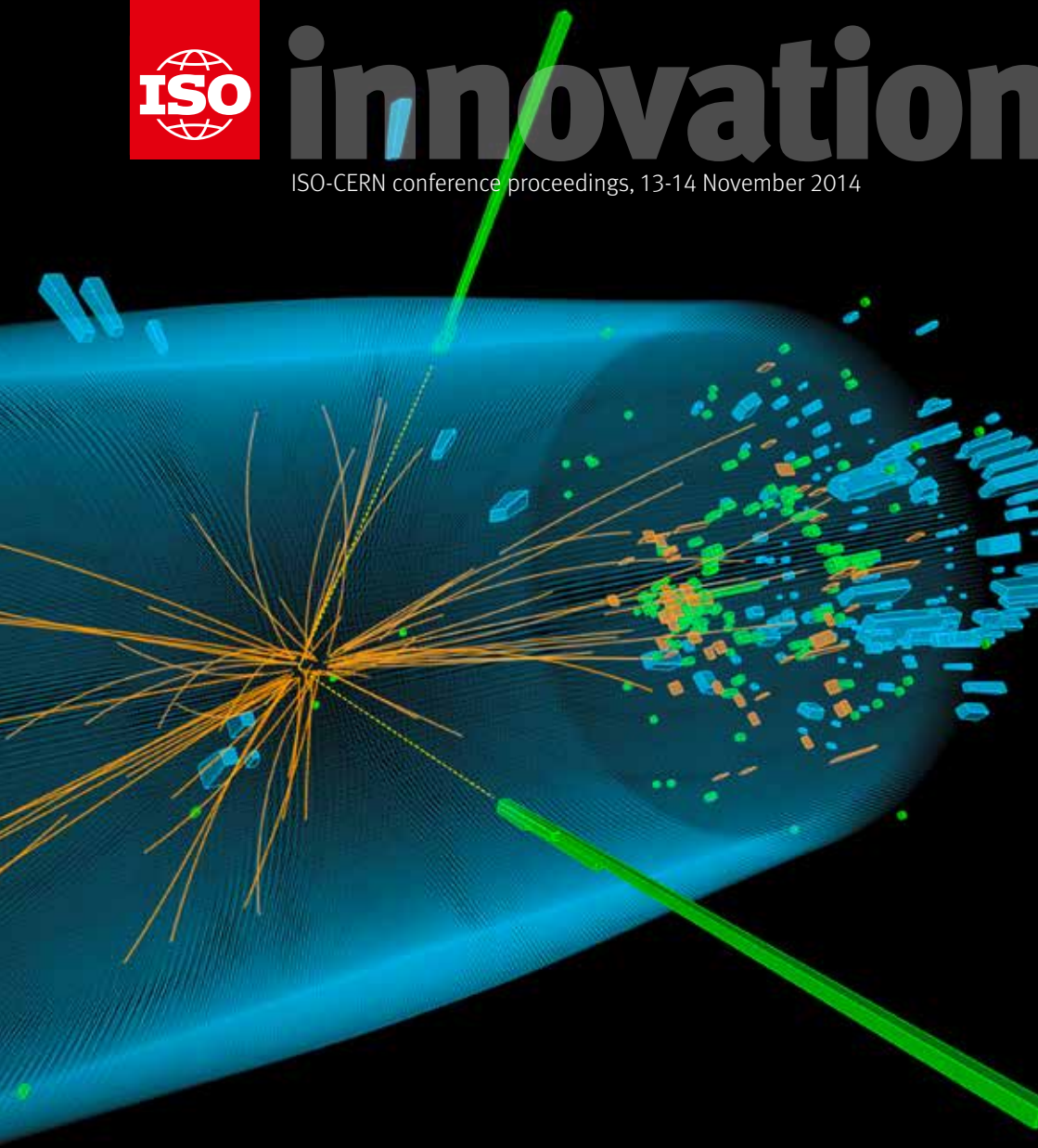
innovation

ISO-CERN conference proceedings, 13-14 November 2014



Standardization and innovation

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Foreword

Daniele Gerundino,
Director, Research and Education, International Organization for Standardization (ISO)

Innovation is defined by the Oslo Manual[1] of the Organisation for Economic Cooperation and Development (OECD) as "*the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*".

In economics, further to Schumpeter's lesson, it is now part of mainstream thinking to consider innovation as the primary engine of economic dynamic : a process of "*...industrial mutation that increasingly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one*[2]". This notion is particularly relevant in today's globalized world and knowledge-based economies, which rely ever more on intangible resources.

Not surprisingly, innovation is widely recognized as one of the essential drivers of successful business and a key contributor to the productivity and economic and social development of nations.

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1 Oslo Manual : Guidelines for Collecting and Interpreting Innovation Data (OECD, 2005).

2 Joseph Schumpeter, Capitalism, Socialism, and Democracy (1942). Schumpeter defined this process as "creative destruction" and observed that it is "the essential fact about capitalism".

Finding ways of fostering innovation is a central concern for both forward-thinking companies and governments. In many countries, there is a strong focus on public funding of research and development and on intellectual property rights (IPR) as instruments of innovation policy and business strategy.

Whilst it is clear that economic and societal benefits from research can only be achieved through their successful transfer into innovative products and processes, this critical aspect – which is where standardization contributes most – is often neglected.

A common and widely held view, on the contrary, assumes that standards and innovation are at odds with each other. But is this true? An increasing number of people, including of course standardizers, but also researchers, business leaders, entrepreneurs, academics and policy makers, believe that this is a misperception – which may have significant negative implications on innovation management and innovation policy.

Many researchers and decision makers are aware that standards actually support innovation. This happens in a number of ways, which are well documented in the literature[3] dedicated to this subject. The most important aspects can be summarized as:

- Contributing to technical evolution by applying, at the right time, critical design constraints (i.e. avoiding *re-inventing the wheel*). Standards can help to reduce wasteful, redundant product development, allowing to free up resources that can instead be dedicated to fresh, inventive work
- Facilitating the development of new markets and trade, by helping to establish and exploit network effects, increasing consumer confidence and allowing to reach critical mass
- Permitting the sharing of investments and risks associated with the development of new technologies and applications (fostering innovation through collaboration)

3 For more information, please consult the ISO repository of studies on Standards and Innovation at: www.iso.org/iso/home/about/training-technical-assistance/standards-in-education/education_innovation-list.htm.

