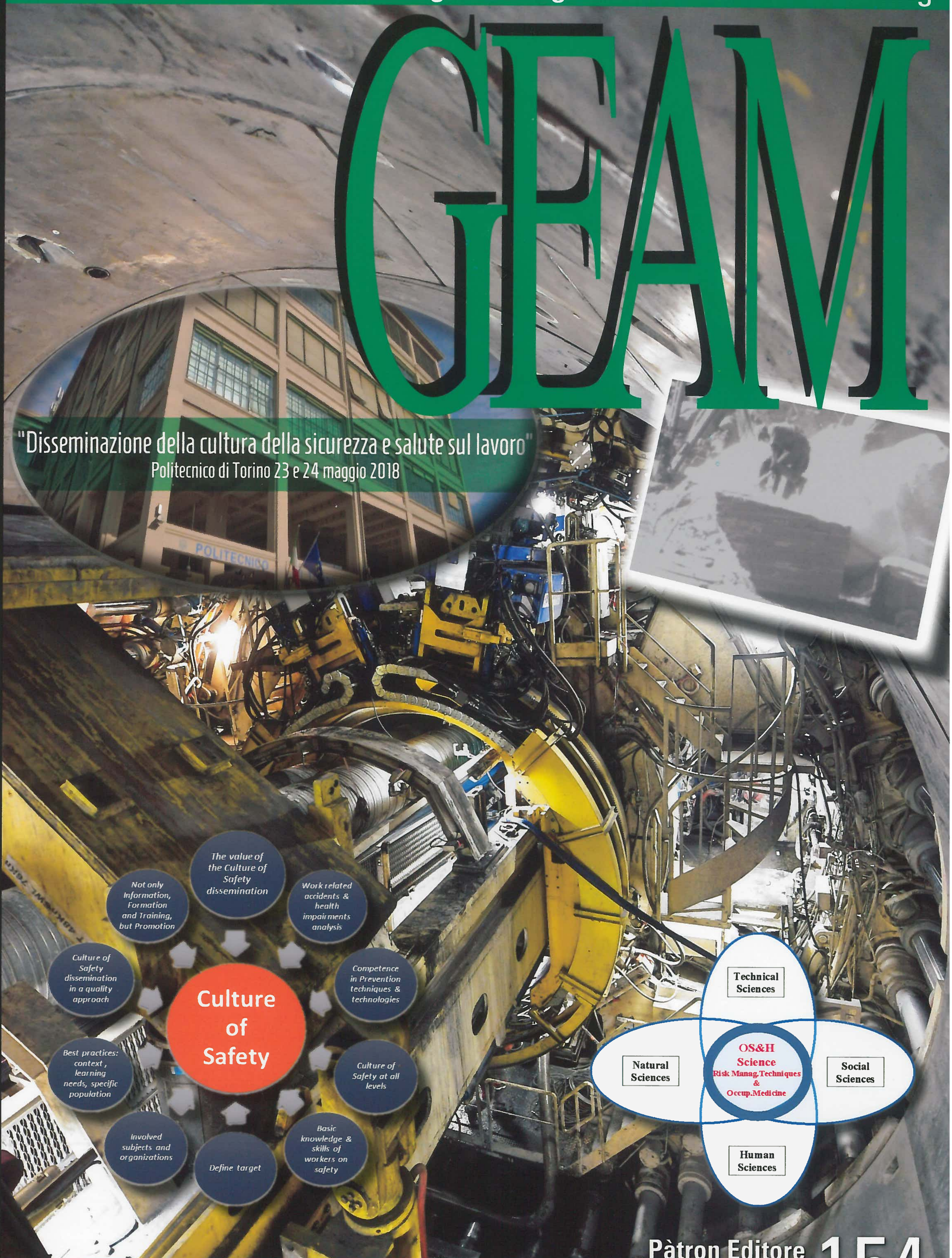

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CONVEGNO

DISSEMINAZIONE DELLA CULTURA DELLA SICUREZZA E SALUTE DEL LAVORO

DISSEMINATION OF THE CULTURE OF OS&H

Politecnico di Torino, 23 e 24 Maggio 2018

Aula Magna del Lingotto

Tematiche:

Le ere della sicurezza e salute del lavoro:
evoluzione dall'approccio degli anni '50 ad industria 4.0

Eras of OS&H Development from early '50 to industry 4.0

Innovazione tecnologica nello scavo e nell'esercizio di gallerie:
aspetti di sicurezza e salute

Innovation in tunneling and tunnel use:
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Sicurezza e Salute sul lavoro
Occupational Safety and Health

Prima parte
Le ere della sicurezza e salute del lavoro: evoluzione dall'approccio degli anni '50 ad Industria 4.0

