

IRSE INTERNATIONAL TECHNICAL COMMITTEE

HOW TO CREATE THE NEXT GENERATION OF SENIOR SIGNAL ENGINEERS

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Introduction

It is generally perceived that there is a shortage of candidates to fill the future roles of Senior and Chief Signal Engineers. In particular, the age group between 40 to 50 years appears to be affected by this condition. This situation is deemed extremely critical: not acting could render this situation uncontrollable, thereby endangering the overall safety of railway systems in the future. This article aims to explain how this came to pass, and to develop elements of an active strategy for the creation of the next generation of Senior Signal Engineers. The IRSE is urged to take an active role in developing such a strategy and acting upon it.

The situation whilst technology was "tangible"

During the age of mechanical and relay interlockings it was possible for one single person – the Chief Signal Engineer – to know everything about and be responsible for all the technical installations ensuring the safe management of the traffic on a railway network. Within the realm of their still integrated railway companies they had full knowledge of train operations. These broadly experienced experts knew what it takes to operate a railway as a whole and were also aware of the entire system lifecycle.

The know-how about the technology on which the interlockings were based was directly available within the railway companies, thereby enabling them, for instance, to adapt interlockings without involving the suppliers. Such a direct contact with the systems used and with the entire railway operation naturally created a pool of candidates who were able to take over responsibility from the Chief Signal Engineer.

Hence, to generate the next generation of Senior Signal Engineers was comparatively easy: have the prospective candidate trained by the current Senior Signal Engineer in depth and pass over responsibility.

The impacts of the introduction of complex technology

In the 1990s, computer-based interlockings and later ETCS/ERTMS and other systems with complex train-borne equipment were introduced. As the complexity of the systems grew; the "tangibility" was lost. There have now emerged a new generation of signal engineers, well educated in engineering subjects like electronic hardware, software and communication, coming from schools and universities.

Many new exciting fields of specialisation have formed in signalling, such as:

- System engineering
- Safe architecture design
- Safety assurance
- Implementation and project management of safety related systems, Testing,
- IT and communications, both for voice and data
- Engineering of track-side equipment (interlocking, level crossings etc.)
- ETCS/CBTC/ATP engineering including interfaces with rolling stock
- Train Traffic Management Systems/Optimisation
- ATO engineering
- Asset Protection systems (WILD, HBD etc)
- Maintenance and asset management systems

In this way, signalling has gone through the same specialisation process as many other technologies and sciences, for instance in medicine. As a result, one single person can hardly know everything anymore and be responsible for everything that makes a modern railway safe. Experts are still very well educated, but their education is now deeper and hence less broad.

From another point of view, two different types of new role for Signal Engineers have emerged:

- Those who develop generic products and systems (requirement engineers, software engineers, hardware engineers, engineers responsible for the safety assurance of signalling principles)
- Those who apply and deploy these generic products and systems and implement installations (the engineers who specify the network-wide needs of the railway, the testing personnel, the people who verify the tests, the engineers who carry out the pilot applications, the engineers who put the system into work (be it as application platforms and/or on sites)

What remained was that Chief Signal Engineers were still clearly personally responsible for the decisions taken and the residual risks accepted concerning safety matters. This capability of managing safety problems is an important part of competence, which can only be acquired progressively and by personal experience.

The companies which were still integrated organised qualifying career paths for the creation of Senior Signal Engineers

Breakup of the industry and change of legal and administrative environment of the railway networks; the situation today

As a consequence of changing political and economic strategies, the specialisation process began to seize not only individuals but also companies. The integrated "all-round" railway companies have split into highly specialised firms, which have struggled ever since to find justification for educating generalists in safety, because such initiatives were no longer needed to fulfil their immediate business aims. As a result, it has become very hard to acquire a broad experience and assume a variety of responsibilities by moving around in different departments and companies.

While companies still find the means for highly specialized training, the individual interested in a broader education is rather left to rely on their own private initiative. The modern career paths create the wrong incentives. As a consequence, talented junior professionals frequently end up in general management positions instead of directing their career towards gaining an overall system view and becoming Chief Signal Engineers.

Another change that came about was the introduction of the CENELEC norms for safety-related railway systems. On the one hand these norms have brought about many positive effects, such as the introduction and systematisation of the safety processes. On the other hand, they tend to amplify the specialisation process even more, and to shift the responsibility for the system's safety away from individuals with sound judgement to process, roles and organisations. Standards, guidelines, processes, complex organisational charts and such often seem to replace broad knowledge concentrated in a small very experienced team, thereby increasing cost and diffusing responsibility without making anything safer.