- Helping the commercial exploitation of innovative ideas, providing a basis for the dissemination of information and an accepted framework within which patents can be drawn up, removing undue proprietary interests and barriers to trade

We, in ISO, believe that standards, and in particular International Standards, are instruments that support technological change, process improvement and technology transfer among sectors and across borders. We dedicate significant attention to practice and clarify the positive, synergistic relationship between standardization and innovation.

We address the issue primarily through the bottom-up process of standards development that, ideally, should ensure the engagement of research and development professionals, representatives from innovative companies, research institutes and academia, providing cutting edge input into the content of standards – but also through specific initiatives such as dedicated task forces, studies and events, aiming to identify and to shape innovative fields, the development of which can benefit from standardization projects.

I think it is useful to recall that one of the strategic objectives of the last *ISO Strategic Plan (2011-2015)* is : **"ISO standards promote innovation and provide solutions to address global challenges"**.

In this effort, we work with many partners, including the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU), international organizations such as the OECD, the World Trade Organization (WTO), a variety of UN agencies, research institutes, industry associations, consortia and grass-roots, research-focused organizations with interests in standardization in their specific domain.

In 2014 we had the privilege to get the support and partnership of CERN, the European Organization for Nuclear Research, which is the largest laboratory for elementary particle physics and one of the world's largest and most respected centres for scientific research.

Having been a physicist myself (my specialty was Elementary particles/Quantum field theory), I felt this experience was particularly exciting. I found it – and I hope the readers will share my view – exceptionally valuable to witness the genuine interest and engagement in standardization of an institution which deals with the absolute frontiers of science and technology and that "conventional wisdom" would consider to be as remote from the world of standards as one could imagine. You will find much more about this in this publication.

In brief, ISO and CERN decided to organize an international conference – on 13-14 November 2014 – aiming to shed light on the relationship between standardization and innovation by addressing the core issues, i.e. the role of standardization in relation to:

- Creating and disseminating technologies and opening new markets
- Supporting the business strategy of innovative companies
- Defining and implementing successful innovation policies

The first three sessions of the conference were focused on these topics. They were complemented by two other sessions – one on the field of green building, as an example for a highly innovative sector, and one on selected projects and experiences of CERN in standardization and metrology, highlighting the perspective of a leading-edge research centre. Two panel discussions completed the conference to facilitate the active engagement of all participants.

More specifically:

- **SESSION 1:** Development and dissemination of new technologies and creation of new markets is probably the most important dimension of the relationship between standardization and innovation: this was the theme addressed by session one.
- **SESSION 2:** In most cases, "conventional wisdom", in both business schools and corporate environments, focuses on how to build, exploit and protect proprietary technologies, aiming to gain competitive advantage by pursuing

a "winner takes all" strategy. How can voluntary standards, which – to a significant extent – are public goods (and therefore available to all actors in a market), be an element of successful business strategy and used to gain competitive advantage? This apparent paradox was the theme addressed by this Session.

- **SESSION 3:** As observed by Prof. Knut Blind (Technical University of Berlin), standardization is a catalyst for innovation: a facilitator for research, a channel for the transfer of technology, a possible mechanism for streamlining intellectual property management and an important component of public procurement aiming to stimulate innovation. These were the themes addressed by Session 3, focused on the role of standardization in the framework of public policies aiming to promote innovation.
- **SESSION 4:** This session was dedicated to highlighting the interplay between standardization and innovation within the sector "Green Buildings". Insights from sector experts were complemented by the presentation of the results of a research project which was supported in 2014 by ISO, in partnership with NIST and EURAMET, and conducted by researchers of Cornell and Lund Universities.
- **SESSION 5:** This session was dedicated to highlighting the role of standardization in CERN's innovation and technology transfer process. Through selected examples it was demonstrated how standardization plays a critical role in the innovation process at CERN and how this innovation can ultimately produce a positive impact on society through specific technology transfer channels.

All the themes are, per se, extremely interesting. However, what made the conference special was the exceptional profile of the speakers.

We had the privilege of having with us outstanding personalities – individuals who have been making exceptional contributions to the development and dissemination of new technologies;

leaders of organizations of different size and scope which excel in leveraging the value of standards and decision makers who have been and are actively engaged in the definition or implementation of public policies that foster innovation.

All of them have made important contributions and are committed to standardization – with the understanding that "standardization", in the context of this conference, was considered from a broad and comprehensive perspective.

We do not have enough space here to discuss "what is a standard" or "what is standardization" – I would just invite you to consider that, following a broad perspective, a codified sanitary protocol of the World Health Organization (WHO) supporting the worldwide dissemination of a simple but formidable invention (the hydroalcoholic gel used to clean hands in hospitals, invented by Prof. Pittet in Geneva) is a "standard"; that "standards" are the deliverables issued by the grass-root organization W3C (World Wide Web Consortium) founded by the inventor of the World Wide Web, Tim Berners-Lee, as well as, of course, the suite of ISO/IEC documents developed by the MPEG group of Leonardo Chiariglione (aka ISO/IEC JTC 1/SC 29/WG 11).

The idea of publishing, as conference proceedings, the transcripts of the remarkable stories shared by the conference speakers, was one of the final recommendations from the participants, who considered it would be useful and important to complement the electronic records of the conference (videos of all sessions and the presentations in pdf format are available here: **www.iso.org/sites/standardsinnovationconference/programme.html**). In this respect, I would like to point out that, for easy reference and consistency, we have left the original numbering of the slides used by the speakers within the transcripts – this means that within the texts, you can find e.g. "Slide 5" as the first slide referenced, followed, say, by "Slide 14" and so on.

ISO has been happy to follow up and we hope that this publication will contribute to improving the understanding of the relationship between standardization and innovation.

Although readers will have to reach their own conclusions, I would like to spend a few more words on some of the lessons learnt through the conference, which, at least for ISO, can be taken as recommendations for future actions.

A first recommendation is certainly to dedicate more energy and focused efforts to the topic. We need to do more to capture information about positive examples and success stories of how standards support innovation, and to communicate them to the interested public.