Eras of OS&H
Development from early '50 to industry 4.0

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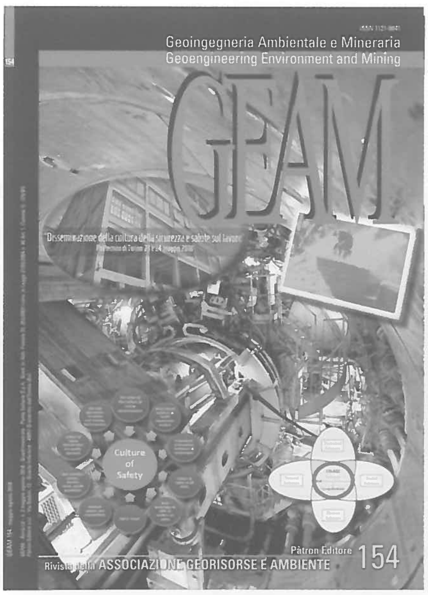

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Prima parte

Le ere della sicurezza e salute del lavoro: evoluzione dall'approccio degli anni '50 ad Industria 4.0

Eras of OS&H Development from early '50 to industry 4.0

The role of basic and applied research activities for the improvement of OS&H conditions and the dissemination of the Culture of Safety

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Although the European panorama is experiencing a profound change in advance to the Industry 4.0, revolutionizing the world of work with technical, technological and information innovations, in Italy even today we have to deal with the "old" problem of work related injuries and fatalities. In particular, the accident indices of the last few years do not seem to differ much from those typical of the 1970s. The cultural effort matured with the enforcement of the European Directives, with the consequent passage from a rigid prescriptive approach to a flexible one based on risk analysis, is therefore not sufficient to face without "trauma" such rapid technological development accompanied by legislative, productive changes and increasingly widespread reassignment of tasks within the Companies.

In this context, the role of scientific research is essential to contribute to technological transfer and scientific knowledge by reconciling the essential aspects of Occupational Safety and Health, through a rigorous and devoted analysis of working scenarios. Furthermore, the dissemination of a Culture of Safety at all levels (Management and Staff roles) can encourage a bilateral synergy "Industry-University" from an OS&H point of view.

The present work discusses in more detail the results of the research carried out by the "young" OS&H researchers of the Polytechnic University of Turin presented on the second day of the Conference Dissemination of the Culture of Safety and Health at work – "Eras of OS&H Development from early '50 to industry 4.0".

Keywords: *Occupational Safety and Health, Culture of Safety, Industry 4.0.*

Il ruolo della ricerca di base ed applicata ai fini miglioramento di OS&H tramite disseminazione della Cultura della Sicurezza. *Nonostante il panorama europeo stia vivendo un profondo cambiamento dovuto all'avvento della Industry 4.0, che rivoluziona il mondo del lavoro dal punto di vista tecnico, tecnologico e dell'informazione, in Italia ancora oggi si fanno i conti con un problema "datato" relativo alle vittime del lavoro: in particolare gli indici infortunistici degli ultimi anni sembrano non differire molto da quelli caratterizzanti gli anni '70. Lo sforzo culturale maturato con l'emanazione delle Direttive Europee con il conseguente passaggio da un rigido approccio prescrittivo ad un approccio flessibile basato sull'analisi di rischio, risulta dunque non sufficiente per fronteggiare senza "traumi" un così rapido sviluppo tecnologico accompagnato da cambiamenti legislativi di settore, produttivi o di mercato, e dall'incessante e sempre più diffusa riassegnazione dei compiti all'interno dell'azienda.*

In tale ambito risulta dunque essenziale il ruolo della ricerca scientifica al fine di contribuire in modo concreto trasferimento tecnologico e delle conoscenze conciliando gli aspetti imprescindibili di Sicurezza ed Salute Occupazionali attraverso una rigorosa e dedicata analisi degli scenari lavorativi, oltre che alla disseminazione di una Cultura della Sicurezza a tutti i livelli aziendali che possa incentivare anche dal punto di vista securistico una sinergia bilaterale "Industria-Università".

Il presente lavoro discute in modo più approfondito i risultati delle ricerche condotte dai "giovani" securisti del Politecnico di Torino presentate in occasione della seconda giornata del Convegno Disseminazione della Cultura della Sicurezza e Salute del Lavoro intitolata "Le ere della sicurezza e salute del lavoro: evoluzione dall'approccio degli anni '50 ad Industria 4.0.

