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ScienceDirect

Procedia CIRP 39 (2016) 109 – 113

www.elsevier.com/locate/procedia

TFC 2015– TRIZ FUTURE 2015

The Variopanto® - With TRIZ from Idea to Reality

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Abstract

The paper deals with the development of an interoperable pantograph for cross-border operation in a multi-site team. TRIZ helped since 2008 to find first feasible ideas and to overcome several barriers on the way to a real product. In 2015 the "Variopanto®" called final product starts testing on a business application.

Peer-review under responsibility of Scientific committee of Triz Future Conference

Keywords: Pantograph; OTSM TRIZ, TONGS, Network of Problems, Contradiction

1. Initial situation – interoperability in Europe

Pantographs are key components in electric traction and are developed continuously since more than 100 years. The main difference between the pantographs in Europe beside the voltage system (see figure 1) is the collector head width. There are 4 mainly used collector head widths in place: 1450 mm, 1600 mm, 1800 mm and 1950 mm. In cross-border traffic, several different pantographs are needed, thus resulting in additional space and weight. On locomotives e.g. the space is limited for the installation of 4 pantographs. Taking redundant availability of pantographs into consideration, this limits passage traffic through Europe. On double-deck trains additional pantographs limit the number of seats, thus reducing the economic benefit for the operator. With a pantograph combining two or more of these collector head requirements it would be possible to overcome above mentioned disadvantages.

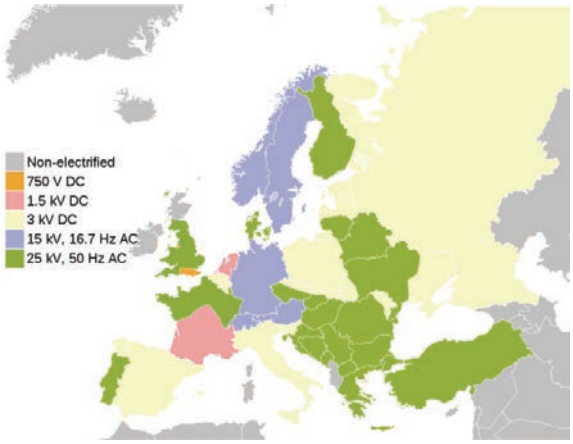

Fig. 1. Voltage systems in Europe [1]

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doi:10.1016/j.procir.2016.01.174

2. TRIZ for problem definition

The initial development program has been started already in 2007, but in 2008 we decided to support further steps by application of TRIZ.
In 2008 a team of Bombardier Transportation and Stemmann-Technik with support of Nikolai Khomenko † started developing an interoperable pantograph. Nikolai Khomenko was the mentor of a related Master Thesis project [2] within the master program “Master of innovative design” by INSA Strasbourg.

2.1. Ideal final result – no pantograph

As a first step, we described the initial situation and the ideal final result. The initial situation (IS) is the huge number of different pantographs per vehicle as described before. The ideal final result is to have no pantograph. This approach is realized by inductive energy supply at urban traffic applications e. g. BOMBARDIER Primove®. But for mainline traffic we decided to go one step back and using the so-called “Most desired result” (MDR) for the more realistic target of having one type of pantograph as a first step.

2.2. Most desired result – one fits all

Then we described the barriers which are hindering us to reach the MDR by using the TONGS model [3]. TONGS is part of OTSM TRIZ, which is a further development of TRIZ by Nikolai Khomenko. More details can be found in [4].
As barriers we described all differences between commonly used pantographs, e.g. different width, different contract strip material, different arms etc.
The TONGS model helped the team to understand where we are, what goals to achieve, which barriers to overcome and which conflicts to solve.

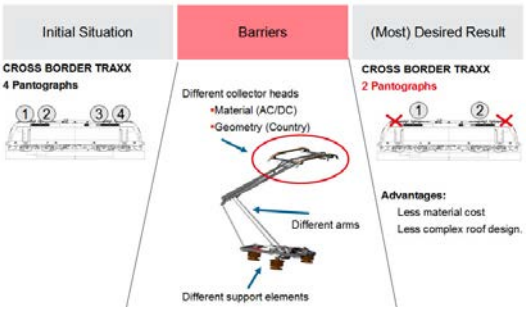

Fig. 2. TONGS Model [5]

In a system roadmap we described the future evolution from today 4 different pantograph types (AC wide, AC narrow, DC wide, DC narrow) to 1 pantographs. As intermediate steps were identified an adaptable geometry, adaptable materials and reliable service in limited conditions.

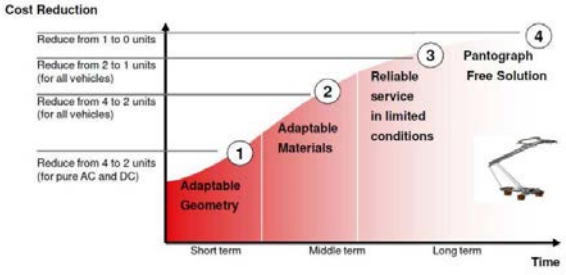

Fig. 3. System roadmap: from 4 to 0 pantographs [5]

2.3. Patent analysis and maturity estimation

Then we executed a patent analysis, where we looked for replacement or dynamic change of collector head. We reviewed existing patent reports to find out existing solutions. The target was to avoid double work and to find interesting ideas to further develop. The patent analysis gave also a view on the maturity of the product pantograph and supported our understanding of areas which we need to focus on.

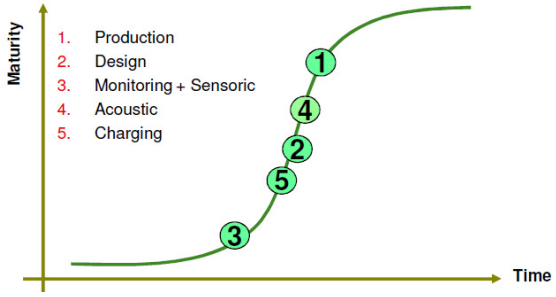

Fig. 4. Maturity estimation by the team [5]

2.4. Network of problems - width adaptation

To analyze the problem and to generate partial solutions, we built a network of problems. There we listed all problems and solution concepts. The OTMS Network of problems helped to get an overall problem understanding of the system under study. By analyzing the network of problems we were focusing on bottlenecks and nodes which impact the network most. We learned that we have to focus on the bottleneck about the width adaptation of the collector head.