A second recommendation concerns how to use examples of excellence in the relationship between standardization and innovation – demonstrated in specific fields and/or by the experience of particular technical committees – as a basis for identifying and promoting best practices, through the ISO system, in linking standards development work with research and development. We can consider various possible activities – the most important aspect is to engage some of the most successful standards groups (of ISO or other organizations) to stimulate a dialogue among them and to identify if and how some of the specific conditions for their success could be replicated in other areas.

A third recommendation concerns the need for more focused research dedicated to priority sectors and emerging technologies prior to the start of standards development, in order to clarify issues of potential interest for standardization and identify key players and their views – of course, by leveraging existing knowledge among ISO members and stakeholders.

Last but not least, we need to strengthen the dialogue between ISO and CERN, with a view to expanding the engagement of CERN in standardization activities (within ISO or other bodies). A number of interesting and important areas were identified at the conference (see more under Session 5). The idea would be to effectively leverage CERN's knowledge in highly specialized areas as a catalyst for aggregating expert knowledge from various organizations at the forefront of research (public research labs, as well as R&D groups within high-tech private companies, e.g. in the aerospace, advanced materials and many other sectors), with

a view to linking them to existing standards groups (or creating new ones), and to consider standards that would cater for the specific needs of advanced users.

I would like to close this foreword by expressing ISO's and my personal deep gratitude to CERN, and to all senior managers and professionals of CERN who participated in the conference. CERN has not only been an invaluable partner in organizing the conference and enriching its content, it also hosted the conference in its prestigious Auditorium, something highly appreciated by the conference participants.

I also wish to thank all the speakers and panellists who have contributed to the conference and to this publication, as well as to the ISO team involved in this initiative. Finally, special thanks to my former personal assistant Jennifer Read Grosfort, for her dedication, support and essential work in transcribing the conference speeches.

Daniele Gerundino, *Director, Research and Education, ISO*

Session 1

Creating and disseminating technologies, opening new markets

Chair's remarks

Chair: Piet-Hein Daverveldt,
Managing Director of the Netherlands Standardization Institute (NEN)

As a former high-energy physicist, I am thrilled to be at CERN and chair the first session on creating and disseminating technologies and opening new markets.

CERN is for me a hotbed of innovation. Whether you talk about construction, electrotechnical, vacuum or computing technology, the challenges addressed here really force innovative solutions. Some of them are very specialized such as the neutrino horn invented by the late Simon van der Meer; others such as the World Wide Web or imaging technology are affecting the lives of billions.

This conference is very timely. Whilst the importance of innovation to boost economic growth, create jobs and address society's grand challenges is very well understood, the role that standards

can play as a bridge to successful innovation is much less understood. Indeed, some people even think that standards might actually hinder innovation. Standards for me are nothing more than the consensus opinion of what is good practice. Standards, I think, play a key role in facilitating the market potential of innovative ideas. Standards set the frameworks needed to unleash creativity and force choices. Without standardization, I believe that innovation slows down because legacy systems survive longer. But the most important benefit of standards is that they contribute to the dissemination of knowledge so that others can build on them and improve them further without having to reinvent the wheel.

If this is true and backed by academic research, why is it that the role of standards to create scale and market acceptance is so often overlooked ? In my view, what is lacking are showcases by practitioners that can be appreciated by senior decision makers and policy makers in the Boardroom. I believe that the worlds of business, research, public authorities and standardization need to be strongly hooked up so that standards are not considered as aims in themselves, but for what they really are : strategic instruments to make innovations truly impactful.

Today, I'm very happy that we have a fantastic line-up of eminent speakers who will present to us their showcases in their own fields. Therefore, it is a real pleasure to introduce our first two speakers : Sergio Bertolucci and Ben Segal.

Speech 1.1 Using standards to go beyond the standard model

Sergio Bertolucci,
Director for Research and Scientific Computing at CERN

I would like to convince you that we are using standards. We are in a sort of schizophrenic situation here because, even if we physicists do not like standards, we cannot manage without them.

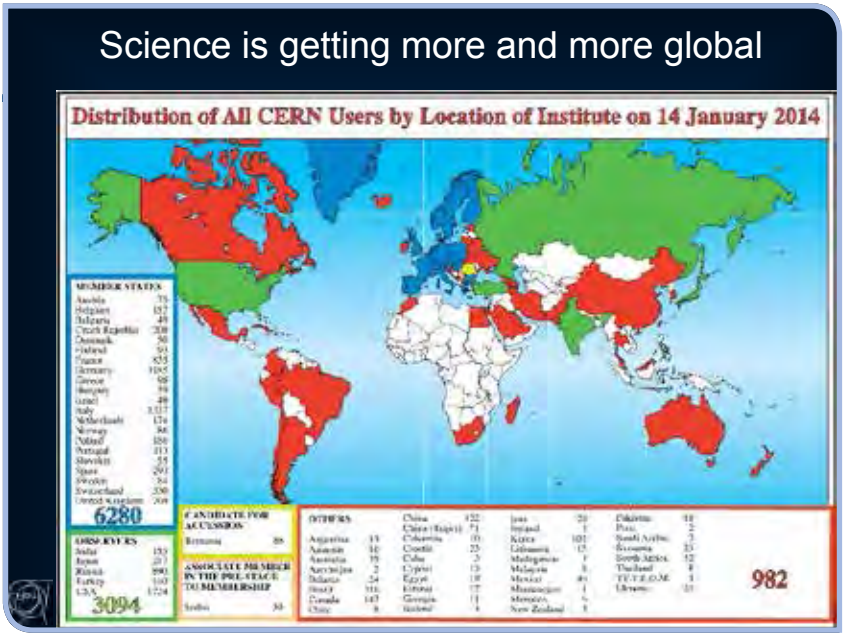
The triangle in Slide 2 shows what CERN is doing : innovation, education, research.