Parole chiave: *Sicurezza e Salute Occupazionali, OS&H, Cultura della Sicurezza, Industria 4.0.*

Introduction

Despite regulatory efforts, the problem of occupational injuries and health impairment remains a challenging task for researchers, due to three main aspects:

- *fast pace of technical and technological innovation vs common safety approaches*: advanced technologies can involve the introduction of new accident scenarios due to unforeseen events sometimes deriving from new Hazard Factors. In such a situation, it is essential to implement new approaches to the Occupational Risk Assessment and Management free from subjective judgement and general or personal experience but actually tailored to the specific situation (Borchiellini *et al.*, 2015).
- *current safety management models*: modern systems characterized by different forms of complexity and coupling affect the design and operational safety conditions: they make it difficult for designers to foresee all potential states of the system and for the operators to handle safely both routine and exceptional circumstances. The current situation is much worse if we take into account the progressive reassignment of tasks within the companies and the needs of customers who heavily influence production rates.
- *poor dissemination of culture of*

Le rôle de la recherche fondamentale et appliquée pour l'amélioration de l'OS&H par la diffusion de la Culture de la Sécurité. *Malgré le panorama européen connaît un profond changement en raison de l'avènement de l'industrie 4.0, qui a révolutionnée le monde du travail d'un point de vue technique, technologique et des informations, en Italie encore aujourd'hui, nous traitons d'un problème «périmé» lié aux victimes du travail: en particulier les indices d'accidents de ces dernières années semblent ne pas différer beaucoup de ceux qui caractérisent les années' 70. L'effort culturel acquis avec la promulgation des directives européennes avec le transition d'une approche normative rigide à une approche flexible basée sur l'analyse des risques, n'est donc pas suffisante pour faire face sans «traumatisme» au développement technologique rapide accompagné de changements législatifs dans le secteur, la production et le marché, et par la réaffectation incessante et de plus en plus généralisée des tâches dans bureau. Dans ce contexte, le rôle de la recherche scientifique est essentiel pour contribuer à le transfert de technologie et de la connaissance selon les aspects essentiels Santé et Sécurité au travail grâce à une analyse rigoureuse des scenarios du travail ainsi que la diffusion d'une Culture de la Sécurité à tous les niveaux qui peut aussi stimuler une synergie bilatérale entre «Industrie - Université». Le présent travail examine les résultats des recherches menées par les «jeunes» du Politecnico di Torino présentée à l'occasion de la deuxième journée de la Conférence Diffusion de la Culture de la Sécurité et de la Santé au travail intitulée «les âges de la Sécurité et de la Santé au travail: évolution de l'approche des années 50 à l'industrie 4.0».*

Mots clé: *Sécurité et Santé au travail, OS&H, Culture de la Sécurité, Industrie 4.0.*

safety: OS&H aspects often appears to be considered a nuisance interfering with production. This scenario involves the widespread use of all-purpose procedures and slapdash approaches resulting in a paper-based safety, denying the risk awareness at the basis of safety performances of a system (Borchiellini *et al.*, 2018, De Cillis *et al.*, 2017).

In the following sections, the Authors propose the result of research work carried out to provide a contribution to solve specific problems affecting industrial scenarios. The topics discussed in the Conference can be addressed to three main OS&H fields: equipment and operator's management, work-related injuries investigation and accident precursors, and special approaches as support to the Risk Assessment and Management.

1. Equipment and operator's management

Today, the correct management of equipment and human resources is essential in order to optimize production and obtain good safety standards. For this reason, in the metalworking field an analytical methodology was developed to optimize worker-workstation matching based on the measurement and comparison of the resources required by the workstation and the individual human capacity to be mobilized.

In addition, we can also evaluate and manage this problem by implementing a *Prevention through Design*[1] – PtD approach promoted by the National Institute of Occupational Safety and Health – NIOSH making possible the workplace and the working activities analyses. The approach includes also the operator/task interactions) before the activities are to be carried out, with the possibility to check and implement corrective measures early in the design phase.

In the correct plant management, is fundamental to manage all the equipment life-time (in particular the last part). In order to manage the aging equipment the following paragraph proposes the Integrated Dynamic Decision Analysis – IDDA for maintenance optimization.

1.1. Optimization worker-workstation matching

Nowadays the majority of organizations operating in manufacturing field recognizes the importance of including the Human Factor – HF contribution into the industrial process optimization (Hong K. *et al.*, 2007). This work presents an operative model developed to quantify the potential impact of the HF into an assembly line of a manufacturing plant, with the aim of reducing operational errors and unsafe behaviour. This work adopted an operative approach based on Straeter (2000) results. The Human Perfomance – HP can be predicted with the assessment of two macro factors:

- Task Complexity – TC: that includes all factors contributing to physical and mental workload requirements to perform a specific operative task;
- Human Capability – HC: that summarises all the individual physical and cognitive abilities.

TC was quantified by a set of observable and measurable variables identified with a task and working-place analysis. HC was assessed by a set of ability tests performed by workers during the working activity. The comparison between HC and TC results allowed the HP assessment. The HP assessment repeated for the entire possible matching worker-working place leaded to the calculation of a matching-matrix. This matrix allowed the identification of the best matching worker-working places based on HP Assessment. In order to verify the effectiveness of theoretical and operative hypothesis the results obtained were used

[1] This approach was already encouraged by 89/391/EEC Directive.

to set a new configuration of the assembly line. A period of three months will be used to monitor the operative results of the new configuration workers-tasks and quality indicators will be collected.

