

Presidential Address: Winds of Change

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It is an exceptional honour for me to serve as your president and to write this address. As with my predecessor, Peter Symons, my term will be devoted to the future of signalling. The IRSE's definition of signalling includes telecommunications, automation and associated technologies, i.e. whatever enables the safe and efficient control of a railway, [1].

If you had asked me three years ago which ground-breaking innovations in railway safety and control I expected to see in the next few years, I would probably have come up with little of significance. However, much has changed in my perception in the last three years: The railway – and the transportation system as a whole for that matter – could soon face some of the most dramatic reshaping ever.

At the border of a new age?

Between June 2015 and October 2016 I participated in the SBB project now called 'Smartrail 4.0' [2], leading to revelations I would not have thought possible and creating an entirely new view of how railway safety and control could be achieved.

In a broader context, autonomous driving has become a widely discussed subject, first on roads and now also on rails. It has become topical for mainline railways to think about Automatic Train Operation, see [3]. Such visions are supported and enabled by the progress (and promises of further progress) of modern IT, including the appearance of seemingly new technologies such as Big Data, the Internet of Things and Deep Learning.



Figure 1 – Build a wall or a windmill when the wind changes? [7]

At the same time, cyber threats – long believed to be rather imaginary in the so-called closed networks of the railway safety domain – have become real, leading to the need for new Cyber Security products and the challenge of integrating requirements for both safety and security into railway systems.

If these changes materialise they are likely to revolutionise the transportation system as a whole. Under the title "New-Rail-Deal, Big Mix or AUTonomy – scenarios for the railway in the year 2040" [4], German research claims that there is a credible outcome in which there is practically no role left for the railway in the overall transportation system!

All this would affect not only the technology of safety and control, but the business models of the entire transportation system in a way that is hard to foresee today. These insights must

motivate the railway industry to increase their innovation efforts, creating dynamics which were not there three years ago and representing the beginning of something new. This cannot be a gradual change which takes many decades, which is what usually happens in the railway domain, and other people seem to share my opinion, for example as in [5] and [6].

"Winds of Change"

Reflecting on all this, I have chosen "Winds of Change" as my theme for my IRSE Presidential Year. The main aims of my term are:

- To reflect on the possible mechanisms at work.
- To demonstrate some elements on which these big changes could probably be based.
- To prepare the IRSE, i.e., ourselves, for this future.

This theme manifested itself in my mind one day quite suddenly, and it became considerably more interesting when I investigated its origins. It appears to be based on an old Chinese proverb:

风向转变时,有人筑墙,有人造风车.

When the direction of the wind changes, some build a wall, some build a windmill.

Build a wall or a windmill when the wind changes? This is indeed a complex question with profound depths, and it perfectly reflects our age-old struggle between providing safety in a vast, heterogeneous and complex system, and at the same time being cost-effective and efficient by harvesting the benefits of modernity.

According to [8], the prices of public transportation in Switzerland have increased by about 60% since 1990, compared with 20% in road transportation (general price increase of consumer goods: 30%, see figure 2). And this, it seems, is just the beginning. Bus operators will soon be allowed to offer services between, for instance, Zurich and Bern for a fraction of what the rail ticket costs. Bus operators are even starting to attack the rail transportation market directly [9]. Does the added value of the rail service really justify such high prices? Moreover, what could happen when the bus drivers would be replaceable by robots? And what will happen to safety standards, if such cost pressures are exerted on the railway?

In the light of this situation, I have the impression that the railways' struggle described above might soon become a struggle for their existence! It is our task and responsibility to reduce the cost of signalling and create additional benefits from it. Expressed in more direct terms, railways must change or else! This sounds frightening, and it is.

Build walls or windmills?

Am I the windmill-building type when the winds of change blow? Yes, I feel very lucky when I see the possibilities of the exciting times we live in, despite the worried impression I may have given in the previous paragraphs. I see myself as an innovator.