SLIDE 2

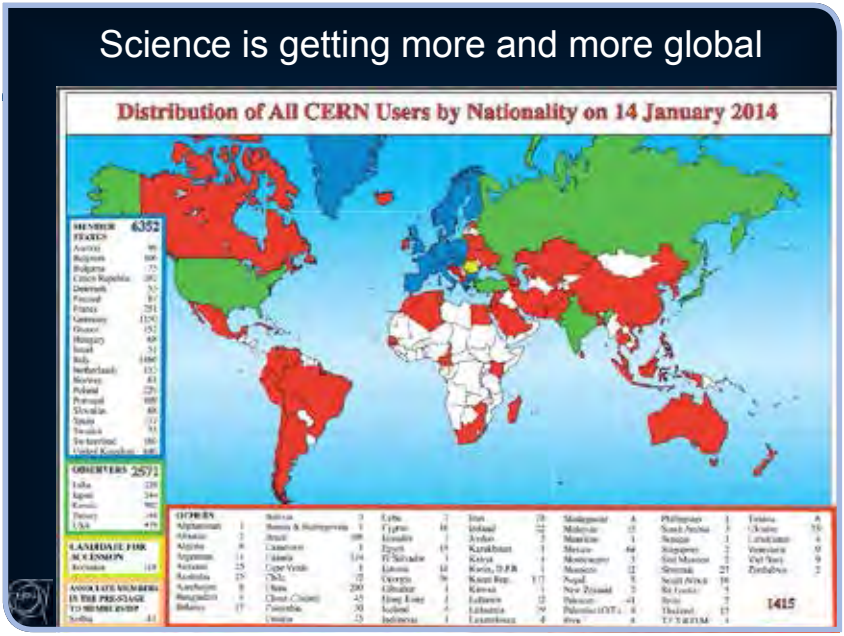
We try to spread our knowledge about the simplest part of nature, the physical part. In order to do that we need to push forward the frontiers of knowledge. Sometimes we are missing the technology we need, or it is too expensive, but in either case we have to be inventive. Obviously, the triangle does not stay together without the principle motor of sustainable research which is the brain of young people. Consequently, CERN trains hundreds of physicists and engineers every year. The dimension of the field is such and the research so fundamental that it overcomes national pride. Our work goes across culture and nationality and there are currently over a hundred different nationals working here at CERN.

CERN was founded over 60 years ago – 60 years, one month and a few days in fact – and was the fruit of an extremely visionary perception of Europe. Just after World War II, when Europe was split between countries that had tried to destroy each other, a group of scientists, who thought that the best way to put Europe back together again would be through science, founded a provisional body. Later, in 1954, under the auspices of UNESCO, this body led to the founding of CERN, then composed of 12 member countries. Today, it has 21 member countries and a budget of around 1 billion Swiss francs paid by the member states in proportion to their GDP.

Slide 4 shows the distribution of CERN collaborators according to the location of their institute and Slide 5 shows the distribution of collaborators by nationality.



SLIDE 4



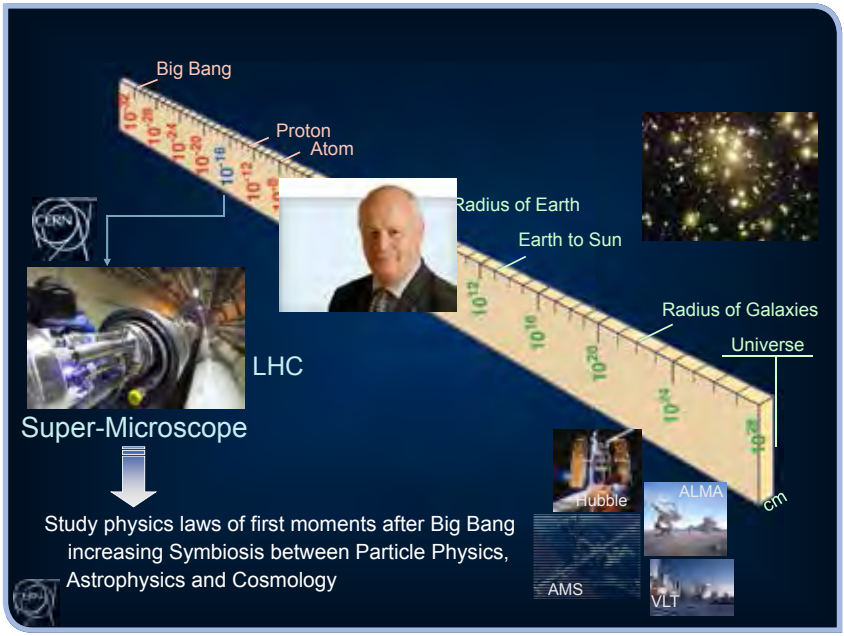
SLIDE 5

By the way, it looks as if CERN is the biggest US laboratory, because the biggest community of researchers is from the US. As you can see, there are over a hundred nationalities and you will understand that, in such an environment, standards play a fundamental role.

The primary standard that we use is not so apparent, but one should bear in mind that fundamental science is one of the simplest ways in which mankind has succeeded in organizing itself. Called "scientific method", it is based on very few rules and was standardized a few hundred years ago. It is simple, fully shared by the scientific community and very much adhered to. From this perspective, we are essentially a simple and highly standardized community. Secondly, we are forced to standardize in a very peculiar way because we have to explore the dichotomy which is there. Science is intrinsically non-democratic because one cannot vote to decide who is right. You just have to exercise it in such a way so that the one person with the right idea in this room can convince all the others, not by vote but through a methodology, a standard procedure that is right.

We would just like to understand how the universe behaved when it was very very young. It was born about 14 billion years ago out of the Big Bang, a fluctuation of the vacuum, a moment in which potential energy transformed itself into kinetic energy and matter, everything which is around us, and more. And it has expanded since to a dimension of 9×10^{28} cm. Again, I am a physicist, I don't use standard units... although I know the conversion – it is 9×10^{26} m...

Anyhow, the reason we would like to understand how the universe was behaving when it was very very young is not just because we are curious, but for another simple reason. When it was younger, the universe showed fundamental symmetry in a much simpler way because it had had less time to exploit small non-conformities and asymmetries.



