Techno-stress prevention in digital society: for a new ecology of interaction between people and IT systems

(Invited paper)

Isabella Corradini[1], Enrico Nardelli[2]

[1] Centro Ricerche Themis, Roma, Italy
isabellacorradini@themiscrime.com
[2] Dipartimento di Matematica, Università Roma "Tor Vergata", Roma, Italy
nardelli@mat.uniroma2.it

Abstract. The explosion of presence of digital technologies has radically changed our life, in ways we are not yet able to fully understand. One area where information technologies (IT) have had deep and wide effects is the workplace. The presence of IT has made work places and hours to blend with family places and hours. A consequence is that a correct evaluation of work-related stress has to appropriately take into consideration this role of IT. In this paper we discuss this situation and propose a new reference model to discuss stress and techno-stress in modern digital society. Prevention and mitigation of work-related stress is one of the main duties of employers for the protection of health and safety of workers at work.

Keywords: Digital Organizations, Human Computer Interaction, Social Web, Work-Related Stress

1 Introduction

Information technology (IT) fills an integral and larger part of our everyday life, both at work and at home. Passive media like television and radio have been replaced by interactive ones. PCs and mobile devices have given rise to new languages and new ways of communicating and socializing.

IT and related services have given birth to specialized professional figures and have affected ways of learning: it is nowadays possible to update and extend one's own knowledge using them.

IT has changed not only individuals' life but enterprises organization, now structured around IT controlled information flows to such a degree that IT infrastructures are critical for enterprises survival.

Unfortunately, too often we forget that the leading and key element in any organization is represented by people inside it.

People and technologies are two elements that must be able to interact respecting their reciprocal boundaries. On one side, in fact, technologies improve with impressive speed, but on the other one cognitive adaptation of human beings to these changes cannot proceed with the same rate. In the work environment, instead, people are constantly required to adapt their own behavior to new procedures, new services, based on new technological systems and devices.

People are forced to follow too many communication threads, receive huge volumes of e-mail and other forms of instant messaging, and somebody even double check over the phone the IT mediated communication has reached its recipient.

Productivity is the main goal, but the other side of the coin is the well-being of workers. IT, when ill-used inside and by organizations, is a risk factor for work-related stress.

2 From stress to technostress

The term "techno-stress" was introduced in 1984 by psychologist Craig Brod who used it to denote stress caused by the use of technologies, mainly information ones. More specifically he defined the techno-stress "*a modern disease of adaptation caused by an inability to cope with the new computer technologies in a healthy manner*" [1].

Next, the meaning of the term has been enlarged by psychologists Michelle Weil and Larry Rosen, who emphasized its negative aspects, and defined it as "*any negative impact on attitudes, thoughts, behaviors, or body physiology that is caused either directly or indirectly by technology*" [2].

Using a psychosocial approach, Salanova et al. defines techno-stress as a "*negative psychological state associated with the use or threat of ICT use in the future. This experience is related to feelings of anxiety, mental fatigue, skepticism and inefficacy*" [3, 4].

While "stress" denotes the result of the adaptation process by an individual to the entire environment, when speaking of "techno-stress" the focus is on the technological dimension of the environment. In this paper we concentrate on this dimension. According to Ragu-Nathan et al. the technological work environment is characterized by three factors [5]:

1. "*enormous and increasing dependence of managers on ICTs and constant introduction of updated versions of software and hardware*",
2. "*a significant difference between the knowledge needed to perform various tasks using ICTs and the level of such knowledge among workers and managers*",
3. "*modern ICTs have changed the work environment and culture*".

But there are, in our view, two more relevant elements to consider for a full characterization of the technological work environment.

The first one is an old one but still neglected: the bad design of interaction between people and devices. Notwithstanding more than 30 years of research in the human-computer interaction (HCI) area, the concept that devices' operating ways have to serve the needs of human beings (and not vice-versa) is not yet given for granted. "Usability engineering" is the technical term denoting this concept and provides a set of methods to guide and help implementing this kind of interaction [6]. But when interacting with technological devices during our working duties too often we are forced to stop ourselves, to ask clarifications, to start over, and all because human-system communication is not properly working.