Most signal engineers, however, usually seem more on the defensive (wall-building) side to me. I am not generally criticising this strategy – it has proven its merits by successfully developing the culture of high safety standards on the railways. And if you think about the cyber security issue, isn't this of necessity about building walls? I can well understand that perceiving today's situation and

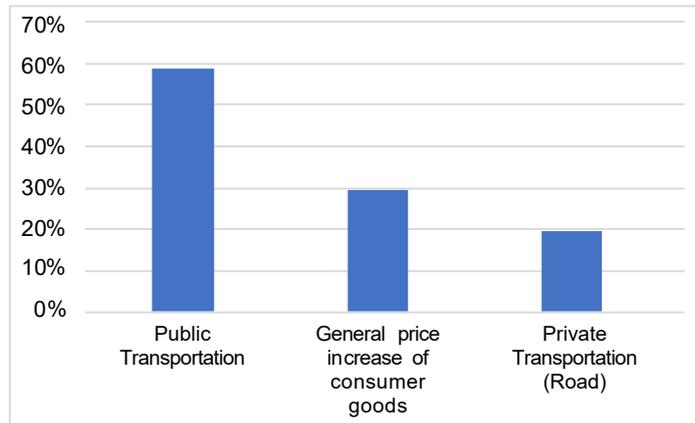


Figure 2 – Comparison of price increases in Switzerland 1990 – 2016

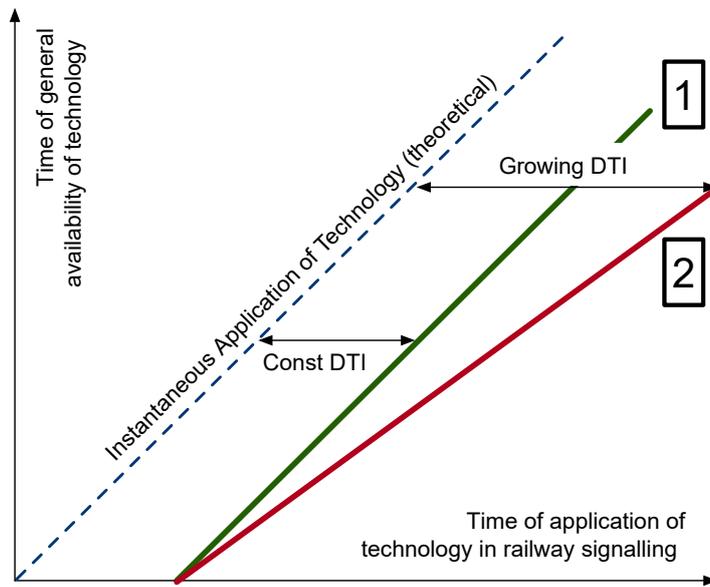


Figure 3 – Distance to Innovation (DTI) in Railway Signalling: is it 1 or 2?

its extrapolation into the future could increase this defensive reflex even further.

So, which recommendation is the appropriate one for a president of the IRSE to make, who is always supposed to balance things carefully? Quite simple:

Build both! Build windmills on top of the walls! The elevated windmills will catch stronger winds and hence be more efficient at no additional cost, because our walls are usually very strong – strong enough to sustain a modern, elegant windmill!

What does this mean in railway terms? We must use our very expensive safety systems to create additional benefits at marginal costs, for instance by using their excellent sensing and communication methods to create functionality which increases the efficiency of the overall system, such as modern traffic management systems that optimise capacity and the flow of trains.

How fast to innovate?

How fast should the windmills be built? The speed of innovation in a specific domain such as railway signalling, compared with the speed of innovation of technology in general, is crucial.

In the past decades, railways often seem to have struggled with innovation. May I refer you to the article "Why is innovation so difficult in railways" [10] of the IRSE International Technical Committee (ITC), which generated a month-long heated debate before it could be published!

If innovations are introduced into the railway domain with only a modest time delay, the domain is healthy (see curve 1 in figure 3). In this case, the so called (temporal) Distance To Innovation (DTI) is constant. However, if we behave in a manner as depicted by curve 2 in figure 3, then our domain is not healthy, as we will progressively lose sight of modern technology. It would cost more and more to modernise the infrastructure, meaning that investment backlogs accumulate,

to the point where the existing system becomes completely unmanageable and would need to be abandoned. Moreover, in general efficiency is lower in a domain with higher DTI, leading to even less funding being generated for the much needed innovation.

