Safety Science 94 (2017) 103–115

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

Discussion

Safety science, a founding fathers' retrospection

John Stoop [a,b,*], Jan de Kroes [c], Andrew Hale [c]

[a] Delft University of Technology, The Netherlands
[b] Amsterdam University of Applied Science, Aviation Academy, The Netherlands
[c] Safety Science Group, Delft University of Technology, The Netherlands

ARTICLE INFO

Article history:
Received 28 June 2016
Received in revised form 6 January 2017
Accepted 9 January 2017

Keywords:
Safety science
Multidisciplinarity
Problem orientation
System approach
Safety investigation methodology
Systems engineering

ABSTRACT

In August 2014, a special issue of Safety Science contested the foundations of safety science as a scientific domain on methodological, theoretical and philosophical grounds. Safety specialists in social, behavioural and organisational sciences discussed what seems to be an identity crisis in occupational safety and social sciences. A tension between scientific and societal relevance of the notion of safety was noted, raising doubts about the scientific validity of safety science (Safety Science, 2014).

As three of the founding fathers of the Safety Science Group (SSG) at Delft University of Technology (DUT) in 1978, we were challenged by this debate to reflect on our ambitions and mission that were expressed during the inception of safety science at DUT. In addition to what has already been described by Hale and De Kroes (1997) and Hale (2014), we elaborate also on personal experiences and insights, gained over a period of some 40 years of work. These additional experiences were gained in particular by the first two authors in the transport domain from a technological and engineering design methodological perspective. They provide a more encompassing scope on the development of safety science in general as a scientific activity at DUT. Parallel developments in other domains have been described in other papers (Hale, 1985, 2006, 2014; Hale and de Kroes, 1997).

First, we have to correct a long term omission by translating the founding documents for safety science at DUT into English to make them accessible for non-Dutch experts.

Second, we highlight the development of three basic notions that were identified in 1978, at the inception of the SSG, as the cornerstones for safety science as a scientific discipline, no matter what domain it is related to: interdisciplinarity, problem-solving orientation and systems approach. We document in this paper their development and use in the transport domain in the DUT as a whole, i.e. more broadly than the SSG.

Third, we discuss more in general the observations, particularly of the first two authors on the value and unique role of safety investigation methodology and systems engineering as powerful feedback loops with learning potential and drivers of change through their potential to address safety in complex, dynamic and open transport systems.

Fourth, we elaborate on three additional basic notions that are needed as extra building blocks for a paradigm shift in safety thinking, irrespective of disciplines and domains – a full information supply, engineering design methodology and multiple intervention strategies.

Finally, we advocate a mutual recognition of the value and validity of scientific paradigms as developed in the various disciplines, that in conjunction constitute safety science as a distinct, multidisciplinary activity in the academic community.

1. Introduction

Challenged by the Special Issue of Safety Science of August 2014, we as three of the founding fathers of safety science at Delft University of Technology (DUT) decided to participate in the debate on the validity and rationales of safety as a scientific activity. The debate in that special issue indicated that some of the intentions of that foundation in the Netherlands appeared to be unknown to members of the broader scientific community, due to the fact that the content of the founding documents had never been translated from Dutch and communicated with the international safety science community. This paper therefore starts by filling that gap and showing how these documents formed the

* Corresponding author at: Amsterdam University of Applied Science, Aviation Academy, Spijksedijk 8A, 4207GN Gorinchem, The Netherlands. Tel.: +31 183 637484, mobile: +31 681061821.
E-mail address: stoop@kindunos.nl (J. Stoop).

http://dx.doi.org/10.1016/j.ssci.2017.01.006
0925-7535/

foundation of the work of the Safety Science Group (SSG). In describing this debate, we choose to come forward with our own experiences, arguments and professional views, from our participation across four or five decades of education, research and development in safety science. This supplements and expands our use of scientific analysis. We argue that a paradigm shift in the debate was and is still necessary to address the differences and difficulties that were addressed in the Special Issue and the problems of establishing and exploiting safety science as a multidiscipline. We argue that progress has been made in this, but it has not been fully established as yet.