This shift away from the trust in individuals to the importance of processes and organisation certainly doesn't support the notion of educating gifted professionals into generalists with strong and responsible personalities as being a worthwhile investment.

These aforementioned developments have resulted in a substantial lack of candidates for future Senior and Chief Signal Engineers

Vision for the future and responsibility of the IRSE

Without any doubt, due to technological development of railway safety and traffic management systems, the field of Signal Engineering has become richer, more productive and more ambitious than it ever was before. Let us face it: the world has changed. To go back to earlier stages in which one person knows everything about a railway operation seems inconceivable. What used to be accomplished before by an individual is now carried out by a team of skilled specialists. However, the leader of such a team – a Senior Signal Engineer – still requires the depth of experience and skills to judge the work of the team members. In each large project an expert with true domain knowledge must be present, empowered and respected. "General purpose" project managers who often have little experience with the application domain cannot and should not assume this accountability.

IRSE already plays an important role in the formation of professionals in signal engineering. The institution could fill a void created by the split-up of industry and should take on more responsibility in defining the senior roles in the field and outlining curricula leading to competence for such higher levels of professionalism. This initiative must aim at developing a general-purpose mentality among the next generation of senior system engineers, who will learn about the culture, philosophy, skills, mind set of Signalling, and ensure that the former specialists gradually take a helicopter view.

For instance, a grade of "Senior Signal Engineer" could be introduced. The emphasis of this education should be to evolve specialists into generalists who are able to assume full responsibility for safety in defined areas within their companies. Senior Signal Engineers would be candidates to join the executive board in the role as Head of Engineering.

Elements of such a curriculum could be:

- Training courses to ensure a common level of knowledge about technical aspects in a broad area and a certain consistency of philosophy
- Introduction to the *efficient* management of safety, based on the CENELEC philosophy
- Case studies taken from the real world to be solved by participants will enrich their learning
- A sequence of internship positions charged with real-life responsibilities to ensure that candidates – mentored by Senior Signalling Engineers – acquire the

integrating capabilities and the interdisciplinary network they need for their future responsibilities

- A final assessment consisting of a technical part and the confirmation by a board of experts that a role of predefined, substantial responsibilities in a number of projects and/or operational areas has been performed satisfactorily over a substantial period of time.

Fixed – possibly international – groups of say 6-8 students - should be put together by design in an interdisciplinary way, encompassing members from different disciplines, product lifecycles and companies. They should be kept together throughout the entire curriculum. A fixed exchange scheme of students among companies can be defined well in advance, allowing for organisational preparation of all involved parties.

With the involvement of Universities such a curriculum could be upgraded to a specialised postgraduate or master's programme or similar to make it even more attractive.

Such an initiative would have positive effects on a number of levels:

- Make the field of signalling attractive to talented young engineers in the long term
- Create a competition within the industry – be it suppliers or infrastructure manager railway undertakings – to integrate such a widely acknowledged interdisciplinary career into their manuals on human resource development – in order to keep rare talent in their company
- Strengthen the technical knowledge and skills of the management team, which should pay off in the long term by avoiding unfavourable strategic decisions due to the lack of technical competence
- Exchanging the know-how on efficient safety philosophies and processes within the industry, independent of the specific specialisation areas
- Creating long-lasting networks of interdisciplinary safety experts based on personal connections
- IRSE would be the "Alumni" organisation of these senior professionals, with the possibility of organising exclusive events and exchanges, which would even further IRSE's reputation

To increase the motivation of all involved parties to actively pursue this path, IRSE should aim to make the availability of qualified Senior Signal Engineers and a Managing Signal Engineer, who possess a rail system view with the corresponding authority and decision power, a mandatory condition for operating any railway on a legislative and normative level.

Conclusion:

Today, Signal Engineers have to face a professional life in a future world without any signals left. However, to conclude that the last signal engineer would have disappeared together with the removal of the last signal would be a completely wrong judgement. Quite the contrary holds: signal engineering has become an emergent and successful discipline at the beginning of a new lifecycle, carried on by a large number of talented highly specialised engineers.

What this discipline currently lacks is the organisational capabilities to generate senior professionals who are educated broadly enough in several dimensions to enable them to keep the overview, know the rights apart from the wrongs, who are capable and confident enough to assume responsibility for the safety of a railway and let us continue to take relaxed rides on railways in the future.

IRSE is in a unique position to assume the responsibility for creating new attractive curricula for senior signalling professionals and selling them to the industry. The way to create a future generation of Senior Signal Engineers has changed, whose motto should be: "Start as a signal engineer, end up as a system engineer".