The DTI of railway signalling in general, and even of an individual railway, is hard to quantify. Worryingly however, there seems to be little evidence for railway signalling following the trajectory indicated by curve 1 in figure 3. For instance, GSM-R is already four generations behind the development of general technology, let alone the typical technology on which interlockings are based in most countries. We need to look at ourselves in the mirror: The technological step of ETCS began some 25 years ago and is still not truly 'business as usual', let alone fully implemented. Would this happen in a truly 'healthy domain', as defined above?

Contrast this picture with the initial development of railways, which applied modern technology almost immediately in their early history. Examples include the electric motor (1834) in the first electric locomotive (1837, DTI = 3 years), the telegraph (1837) as safe signal telegraph (1844, DTI = 7 years) and mechanical interlockings (1856) based the idea of the Arithmometer (1851, DTI = 5 years) [11].

Today, I personally think we are much closer to exhibiting the behaviour of curve 2 and therefore, if I am correct, it is absolutely crucial to increase the speed of innovation in our domain.

To change stepwise or with a Big Bang?

Another age-old question in this context is whether to renew stepwise (in an evolutionary manner) or with a 'Big Bang' approach. Should the walls be renovated stone by stone and many new small sections of the wall be rebuilt where and when circumstances call for it? Or should large segments of the wall be torn down in one go and completely be rebuilt at once? And how should we proceed with the windmills? Do we adapt the walls to support windmills when they are being renovated, or perform this in a second round of activity?

In my perception, a respectable majority of signal engineers would vote for the stepwise evolutionary strategy. In [12], ÖBB supports this view by stating: "One of the misconceptions is that digitalisation signifies large, disruptive changes like autonomous driving or other hyped technologies (though we will be waiting a long time for a truly significant change in rail digitalisation)."

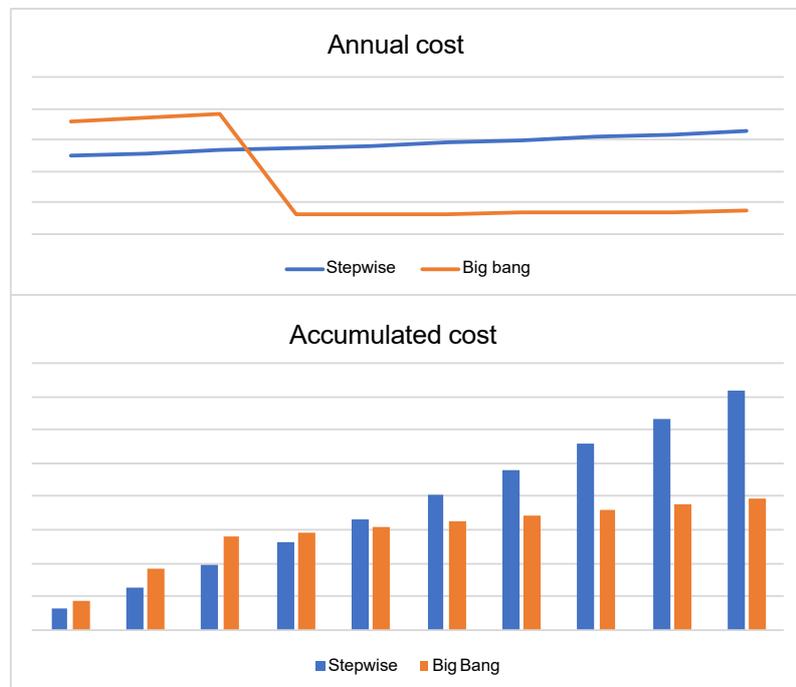


Figure 4 – Annual and accumulated cost in Stepwise and Big Bang Approaches (qualitative).

SBB's CEO, on the other hand, seems of different opinion: "We would like to make a Quantum Leap with the railway." [6]. It is the very nature of quantum leaps that they have nothing gradual in them. The Danish re-signalling project is also representative of the Big Bang approach.