When the term usability engineering was coined, towards the half of eighties, most of people did not spend most of their working hours in front of a PC screen and there was a clear separation between time spent interacting with IT devices and time spent in other activities. Now that we spend most of out working time interacting with others through IT devices, research is aptly speaking of "sustainable interaction", emphasizing the need of allowing human beings a proper management of their cognitive resources [7].

The second one is that the dramatic changes in the way people work in organizations have a large impact on daily habits and create a new way of perceiving one's own work environment and make more difficult to clearly separate it from one's own private life. In a psychosocial approach, the individual is strictly connected to her environment, and this connection affects her behavior. How can an IT-based work environment be properly defined? It is both physical and virtual, at the same time. It is at the same time both work-related and private invading.

The lack of sustainable interaction and the difficulty of separation between work-related IT-mediated interactions and private-related ones give rise to two problems: a first one relative to cognitive faculties of an individual, and a second one concerning her self-determination possibility.

The cognitive problem is that it is difficult for an individual to re-conciliate between her needs and the work environment's requirements. In fact, she is more and more overloaded with information, given the ubiquitous presence of communication systems, and find herself following at the same time an ever increasing number of tasks. Clearly, given the bounds on cognitive capacity of the human beings, the larger is the amount of data presented to an individual, the less she is able to focus her attention on the relevant ones. In the same way, the more parallel tasks an individual follows, the less she is effective on each one.

The self-determination problem is the following. An individual has usually in her private life the possibility and the power of defining duration and pace of her interactions with IT systems and devices in accordance with her needs. In the work life usually there is not such a freedom, since doing so would most probably conflict with organizational requirements and goals.

The relevance of all these elements has come out from our on-field activity in the area of health and safety in the workplace, where we evaluate work-related stress risks in organizations. Given the above described role of IT in organizations, a complete eval-

uation of these risks cannot hence be performed without a thorough investigation of relations between IT and people and a study of the impact of IT on individuals.

A number of authors have analyzed factors (usually called *stressors*) that may trigger a stress response in an organism. Concerning the work environment, we report as particularly relevant the Hacker's analysis (1991), which distinguishes between factors related to the *work context* and factors related to *work content* [8], grouped in homogeneous categories:

Categories related to work *context*	Categories related to work *content*
organizational culture and function	workplace and work equipment
role in the organization	organization of tasks
career development	workload / pace of work
decision-making autonomy / control	working hours
interpersonal relationships	
home-work interface	

A classification based on these two dimensions of work context and work content is used also in the methodological guidelines defined by the Italian Ministry of Work [33]. We advance this analysis one step further. In fact, the digital revolution has so profoundly transformed organizations that IT is now a constituent factor of both the environment and the content of work. IT systems are, at the same time, (*i*) integral part of the environment where human beings work and (*ii*) devices bearing work content and supporting its processing. We therefore posit that it is appropriate to consider IT as an autonomous dimension of a reference model to discuss work-related stress [9].

In our view, the reference model to discuss relations between person and workplace in relation to stress is the one in figure 1 below, where it is emphasized that IT plays a key role both in work context and content. The figure shows also that human being is the center of every organization: this is the foundational element for our approach to work-related stress risk evaluation.