During the past decades, we have focused on testing and developing the initial notions that were defined during the foundation of safety science in DUT as a scientific activity. These notions were often discussed in professional journals, industrial networks and topical conferences and were addressed in graduation projects to gain feedback from various application domains and industrial sectors. Although this testing appeared to us to be relatively successful, it also revealed several deficiencies in the initial founding rationales. Diverging mechanisms, inherent differences between scientific disciplines, application domains and the various transport modes and industrial sectors in particular, required careful reflection on the strengths and weaknesses of the conceptual thinking on an integral safety approach. In this paper, we first elaborate on the historical development of safety science at DUT as a specific development in its international context. In addition to the contribution of the third author as the chair holder in his Postscript in the special issue (Hale, 2014), we summarise the three basic notions that were identified in the debates leading to the establishment of the chair in Safety Science and the SSG: interdisciplinarity, problem-solving orientation and the systems approach. In this paper, we contribute to the debate from a more specific transport safety and engineering design perspective. In this development attention is paid to diverging trends, both between occupational and transport safety and discrepancies between technological domains within DUT, emerging from their scientific and societal relevance. Secondly, we highlight transport safety in particular, where the first two authors have been largely active, referring to societal needs, its international context with respect to accident investigations and involvement in the conceptual design phase in particular.

The other domains of occupational, public and consumer safety are not explicitly dealt with in this paper, although the authors would argue that most of the notions dealt with apply just as well to those other domains.[1]

Thirdly, we discuss the strengths and weakness of the founding notions as applied in the transport domain, in particular with respect to the specific forms of formal logic that are applicable, the various schools of safety thinking and the need to recognize the architecture in socio-technical transport system concepts. Such a careful disclosure of properties however, although it proves necessary, it is not sufficient to explain differences, controversies across disciplines and domains and a resistance to change. Increasing complexity in the design and operation of major infrastructural projects, several major catastrophic occurrences in various transport modes, creation of public-private partnerships, new business models and introduction of innovative and disruptive technologies fuelled a societal demand for a shift in safety thinking, risk management and governmental control strategies. To understand underlying differences between approaches, notions and concepts that are applied in transport safety, we analyse the strengths and weaknesses of our three primary notions and what the obstructions could be that prevent the realisation of our intentions in practice.

To address the fundamental question raised in the Special Issue of Safety Science -is safety science a science or not- and to overcome the observed difficulties in a cooperation between social, technical and design sciences, a debate on paradigms and paradigm shift proves to be inevitable. Such a debate is not about succession or dominance of single disciplines, but –as defined by Kuhn- a fundamental change in the basic concept and experimental practices of each of the contributing scientific disciplines (Kuhn, 1962). By definition, a paradigm designates what the members of scientific communities have in common and what they share in values, notions, methods and techniques. We identify three building blocks not always present, but necessary for a paradigm shift in our exploration of this stagnation in achieving a synthesis: a full information paradigm including the use of raw data sources, the need to incorporate engineering design methodology to impose adaptation and change, and the creation of a landscape for vectoring safety through the various solution domains. Our observations of the developments over the past four decades has convinced us that there is a reason for the existence of, and the need for safety science as a scientific activity. Such an encompassing and converging description in an international context is not yet available.

2. A chronology: safety science at Delft University of Technology

2.1. Establishing the safety science group

DUT established a professorial chair in ‘social hygiene’ in 1907 in the aftermath of the Parliamentary Hearing of 1888 on resolving the misery of the working classes in the 19th century. This chair covered a range of disciplines and dealt, among other things, with safety. This was the first Dutch recognition of the need for academic study of and attention to safety. Professor Heijermans was appointed to the chair, but this was later abolished in the crisis of 1931 (Stoop, 1999). It lasted until 1975 before DUT paid attention again to the question of safety and health as an academic subject in engineering research and education.

During discussion on the safety of the planned nuclear power generator at Kalkar in Germany, a symposium at DUT was organized on 27–28 November 1975 entitled ‘Core questions about the fast breeder’. In the aftermath of the conference, the question was raised whether generalizing safety issues across scientific and industrial domains was feasible and desirable.

In answering the question, the University Council of DUT organized a second symposium on 11 and 12 October 1978 with the title ‘Academic Education and Research in Safety’ (UOOV, 1978). This symposium was attended by over 300 Dutch and foreign participants from industry, academia, research institutes and governance. It was organized as an open and participative discourse in order to achieve a breakthrough in the impasse in dealing with complex and major safety issues. Emphasis was laid on the need to achieve close cooperation between the various levels of academic and post graduate education and various disciplines involved in scientific research. Bridging the gap between theory and practice was considered a prerequisite to cope with increased complexity and new challenges imposed by new technology, growth in scale and overlapping and interrelated developments of a technological, behavioural, social and managerial nature. In summary, it concluded that the dynamics of science, technology and society in relation to safety should be explored on a higher academic level. To improve this situation, the characteristics and requirements of a fundamental leap forwards needed to be

[1] Some discussion of them can be found in the third author’s introductory and valedictory lectures (Hale, 1985, 2006), his postscript to the special issue (Hale, 2014) and the paper of Hale and de Kroes (1997) in the issue of Safety Science celebrating the tenth anniversary of the SSG.