The comparison of quality data (Human Errors) and safety data (injuries, medications, unsafe acts) ante and post re-configuration would allow the evaluation of the impact of the method.

1.2. Computer Image Generation for Job Simulation – CIGJS

In the OS&H field, the most important phase of the whole Risk Analysis process is the Hazard Identification: obviously, if a Hazard Factor is not detected (or underestimated), the result is an incomplete Risk Analysis and consequently a misleading Risk Assessment and Management.

In order to conduct an effective Hazard Identification a large number of techniques can support the analyst but the selection of the most suitable technique depends on the operative context and the expected results (Borchiellini *et al.*, 2016).

Among the techniques, the Job Safety Analysis – JSA, is widely used in industrial contexts where some difficulties arise in establishing the effective workers' exposure condition due to the variability of working conditions. The JSA technique focuses on the relationship among the worker, the task, the equipment, and the work environment, so that, systematically, the hazards involved, the associated risk, and the practically applicable technical and procedural countermeasures may be directly identified.

The Computer Image Generation for Job Simulation – CIGJS implements and improves the analysis capabilities of the traditional JSA technique in routine conditions and, at a provisional stage based on virtual images, animation and 3D interactive environment specially developed for JSA purposes (Bersano *et al.*, 2010).

CIGJS can be considered as a helpful tool to support the application of the JSA technique, in the light of a wider Risk Assessment and Management: it allows an intuitive and complete Hazard Identification and, unlike traditional JSA, an Interference Definition, either between worker/machinery and worker/worker. The computer-aided tool makes it possible to simulate a 3D working scenario by means the rendering of the working environment with operative/not operative content allowing the real-time interaction (Fig. 1).

This is particularly important since it allows considering the features and the way of interact of the work environment, machinery, etc., in a realistic manner. These features may be useful to simulate the actions of a real worker in a real scenario, for instance, with the aim to investigate the possibility of a contact with harmful parts of machinery or equipment, or to avoid overextension, etc. (Labagnara *et al.*, 2016). The proposed example clearly shows the safety conditions of the worker in a simulated real situation, and it highlights how an operator with notably different anthropometric characteristics may be exposed to different hazards.

For these reasons the CIGJS discloses new and interesting possibilities in the Risk Analysis and Management of new operating layouts at the very first design stage (both in normal and emergency situations), contributing effectively to a PtD approach.

1.3 Aging management with Integrated Dynamic Decision Analysis

Nowadays different plants have passed the expected lifetime defined during their design phase. This occurs because there are same difficulties for the plant revamping, related to economical, regulatory and environmental constraints.

Plant aging, when incorrectly managed, can bring to serious

Fig. 1. Application of the technique to a maintenance operation on the top of a silo.
Applicazione della tecnica ad un'operazione di manutenzione sul tetto di un silos.

accidents (Horrocks *et al.*, 2010). Moreover, the use of ageing equipment reduces the competitiveness of the company, since they usually require more energy, more maintenance and often-expensive raw materials. Instead the adoption of modern plants, developed with new philosophies, as process intensification (Baldissone *et al.*, 2016, 2017), or with an increased attention to the sustainability, can use less energy, and they can increase the plant flexibility both for the product quantity and for the type of production (Reay *et al.*, 2013).

But the adoption of the new technology and the plant revamping require high investment cost. In case the company could not afford the investment or could be bonded by other constraints, the solutions could be of increasing the plant lifetime, and in given condition also plant efficiency and energy saving (Darabnia and Demichela, 2013; Demichela at al., 2018), through a correct maintenance.

A risk based approach to decide between different alternatives of maintenance strategy is here presented. This approach is developed in project PROAGE financed by the INAIL, in the SAFERA framework. It analyses the risk associated to the different maintenance strategies, starting from the possible equipment condition at the moment of the maintenance.

The risk assessment is made through the Integrated Dynamic Decision Analysis – IDDA.

The IDDA methodology links a logical-probabilistic model and a phenomenological model; the analysis framework is shown in figure 2.

The logical-probabilistic model, based on the general logic theory, is built according to its own syntactic system to shape an enhanced event tree structure. IDDA can develop all the possible sequences of events that the plant could undergo. Each sequence of events is correlated with its probability of occurrence.

A phenomenological model, together with the logical modelling, must be prepared to describe the physical behaviour of the system. The phenomenological model could influence the updating of the logical model generating a better description of the real behaviour of the system. The phenomenological model can provide a direct estimation of the consequences for each single sequence to obtain a risk estimation, the evaluation of the overall risk of the system and the expected value of the consequences. The latter is calculated as a weighted average of the consequences, according to their probability. In this way the plant management can define the maintenance strategy on the risk value.