SLIDE 8

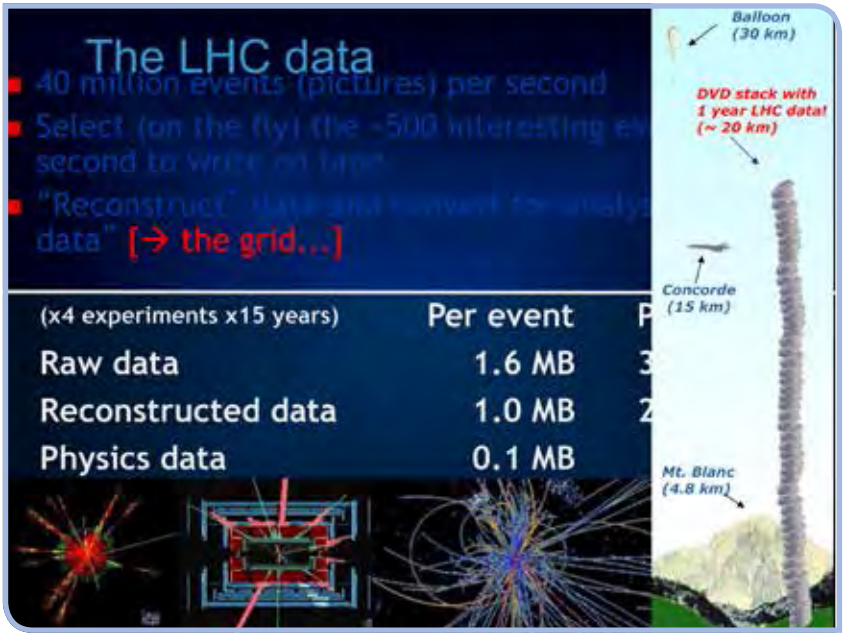
The logarithmic ruler in Slide 8 shows at one end the dimension of the Planck scale (at which the fluctuation of vacuum occurs and quantum gravity and quantum theory come together) and, at the other end, the dimension of the universe as it is today. We are more or less in the centre of this scale but let me, for a day, put at the centre of the universe the ISO Secretary-General, well... for a day.

There are two ways in which one can explore the past, the origin. One way is to look at distant objects. If you look at the galaxy which is one billion light years away (information moves at high speed but still at a finite speed), you're looking at the universe as it was one billion years ago ; and the further you look, the more backward you go in time. It approaches a limit too, because when you arrive at a point located about 380 000 years after the beginning of the universe – beginning of time and space, not only of the universe – the universe was so hot that all that was admitted was a plasma of photons, electrons and protons : radiation could not escape and the universe was completely " opaque ". We cannot see anything beyond that wall.

We used to study with a lot of interest what was on this side of the wall, the cosmic microwave background [380 000 years after the Big Bang, radiation could escape in every direction and we can observe this leftover of the Big Bang]. However, if you want to go beyond that, what you have to do is to make a small Big Bang. A particle of high energy is a wave of very short wavelength and by accelerating particles and smashing them one against the other, you create, in a very small volume and for a tiny amount of time, conditions very near to the Big Bang.

With the LHC (Large Hadron Collider), we start seeing how the universe was one thousandth of a billionth of a second after the Big Bang. However, the most interesting things happened either just at that time or before, actually most of them before, so we should build something bigger...

So, what do we have now ? What is our standard model (see Slide 13) ?



SLIDE 13

Nowadays, it is a simple description which is correct from the point of view of quantum mechanics and the special theory of relativity which says that, in order to build all the world around us (the stars, the planets, ourselves), you need a few components : six quarks, six leptons and a few messengers which are transmitting forces. This is a beautiful and very elegant thing, which explains everything from chemistry to how the atomic nuclei stay together, how the sun works, how super novae explode and so on.

However, there are some problems in this picture, i.e. all these particles should have zero mass. If mass were not there, we would also not be here at this conference because, in order to make an atom, you need mass. So, in theory, an embedded mechanism was predicting that, at a certain point in time in the universe, something happened to give mass to the particles. That's why the Higgs boson is important. And it happened like that in this narrative.

At the beginning of the universe, all the particles were massless because there was a field permeating all the universe. The energy was zero so the field was not effective. Then, when the universe started expanding, about one hundred of a billionth of a second after the Big Bang, it went through a phased transition. Just as with cooling water, which at some point becomes ice, the field moved to a negative value so the universe was sitting, rotating in three dimensions like a sombrero hat and then it collapsed into the next minimum spontaneously. It could have chosen any direction and, by doing that, all the particles started interacting with this field which was permeating all the universe – the nice thing is that this field, the Higgs field, is still around us now. By interacting, depending on how strong the interaction is, the particles acquired more or less mass and the Higgs boson is the component of this field, the quantum of this field. That's why the discovery of the Higgs boson was important. It was not just another particle, it was the key element to either prove or falsify this theory.

In order to do just that, we had to build 27 km of a very sophisticated technology, a 27 km superconducting magnet kept at 1.9 K because we had to circulate super fluid helium with a vacuum

– which is an order of magnitude better than the vacuum that you'll find in outer space – with an energy stored in the beam that is equal to the energy of a large 50 000 tonne container ship going at 20 knots. So you cannot just fool around with a beam like that. The control system, in fact everything, has to be of incredibly high quality which requires incredibly high standards. As I told you, the machine is the microscope and the microscope is most useless unless you put around it eyes and the experiment – the apparatuses are eyes.

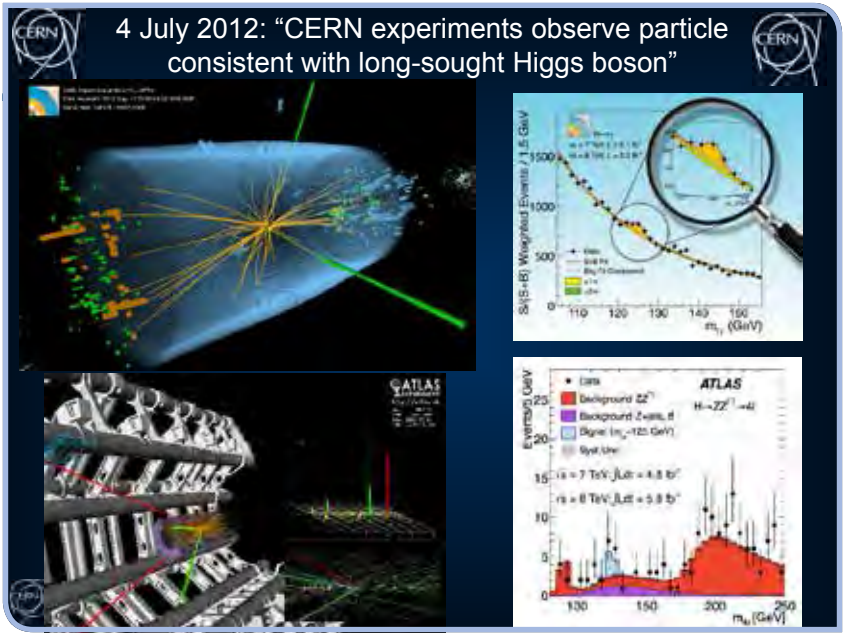
Eyes are digital cameras. This is a bit exaggerated because they are at least 25 m tall, 50 m long, with 100 million electronic channels. Not only do they need to be big, they need to be big and precise because the position of every single one of these 100 million channels is known to a tenth of a millimetre when it's not very precise – or to one 100th of a millimetre for most of them. So you can imagine that with a system like that, it's not that you put it there one day and it stays there forever ; you have to have a system that continuously tells you where things are.