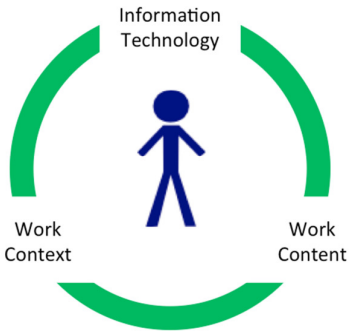

Fig. 1. The reference model for discussing work-related stress (© Corradini & Nardelli 2014)

We therefore now discuss factors of workplace stress related to Information Technology. Our proposal is based on an analysis of both stress literature (Lazarus & Folkman [10], Cooper [11], Karasek [12], French & Caplan [13], French, Caplan & Van Harrison [14], Warr [15], Edwards [16]) and HCI literature (Nielsen [6], Booth [17], Shneidermann [18], Mayhew [19], Dix, Finlay, Abowd & Beale [20], Preece, Rogers & Sharp [21], Norman [22], Hix & Rex Hartson [23]), beyond our on-the-field experience in these sectors with Italian companies.

We have identified a number of stressors and we propose to group them in five categories. These stressors are specific for IT, that is, they would not be present if the digital revolution had not so profoundly transformed both the environment and the content of work.

The five categories are:

- *Control*, to which degree IT can be controlled by its user
- *Effectiveness*, how well – in the user perception – IT is adequate to work tasks
- *Efficiency*, which level of ease/difficulty the user experience in using IT
- *Evolution*, how maintenance and upgrade actions affect work with IT
- *Learning*, related to getting and retaining knowledge about IT systems

Please note that some IT specific stressors interact with some work content/context stressors, even if they are reciprocally independent. Consider, for example, reading e-mails. Let us assume that, in terms of decision-making autonomy (a category of work context stressors) and of organizations of tasks (a category of work content stressors) the worker is forced to use IT to read and answer to her e-mails. This means that her level of control under these two dimensions is low. Now, if the IT device does not give her the level of control needed to accomplish these tasks matching her constraints, then not accessing her e-mails might increase her stress level. On the other side, an IT device fully under her control would not worsen her ability to cope with the demands coming from her organization.

3 Techno-stress, health and safety in the workplace

In Europe, the framework directive 89/391/EEC defines a set of fundamental norms for the protection of health and safety of workers at work [24]. It lays down general principles concerning the prevention and protection of workers against occupational accidents and diseases. Among these principles, particularly relevant to the subject discussed in this paper are:

- adapting the work to the individual
- adapting to technical progress

Moreover, among the obligations of the employer, we cite:

- take into consideration the worker's capabilities as regards health and safety when he entrusts tasks to workers
- consult workers on the introduction of new technologies

The cornerstone of the entire directive is the assessment of risks of workers. The legislative act transposing this European directive into national law in Italy is the legislative decree (D. Lgs.) 81/2008. Its article 28 states the obligation for the employer to assess, inter alia, work-related stress of its workers.

Given the above discussion, it is clear that among factors determining work-related stress the employer has to consider techno-stressors as information overload, multitasking, cognitive load, work/life balance.

Indeed, since 2007, techno-stress has been recognized in Italy as an occupational health by a justice court, in a trial whose prosecutor was public ministry Guariniello and regarding a call center [25], and it is hence an element to be analyzed during the evaluation of work-related risks, as prescribed by the above cited D.Lgs. 81/2008.

A research conducted in Italy by the "Netdipendenza" association points out that there are a number of categories of workers subject to techno-stress [26], among them: network consultants[1], ICT workers, call center operators, business consultants, journalists, advertising people, and financial analysts. These categories contain a total of 1.9 million workers.

Moreover, a survey, carried out on 2,000 trainers by the same association in cooperation with the Italian association of work safety trainers (AIFOS), has noticed that 60% of them think techno-stress is a risk for workers' health and 90% of them consider an appropriate training necessary so as to prevent it.

Trends appear even more worrisome, since an F-Secure world survey finds that almost half of employees in small and medium size businesses regularly uses more than one IT device for work [27] and a study by Cisco estimates the number of mobile connections to the Internet in the world will be at the end of 2014 higher than the global population of 7 billion [28].

4 Techno-stress and business process design: an integrated approach

Technology has proceeded at a speed too high with respect to our adaptation capability. We therefore cannot anymore count on the innate set of abilities of human beings in this area.