2. Work-related injuries investigation and accident precursors

The study of the causes that lead to an accident is precious to avoid the recurrence of the same

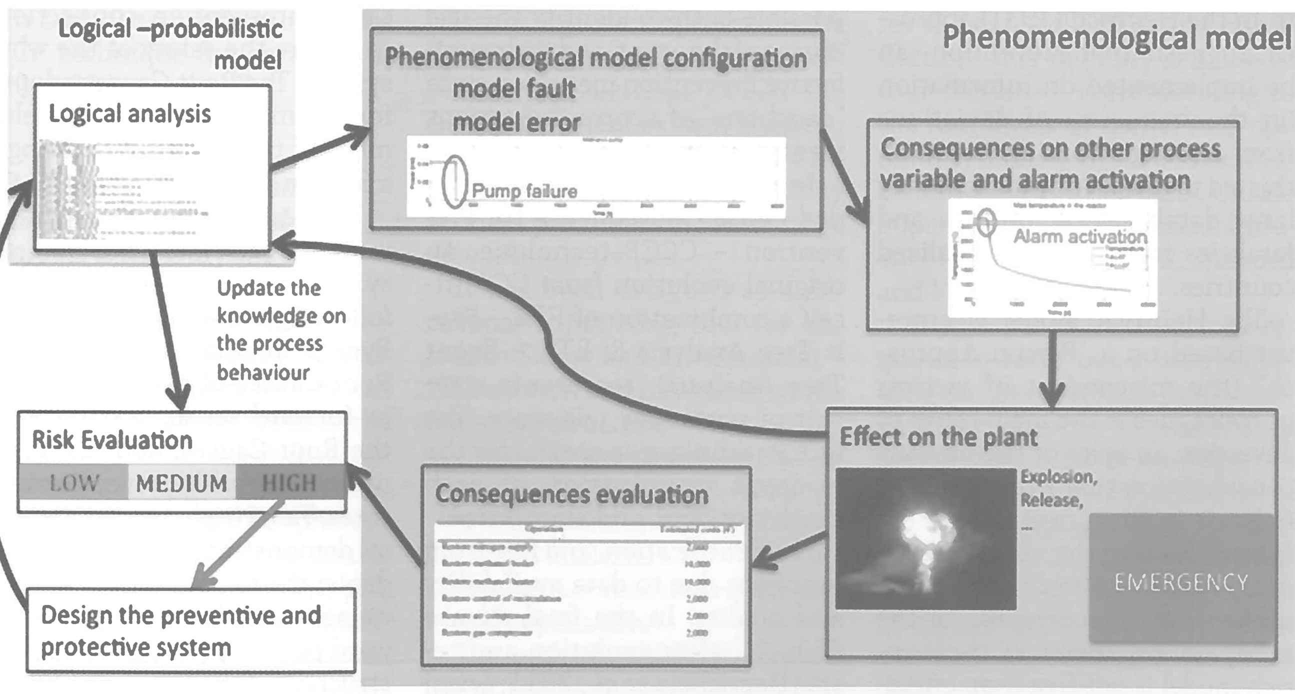


Fig. 2. The IDDA methodology framework.
Struttura della metodologia IDDA.

dynamic in a similar scenario and the resulting indications can help the analyst to understand the Root Causes of the event. This is one of the potentiality of a computer – assisted tool whose protocol is an original elaboration of the Cause Consequence Analysis – CCA that can be used to support analysis for the in-depth examination of accidents in a System Approach. This technique makes it possible to get Prevention information by means of a *bottom – up* path to break the chain of deviations that caused the event.

For work – related injuries' investigation, the analysis of accidental precursors allows to act even before the incident occurs, analyzing and correcting unsafe conditions and unsafe behaviors, that can lead to accidents without waiting for the consequences.

2.1. Computer-aided Cause Consequence for Prevention – CCCP technique

The use of the statistical data on work-related accidents derived from the Heinrich (1931) approach, suggests that Prevention can be implemented on information on the frequency of deviations from a correct working situation: this led to the development of very large databases on injuries and fatalities in many industrialized countries.

The Heinrich model is however based on a "Person Approach" (the misconduct of victims or colleagues is the main cause of deviation, in spite of the obvious consideration that they, and they only, are in direct contact with the Hazard Factor): the resulting accident analysis is often incorrect and useless for improvements of the safety system. Therefore, the Heinrich model is not free from criticism, both in itself (Reason, 2000), and in terms of representativeness of the input data (Manuele, 2011), and hence at least obsolete for the modern safety science.

The identification of Prevention measures starting from accident databases therefore requires thorough critical and considerable caution in the selection and management of the input data, even if focused on comparable contexts, in order to ensure effective reliability. Even so, accident databases can still be of help for the inspector's attention towards the more common direct causes of the event making possible effective inspections actions.