This gigantic camera, a 100 mega pixel camera, should also be capable of taking 40 million pictures a second and not only that. In that same second they have to look at the 40 million pictures and choose the thousand that we can afford to store in a place for interesting physics. In doing this very large selection, we produce 30 PetaBytes of data a year which, if put on DVD, will give you a nice pile of DVDs four times as high as the Mont-Blanc. And, knowing my colleagues, at the end of the year everyone will want the first one at the bottom.

So, we just had to invent something that was different and something different was an evolution of the Web which was using about half a million CPUs around the world, a single coherent system called the Grid, a precursor of the Cloud. In order to do that, again you have to exploit standards, standards and standards. Otherwise you will never be capable of achieving a coherent wave. If today or tomorrow, you walk to the computing centre or if you look on Google, you will see that at this moment

there are probably 130 000 jobs running around in the world – we will talk about it later.

All that for these small bumps (see Slide 15) which, by the way, have a statistical significance greater than 5 standard deviations, but the story is a bit more complicated because it takes time.



SLIDE 15

It takes time because you start acquiring data, you start selecting, you produce one Higgs boson every hundred-thousand billion collisions. You have to pick it up very carefully. But when you get there, especially if you get there with two experiments, and you know the probability of fooling yourself is less than one part in 30 billion (5 standard deviations), then you declare your discovery.

To sum up, standards in this field are used in three ways. We implement standards because they are a key enabler of the globalization of the field. At the same time, we are evangelists of standardization because we’re using it with all the entities with which we work, in the industries and so on. At the same time,

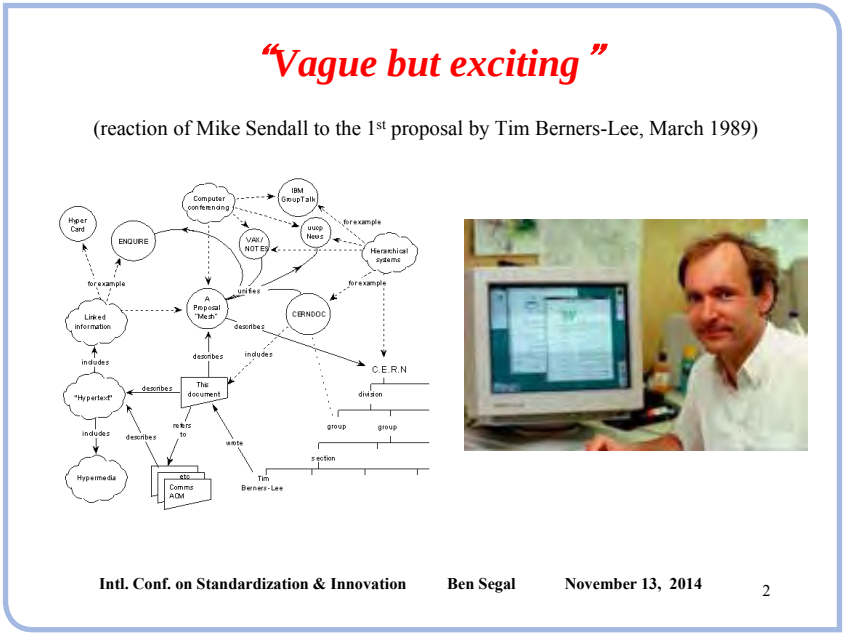
we are proud to be a producer of standards and we tend – being fundamentally researchers paid by your taxpayer's money – to just enforce an open idea of standardization.

We have many success stories to tell, but we are not yet happy with what we do because we can do much more to extend this culture even further. You know, physics and this large challenge has taught us that we need standardization. Twenty years ago, a physicist was probably as far from standardization as you can imagine. Now we have become a bit wiser, helped also by our colleagues, the engineers. I am happy now to hand the floor over to Ben.

Speech 1.2 Weaving the Web

Honorary CERN staff member
Ben Segal, *[Ben coordinated the introduction of the Internet Protocols at CERN beginning in 1985 and, as a mentor of Tim Berners-Lee, supported the development of the World Wide Web in the early days (1989-91)]*

I'm going to tell you a very human story that happened here at CERN which involves standards, involves innovation and involves accidents. So, there's the young man in 1989 or so... (see Slide 2)