An integrated approach to the management of IT inside companies, encompassing psycho-social and organizational and technical viewpoints, is therefore needed and is a priority for a proper evaluation of risk of techno-stress and its effective prevention.

This means working both on technical implementation of IT systems, so as to make them cognitively sustainable for individuals, and on how people approaches them, so as persons are aware of the most appropriate ways of using them.

[1] These are defined as people using for their work at least three different IT devices.

Moreover, it is necessary to define methods for risk evaluation which explicitly take into account people perception of their use of IT systems and devices.

This paper points out the utility of an integrated approach, where human centered sciences and IT focused disciplines cooperate. We are using this approach in the analysis of medium and large Italian companies and the first outcomes confirm the necessity of such an approach to be able to correctly evaluate techno-stress.

From a methodological viewpoint, we are developing an approach for work-related stress evaluation where IT is one additional dimension of investigation, on a par with work context and work content. Our approach is based on the development of the following tools (to be validated by means of pilot studies):

- a control list aiming at surveying the current situation of an organization along all the three dimensions of our model (work context, work content, IT)
- a questionnaire investigating the perception of workers with respect to all the three dimensions

The control list is not a one-size-fit-all tool. It has to be specialized according to the specific characteristics of the organization under scrutiny. This may happen, for example, by extending and deepening some sections.

The perception questionnaire is based on PRISMA, an Italian questionnaire for the evaluation of work-related stress. PRISMA is a validated and standardized instrument, with good internal consistency of the subscales and whose construct validity has been confirmed [29, 30, 31].

The relevance of IT in blurring the boundaries between work and private life and the relevance of a proper consideration of this role to keep a safe work/life balance is shown also by the fact that some European companies have already taken practical measures in this direction.

For example, Deutsch Telecom has since 4 years established that no employee is required to read e-mail after leaving her workplace. Other German companies have adopted similar measures. The most recent one, among the publicly known ones, is the BMW's decision establishing that time spent working through IT devices outside working hours must be considered an overtime work [32].

5 Conclusions

The pervasiveness of IT systems to control and manage information flows in modern organizations and the possibility of accessing them anywhere and anytime has profoundly changed the standard perception of boundaries between workplace and private life.

In this paper we have discussed the importance of considering IT as an independent dimension for the analysis of work-related stress in modern IT-based organizations.

We have posited that any serious assessment of work-related risks has to explicitly analyze the role of IT and its impact on life and behavior of workers. This has to be performed using an integrated approach, where human centered sciences and IT focused disciplines cooperate.