Thanks to the analysis of fatal accidents occurred in critical NACE sectors, carried out for the Prosecutor assignment, the Authors developed an original approach based on a post-event investigation to identify the correlation between the intermediate and root causes leading to unwanted events. The focusing on a limited number of real events used as case histories and characterized by exhaustive and detailed information made possible an in depth analysis upon which it became possible both to identify the real causes of the event, and to draw effective Prevention measures, since "daughters" of a corrective actions identification.

In this area, the Computer-aided Cause Consequence for Prevention – CCCP technique, an original evolution from CCA (itself a combination of FTA – Fault Tree Analysis & ETA – Event Tree Analysis), represents a result of particular relevance. The CCCP technique is special for the in-depth examination of each single accident and countermeasures identification, and free from problems due to data availability and quality. In the final release (Tab. 1), after evolution and tests (Demichela *et al.*, 2011; Luzzi *et al.*, 2015), the CCCP approach can effectively contribute to understand the preconditions leading to the very Root Causes of work-related accidents.

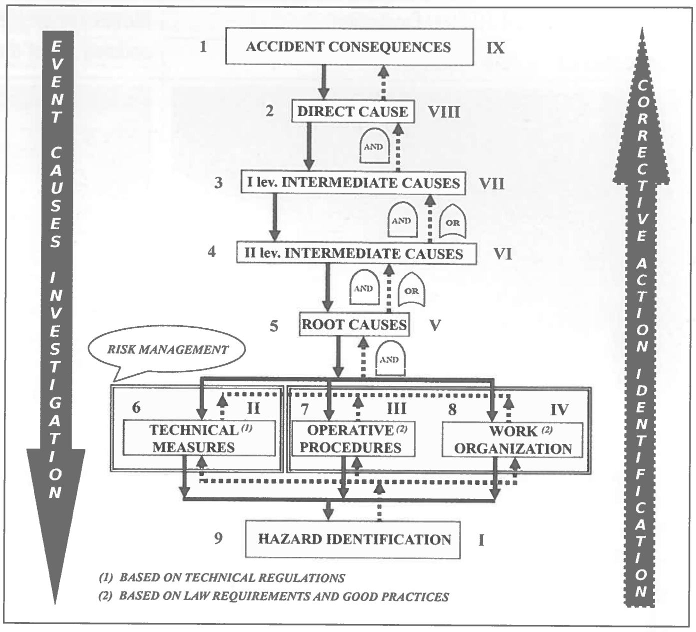
The computer aided technique is of valuable support, reduces the possibility of errors due to analyst's subjective judgment or hasty evaluation, leaving him however always free to make independent decisions, and makes possible to consider the too easy conclusion involving some victim's misbehavior as one of the possible causes.

The CCCP technique focuses on the Root Causes of work related accidents, the target of the analysis being a thorough investigation of the chain of indirect causes, which, in logically connected steps from the Top Event to the Root Causes, produced the accident.

Prevention countermeasures are then thought not only for each cause, but also for combinations of intermediate causes, so that a number of links can be developed correlating the possible indirect causes of the event to the corrective measures. A net of corrective measures is created, among which it is possible to select some of the cause-intervention connections, to ensure the safety of the whole system. The Root Causes adopted for the model grant the development of the analysis according to a System Approach.

The peculiarity of the technique is the capacity of modeling the system both in backward sense following a chain of Intermediate Events in order to identify the Root Causes of a Top Event, and in forward sense, starting from the Root Causes, and discussing the most suitable prevention measures. Tab. 1(right) shows a graphical demonstration: the two arrows depict the backward path of event causes investigation and the forward path of prevention. The construction of the tree is not a linear process, but may imply a number of iterations before reaching a final

Tab. 1. home screen of the CCCP software (left), flow chart of the accidents analysis two-way approach (right).
Schermata iniziale del software CCCP(sx) e duplice flusso logico di analisi(dx).



configuration that adapts to the specific case.

The **integrate software environment** *Infortuni sul lavoro (Work-related accidents)* & *Root Causes* translates the theoretical model into a useful computer guide. All the occurrences are strictly codified to make the analysis objective and free from ambiguity.

In table 2 an application of the CCCP technique for an accident occurred in a steel mill.

2.2. Accidents precursors data classification and analysis with the fuzzy logic

The "Zero Accidents Vision", recently adopted especially in companies characterized by few occupational accidents, focused the attention on the identification, reporting and analysis of accident precursors, in order to prevent their occurrence and the consequent accidents. An accident precursor can be defined as a truncated accident sequence (Jones *et al.*, 1999; Saleh *et al.*, 2013); therefore, the concept of accident precursor can include Near Miss events, Unsafe Acts and Unsafe Conditions. Unsafe Acts made by the personnel and Unsafe Conditions at the workplace (Phimister, *et al.*, 2004).