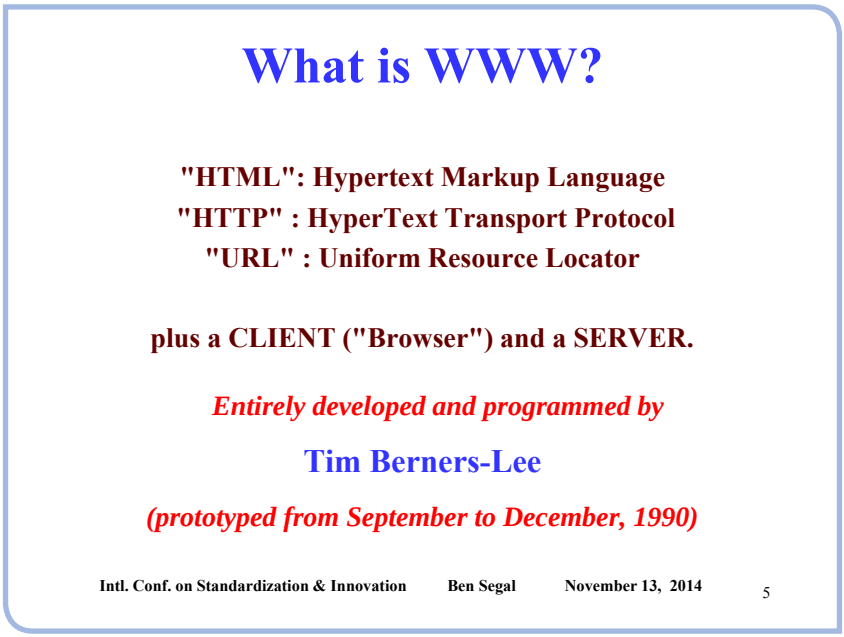


SLIDE 2

Tim Berners-Lee was a Fellow here and the diagram you see is an example of his lateral thinking. To explain that diagram to you, I would need 15 minutes, which I haven't got and I'm not going to do, but the way Tim thought was very visionary, very original

and Tim was also a very very good implementer, as we shall see. His dream was – as he used to say to me – "You know, we just have to agree on a few simple things". The main problem was that, at that time, there was no way people were going to agree on those few simple things. There were so many stakeholders. At that time, standards [*in the IT and telecommunication fields*] were mostly proprietary standards. Each company had its own operating system; each company had its own networking system; each company had its own computer architecture and there was no consensus even in the way that the bits and the bytes were ordered, or the bytes and the words were ordered. Everything was chaotic. So the dream that you should be able to connect computers all over the world with a few simple things seemed way, way far out. In fact, we did agree on a few simple things and Tim, having invented the World Wide Web (WWW), went on to found, but not at CERN, a standards organization called the World Wide Web Consortium, otherwise known as W3C. He's still there. It's still creating standards around the Web and things like XML, and so standardization is a part of his story.

What is WWW? Well, it has four main components: "HTML" – Hypertext Markup Language, "HTTP" – HyperText Transport Protocol, "URL" – a naming convention, along with a software architecture involving a client (a "browser") and a server. The idea behind this was that hypertext, a document which contains links to other documents or parts of documents, should be structured in such a way that those links should be able to ride over networks between computers. That was his idea, an idea worthy of Einstein. But to bring that idea to reality, it took extremely special capacity that this young man had. He developed all these elements that you see there entirely himself.



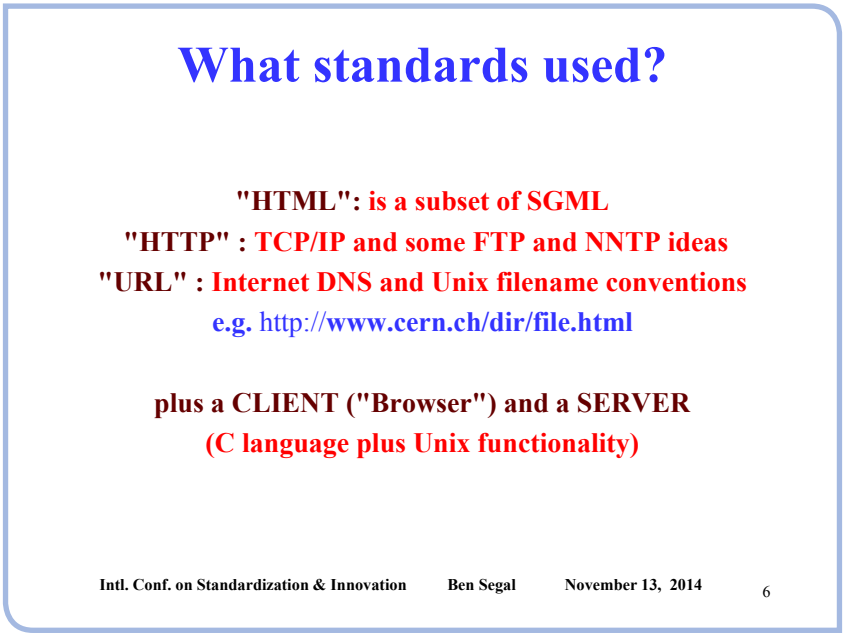
SLIDE 5

And, when he was given the right sort of machine to do it on, he programmed the prototype in three months. This was an absolutely prodigious achievement (see Slide 5).

Now what standards did he use? I should say that, at that time, there was considerable controversy around standards. I spent my time, in those years, bringing into CERN what we now know as the Internet protocols – TCP/IP and family – and back in 1984, these were not wanted at CERN. They were American, they weren't wanted in Europe. The tension between bringing in those standards, which in the end prevailed, and standards which ISO, IEC and ITU were promoting – top-down development, committee-driven standards that never converged because the time constant of that process was too long, the technology was always ahead of it – was a major tension in the 80s and 90s. The sort of standards that were winning were standards developed bottom-up by consensus, without big high-level committees, developed basically by graduate students. These were the Internet protocols. The same thing was going on in computer systems, in operating systems,

in computer languages. What emerged was something called the UNIX operating system, an open operating system written in a new language called "C" which, by the way, in 1983 when I started programming in "C", I was discouraged from doing, because it was considered to be "not a good language".

I was one of the proponents of this sort of technology (UNIX, TCP/IP, C language) and I came across Tim when he – that was his official job at CERN – was connecting all sorts of systems with what we call the remote procedure call system and we had done some research on that. This young man came and talked to us about this. Alone, he took it much further than any other person had done at CERN. I noticed him. He was a really prodigious implementer but that was his official job. On the side, he was dreaming about the Web. So he proposed the Web. The proposal was finally accepted after a year. He was given a couple of special machines to work on, which I'll mention later, and he produced the Web. So what standards did he use (see Slide 6)?