Who is right or wrong cannot be said in general terms – it depends very much on the circumstances. In my perception, however, there is a too conservative tendency in signalling, with not enough courage to take larger steps. Much of the risk aversion that we see in our industry stems from problems discussed in [14]. Several independent unpublished studies by railways have reached the same conclusion: Big Bang can save up to 50% of the cost. A qualitative model of this is shown in figure 4. While the initial investments are higher, they drop substantially after the innovation is in use, because of the higher degree of uniformity, the lower maintenance cost and the fact that every newly introduced system doesn't have to be compatible with all other legacy systems, see [13].

Admittedly, the risks with Big Bang are higher, but so are the opportunities and benefits, and so again we arrive at the question: do we build walls or windmills in the future?

There remains the question of the business case, of course. Where to find the additional initial investment required for a Big Bang approach? There are two important preconditions for this:

- The industry structure and governance must allow for strategic budgeting over several years (if not decades).
- It must be possible to make business cases for the overall systems, not just for individual parts.

If these preconditions are not fulfilled, they must be made to be fulfilled, otherwise the benefits illustrated by figure 4 cannot be realised. It is to no avail if neither the walls can be renovated nor the windmills built because each does not generate a positive business case when considered separately. And we need to make this clear to the stakeholders and investors!

Vademecum "Winds of Change"

You may disagree with some or much of what I have said, but don't you also find some grains of truth worth considering? I have prepared the 'Vademecum Winds of Change' in the green panel overleaf, a check list to see whether you, your project, the industry and the IRSE is on the right track with the "Winds of Change". It fits neatly in the pocket of every signal and telecommunications engineer.

Conclusion

We could see quite dramatic changes in signalling, railways and the transportation system as a whole. This prospect alone demands hard work from us: We must find an appropriate balance of 'walls' (maintaining the tradition of high safety standards) and 'windmills' (harvesting opportunities and increasing efficiency) in times of uncertainty.

“Winds of Change”

- 1) Have we thought hard enough about building more and efficient windmills?
- 2) Is a gradual change the right thing to do, or do we have the courage for more?
- 3) Application of modern technology:
 - a) Do I get sufficiently engaged with modern technology by attending IRSE events and reading technical papers?
 - b) Do I support suppliers enough to persuade them to apply modern technology to signalling?
 - c) Do I support the railways enough to make them want to apply modern technology to their operations?
 - d) Are we ready for ‘digitalisation’ and ‘4.0’: data/sensor/actors/communication methods?
- 4) Are our architectures modular in a way that they will support future innovations?
- 5) Have we observed and learned the lessons of the pitfalls in “Why signalling projects fail?” [14]
- 6) What does the common sense of an IRSE signal, telecommunication or automation engineer tell us about what we are presently doing to help the future prosperity of railways?
- 7) Do I communicate courageously and clearly enough to the decision makers that I have access to?

We cannot leave it to ‘others’ to do it. **All members of the IRSE and players in the rail industry are summoned to master this task together.** There are so many fine minds in this industry: we can and will succeed, but this requires clear communication to the leaders of this industry and to governments.

Many of the topics discussed in this paper will also feature in my Presidential Programme, which will, as in previous years, again be ‘on the road’ throughout 2018-19. We are planning live streaming of the events, so that you can join from

anywhere and even participate in the discussions live. I sincerely hope you will make this idea a success by using this new service.

For me, the IRSE’s main purpose is: *To serve as the worldwide leading organisation for innovative exchange of know-how and experiences in the field of Signalling, Automation and Telecommunication at the interfaces between railways, suppliers, government and education on ‘neutral ground’.*

I am planning to devote my term as president to this. Let me finish with a citation from the Inaugural Address of president John F Kennedy, Washington, DC 20 January 1961, whose optimism impressed me greatly whilst on a visit to the JFK Museum in Dallas during the 2017 IRSE Convention:

“All this will not be finished in the first one hundred days. Nor will it be finished in the first one thousand days, ..., nor even perhaps in our lifetime on this planet. But let us begin.”

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