In this work, insert within the project CS&P financed by the INAIL Piedmont Direction, an Accident Precursors – AP management system has been developed, starting from the structure of the Near Miss management system, on the basis of a centralized approach (Gnoni and Lettera, 2012). The AP Management system has been developed as a general method for detecting, reporting and analyzing accident precursors in a wide range of working activities.

It has been designed as a decisional supporting tool for the Health Safety and Environment – HSE service, and it is based on the following structure:

1. Accident precursors identification and reporting (Unsafe Acts & Conditions and Near Misses);
2. Causes analysis;
3. Prevention measures planning and application.

The method used for the reporting of the Occupational Accident Precursors is based on the Human Factors Analysis and Classification System – HFACS, originally developed for the accident analysis in the aeronautic sector (Darabnia and Demichela, 2015). Its taxonomy describes the active failures and the latent failures or conditions that may influence accident occurrence and dynamic (Wiegmann and Shappell, 2001).

A dedicated tool was developed for the data collection and classification: this module, is made of four sections – corresponding to the four levels of the HFACS taxonomy, namely Unsafe Acts, Preconditions for Unsafe Acts, Unsafe Supervision, Organizational Influence (Salmon *et al.*, 2012, Shappell and Wiegmann, 2003).

The proposed methodology requires to carry out a brief interview to the involved personnel, with the purpose of uncovering the specific causes of the observed event, and to deeply understand the motivations of the occurrence of the event. This step is particularly relevant for the identification of the preventive actions to be implemented to cope with the event observed.

The Data Analysis step is based on the Fuzzy Logic Approach

Tab. 2. Compendium forms on some accidents analyzed with the CCCP technique.
Form utilizzato per la presentazione dei risultati della tecnica CCCP.

Activity sector: *C24.10-Steel Production*	**Notes**: *the overhead traveling crane velocity was increased from 3.5 m/s to 5.2 m/s. NO updated IFT of the operator*
Consequence → *Fatal – Burns*	

tilted ladle area of the spill

effects of the heat wave

- in a steel mill, a modification was introduced to improve the performances of an overhead traveling crane used for the 160 t ladles handling;
- the IFT of the crane operator was not updated including the new crane performances;
- due to the excessive descent velocity, the ladle interfered with an obstacle, tipped and spilled approx.. 100t of molten steel;
- the consequent thermal wave and steel droplets explosion caused impressive consequences and fatal burns to a worker operating in the area.

	Accident causes chain	*Possible corrective actions*	
1	Fatal burns	*n.a.*	IX
2	Victim reached by the thermal wave from approx. 100 t of spilled steel	*n.a.*	VIII
3	Ladle tilt and molten steel spillage	*n.a.*	VII
4	Excessive velocity in the ladle handling	*n.a.*	VI
5	Modification of the operating parameters of the overhead traveling crane Procedures/organization of work, Operators IFT	*see III*	V
RM	Poor risk management	*Resulting from II, III & IV*	RM
6	Absence of plant tests after the changes	*Supervising and IFT even for occasional /infrequent crane operators*	IV
7	Operation not analyzed after changes. Absence of communication between operators	*Revision of the modified plant conformity to the safety standards*	III
8	Absence of supervision and IFT	*Updated technologies for higher and safer crane performances and ladle handling. Performance and Safety tests on the plant*	II
9	No revision of the Risk Assessment and Management after the crane operating parameters modification	*Devoted Risk Assessment and Management applied to a plant modification proposal*	I

(Murè *et al.*, 2015): the tool initially developed by Murè & Demichela (2007 and 2009) for the occupational accident risk assessment, was then modified to be used for the accident precursor analysis. It allows an aggregate approach to the accident precursor assessment and leads to the preventive measurement planning in accordance with the Health Safety and Environment – HSE service. Thus, the analysis is carried out on clusters of homogenous observed and catalogued events. This is particularly convenient when different observers collected the data; in fact, the cluster construction allows decreasing the degree of relevance of the subjective part of the data, because of their low frequency of repetition.

In the fuzzy logic is necessary define the input variable, the output variable and the rules.

The sublevels in the HFACS taxonomy were used as input variables. The use of these variables is justified as they establish a sufficient level of detail in the description of the causes of the observed events. The input values are represented by the fraction of the presence of the taxonomy sublevels (causes) within the cluster of the data analysed (ranged between 0 and 1). Since the distribution of the data is unknown, as work hypothesis each variable was divided in 3 membership functions equally distributed with a trapezoidal shape. Preventive measures to be adopted to eliminate or reduce a certain type of event are used as the output variables. For the output variables, three membership functions were used, with trapezoidal shape.