References

1. Brod, Craig (1984). "Technostress: The Human Cost of the Computer Revolution". Addison Wesley, Reading, Mass.
2. Weil, Michelle and Rosen, Larry (1997). "TechnoStress: Coping with Technology @Work @Home @Play", Wiley.
3. Salanova, Marisa, and Llorens, Susana, and Cifre, Eva, and Nogareda, Clotilde (2007). "El tecnoestres: Concepto, medida y prevencion" [Technostress: Concept, measurement and prevention]. Nota Tecnica de Prevencion, 730. Madrid, Spain: INSHT.
4. Salanova, Marisa, and Llorens, Susana, and Cifre, Eva (2013). "The dark side of technologies: Technostress among users of information and communication technologies". International Journal of Psychology, 48(3), 422-436.
5. Ragu-Nathan, T.S., and Tarafdar, Monideepa, and Ragu-Nathan, Bhanu.S., and Tu, Qiang (2008). "The Consequences of Technostress for End Users in Organizations: Conceptual Development and Empirical Validation". Information Systems Research, Vol. 19, No. 4, December 2008, pp. 417–433
6. J. Nielsen (1993). "Usability Engineering", Morgan Kaufmann.
7. E. Blevis (2007). "Sustainable Interaction Design", International ACM Conf. on Computer-Human Interaction (CHI), San Jose, California, USA.
8. W. Hacker (1991). "Objective work environment: analysis and evaluation of objective work characteristics". Paper presented to: A Healthier Work Environment: Basic Concept & Methods of Measurement. Hogberga, Lidingo, Stockholm.
9. I. Corradini, E. Nardelli (2014). "Work organization, information technology and stress", Forthcoming.
10. R.S.Lazarus, S.Folkman, *Stress appraisal and coping*, Springer, NewYork, 1984.
11. C.L.Cooper. "Job distress: recent research and the emergency role of the clinical occupational psychologist". Bulletin of the British Psychological Society, 39, 325-331, 1986.
12. R.A.Karasek. "Job demands, job decision latitude, and mental strain: implications for job redesign". Administrative Science Quarterly, 24, 285-308, 1979.
13. J.R.French jr, R.D.Caplan. Organizational stress and individual strain". In A.J.Marrows (ed.) *The failure of success*, Amacom, NewYork, 30-66, 1973.
14. J.R.French jr, R.D.Caplan, R.Van Harrison. *The mechanisms of job stress and strain*. John Wiley & Sons, NewYork, 1982.
15. P.B.Warr. *Work, unemployment, and mental health*. Clarendon Press, Oxford, 1987.
16. J.R.Edwards, "Person-environment fit in organizations: an assessment of theoretical progress". The Academy of Management Annals, 2, 167-230, 2008.
17. P.Booth. *An introduction to human-computer interaction*. Lawrence Erlbaum Associates, 1989.
18. B.Shneidermann. *Designing the user interface: strategies for effective human-computer interaction*. Addison Wesley, 1987. 5th edition 2009.

19. D.J.Mayhew, *Principles and guidelines in software user interface design*. Prentice Hall, 1992.
20. A.Dix, J.Finlay, G.Abowd, R.Beale. Human-computer interaction. Prentice Hall, 1993.
21. J.Preece, Y.Roger, H.Sharp. *Interaction design*. John Wiley & Sons, NewYork, 2002.
22. D.A.Norman. *The invisible computer*. MIT Press, 1998.
23. D.Hix, H. Rex Hartson. *Developing user interfaces: ensuring usability through product and process*. John Wiley & Sons, 1993.
24. https://osha.europa.eu/en/legislation/directives/the-osh-framework-directive/1
25. Tribunale di Torino, 2007.
26. Associazione Netdipendenza, http://www.netdipendenzaonlus.it
27. F-Secure, Digital Company Survey, November 2013, http://www.f-secure.com/en/web/corporation_global/news-info/product-news-offers/view/story/1347740/Tapping,%20Touching,%20Typing:%20Welcome%20to%20the%20Era%20of%20Fluid-Fingered%20Employees
28. Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update 2013–2018, http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html
29. I. Carosi, M. Scatigna, I. Corradini, S. Chirilli, V. Martinez, M. Pericoli, A. Fiorenzani, L. Fabiani (2010). "Validation of an Italian Questionnaire for work related-stress risks assessment- Study protocol and preliminary results". 20th IUHPE World Conference on Health Promotion, 11-15 July, Geneva.
30. Corradini I., Lambertucci P. (2012). "Lo stress nei luoghi di lavoro. Profili psicologici, giuridici e metodologie di valutazione". Themis Edizioni, Roma.
31. I. Corradini (2013). "Lo stress sul lavoro: P.R.I.S.M.A., un nuovo strumento di indagine", Stress e Vita. La scienza dello stress e la scienza della salute alla luce della Psiconeuro-endocrinoimmunologia, Francesco Bottaccioli (a cura di), Tecniche Nuove.
32. Banning e-mail after work, http://www.dw.de/banning-e-mail-after-work/a-17445387
33. Italian Ministry of Work, Permanent Advisory Committee for Workplace Health and Safety, Guidelines for work-related stress evaluation, November 2010, http://www.lavoro.gov.it/Strumenti/Normativa/Documents/2010/20101118_LC.pdf (in italian)