The rules are used to correlate the input variables and the output variables. The rules cover the

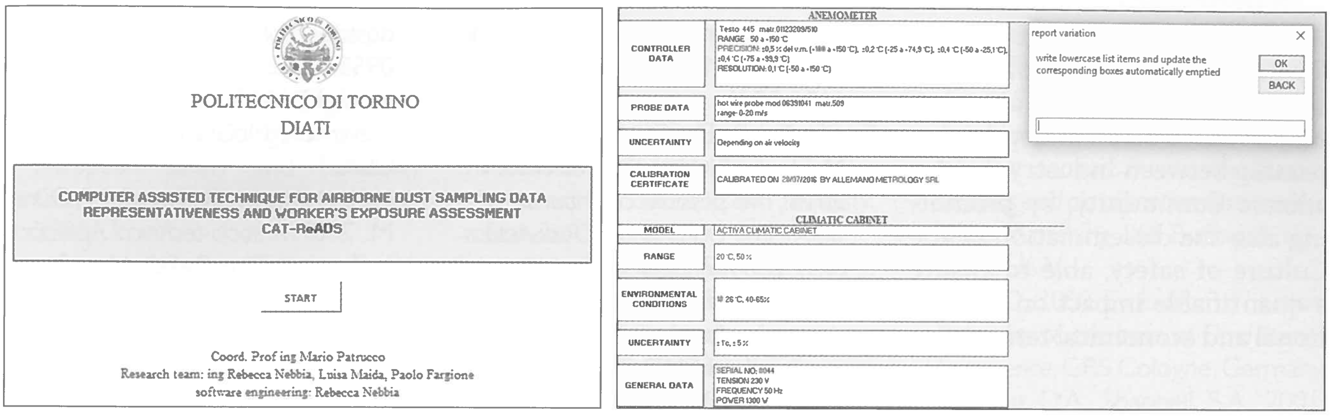


Fig. 3. Software home screen (left) and preliminary data collection sample sheet (right).
Schermata iniziale del software e foglio di acquisizione dati preliminari (destra).

$9.4 \cdot 10^{10}$ permutations of the input variables plus a batch of extra rules. The extra rules are developed to consider the cases where one or more input parameters are not present. In this way the total rules number is around of $7.0 \cdot 10^{13}$. The rules were defined in accord with the expert's opinion and the company experience.

In this way at the HSE Service is provided a series of possible preventive measure to reduce and eliminated the not wanted event, at each measure is couple a degree of effectiveness of the measure.

3. Special approaches as support to the risk assessment and management

The transformation of the working environment and the techniques and technologies employed leads to a greater difficulty in the definition of the workers' exposure models due to the activities 'variability strictly linked to customers' need. In this ontext, a tailored analysis to each specific working scenario is essential to achieve a truly representative assessment of the situation.

For this reason, a rigorous approach has been developed between Politecnico di Torino and Università degli Studi di Torino[2] (designed for airborne pollutants) to ensure both the correct design of the measuring campaigns and the statistical representativeness evaluation of the measures obtained in order to make it possible a correct comparison with the reference limit values. The approach was implemented also in a Computer – Assisted tool (Fig. 3) suitable for the storage, process and management of information, supporting the analyst during the preliminary survey *in situ*, the sampling, the laboratory analysis (as discussed in Bisio *et al.*, 2016) and the interpretation of results (Bisio *et al.*, 2017). This computer-assisted technique for airborne dust sampling reduces the probability of manual errors in data processing, allows storing directly all the data collected during the various sampling steps, creating a database of the various measurement campaigns for each scenario. In particular, this software guides the user on the calculation of expanded uncertainty and on the choice of the best analysis technique to estimate the compliance/noncompliance with the limit values.

The software can also produce, in a semi-automatic mode, final reports and it is structured to ensure the possibility of having anonymous information to which to associate, user by user, the individual keys of reading.

4. Conclusion

The paper stresses that only a close relationship between Research Universities and Industry can lead to identifying truly viable solutions for present OS&H criticalities pervading the industrial reality. Especially today, the technological evolution confronts Researcher Communities with new challenges, i.e. implications of the introduction of collaborative/co-operative robotics on workplace and working activities robots or the wide use of nanoparticles, etc. From this point of view, the relationship between Research and Industry must be of sound collaboration and osmosis, even if research by its nature try to look further, to prevent the future needs of companies. At the same time, it is of fundamental importance that the solutions developed in the research laboratories pervade the industrial reality, by evaluating first OS&H implications and economic and technical feasibility.

2 PoliTo-UniTo research project: *"The General Safety Issues and Goals in Turin Universities-TGSIGTU"*.

In addition the recent EU policy on the research, as shown in the H2020 framework, aimed at project based on an in-depth partnership between Industry and Academic Community, by promoting also the dissemination of the Culture of safety, able to ensure a quantifiable impact on occupational and economical terms.

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