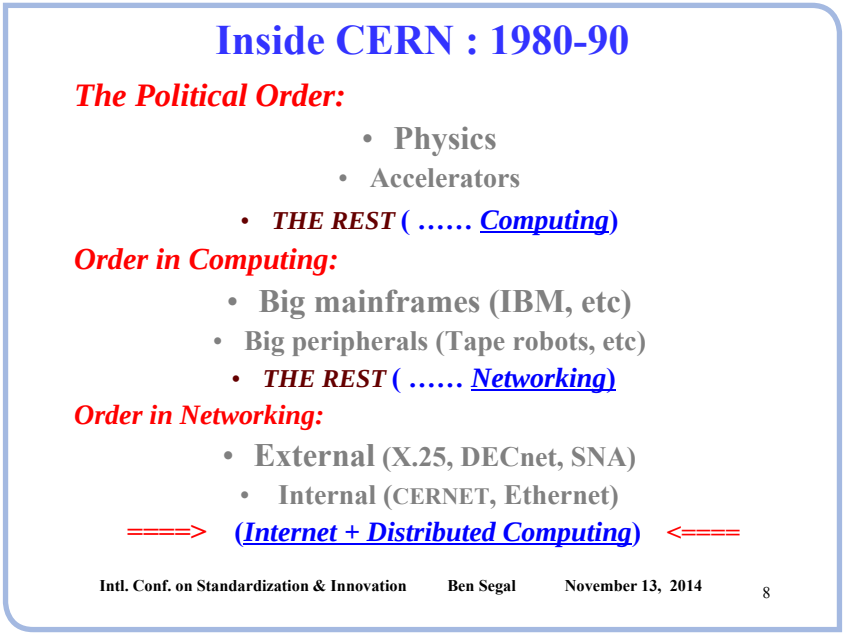


SLIDE 6

Yes, he was influenced by UNIX and its way of looking at things, and by TCP/IP, which he chose even though it was far from obvious that it was going to prevail at that time. His HTML component was the language, the thing that you have to agree on in order to put your stuff on the Web. The simple thing – you only have to write your text in HTML – is a subset of a standard called SGML which I believe was an ISO standard. HTTP is the transport protocol that allows you to ask for and provide data in this system. It actually rides on TCP/IP and it had some ideas in it like what we call "get and put" from Internet FTP (File Transfer Protocol) and a protocol called NNTP (Network News Transfer Protocol), which I actually recommended he should look at.

And then there was the URL, a very interesting case, the naming convention. How do you name the objects on the Web? There used to be international conferences all over the world on naming; naming was a big deal in the computer science business. The British liked to have the names in one order just as they drive on, you know, the left-hand side, the other people not, and so on! And, by the way, there wasn't even any consensus on the data representation, on the character coding. Today, we all use something called ASCII or extended ASCII. In those days, that was far from established. IBM used EBCDIC. Control Data used 6-bit character-codes so the amount of chaos at this time, as can be imagined, was incredible. There were very few standards and there was this tension. So what did he do to name it? He took the Internet domain system. This is the Internet domain that is so very familiar to us today. That was already a courageous choice and he took the UNIX file name convention of slashes. This means "Go to this machine here, look in this directory, then in this sub-part and finally you'll find a file". This I won't go into further. We all know what a browser is now, and a server. For that, he used C language and UNIX functionality that were clearly based on standards, but these were the sorts of emerging standards, bottom-up standards, which were present in the research community but were not yet in the international realm, if you like.

Let me spend a word on the background. I'm not going to skip this because I think it needs to be mentioned that this whole thing was an accident. It was a spare-time project by a guy with a vision and amazing implementation potential. CERN is very proud today to say that the Web was invented at CERN, which is true. But CERN didn't order the Web. I'm just going to give you the background to this because it's a beautiful story. He had the vision and perseverance. He had the implementation skills. He could make wonderful choices but he was not in an ideal place. He was in a place that permitted him to do what he did, but CERN didn't order it and didn't particularly encourage him. This is what the political order was like in CERN in 1980-90 (see Slide 8).



SLIDE 8

It was like this, and still is to some extent, by the way. The top of the pile is physics and accelerators. That's where the big money and power are in CERN. Computing is one of the (relatively) low-level things at CERN. Then what was the order in computing? There was a hierarchy, with big mainframes, big peripherals or

expensive stuff at the top, and then the rest. Networking was with the rest. Then comes the order in networking. There was external networking – all proprietary stuff except for X.25. Then internal networking : Ethernet and CERNET, a home-made network. Internet and distributed computing were at the bottom so, at the bottom of the bottom, that's where the Web came out of.

So what was needed ? Tim's manager was a wonderful guy called Mike Sendall, who unfortunately passed away over 10 years ago, too young. He was a senior guy in CERN and he was the one that wrote on the first proposal made by Tim " Vague but exciting ". He encouraged him, he gave him time, gave him NexT machines that he needed and basically supported him. CERN has always had this " hands-on " spirit and pragmatism. Internet technology was a vital component. It was just being accepted at CERN. This was after five years of my work with a few people. CERN had just realized that we had to have the Internet here at CERN. I'd been allowed to install Internet protocols inside CERN but I was specifically forbidden to run the Internet outside CERN.

Now, I need to mention the open-source movement. Tim was very aware of the open-source movement. This is where he got the support that was not available at CERN when he needed to extend the Web beyond the NexT machine. This was Steve Job's new machine after he had left Apple, which happened to have some features that really helped Tim start his project quickly. The whole underground spirit of the project, in that he had just enough space, was an advantage. It's an essential part of innovation as we'll see at the end. And, finally, he had to keep it simple, so, for instance, he was criticized by the hypertext people because his hypertext system allowed for broken links, and they hated broken links, but in order for it to scale to a worldwide system, it had to allow for broken links.

In summary, the Web was accidentally created at CERN from its weakest part, using underground resources... but that helped in retrospect. I don't know if you've heard of the book by Nicholas Taleb called *The Black Swan*. The Web was a black swan. It came from nowhere, it couldn't have been foreseen. " History does not

crawl, it jumps" (Taleb). These are all black swans: the Web, Google, and Facebook. By the way, the Google search engine was not part of Tim's Web concept; it was a missing element.

This is how the future looks.

SLIDE 13

What we can do is only prepare the ground (see Slide 13). My message to you is this: How do we encourage innovation? Try to reveal and mentor innovative talent that we see in our organizations; leverage existing code and standards, absolutely; encourage interaction with people outside the organization; make space, just enough space for these innovative projects; allow personal research time, if you're a research organization – Google allows its employees to spend 20% of their time doing their own thing – and be humble, be humble.

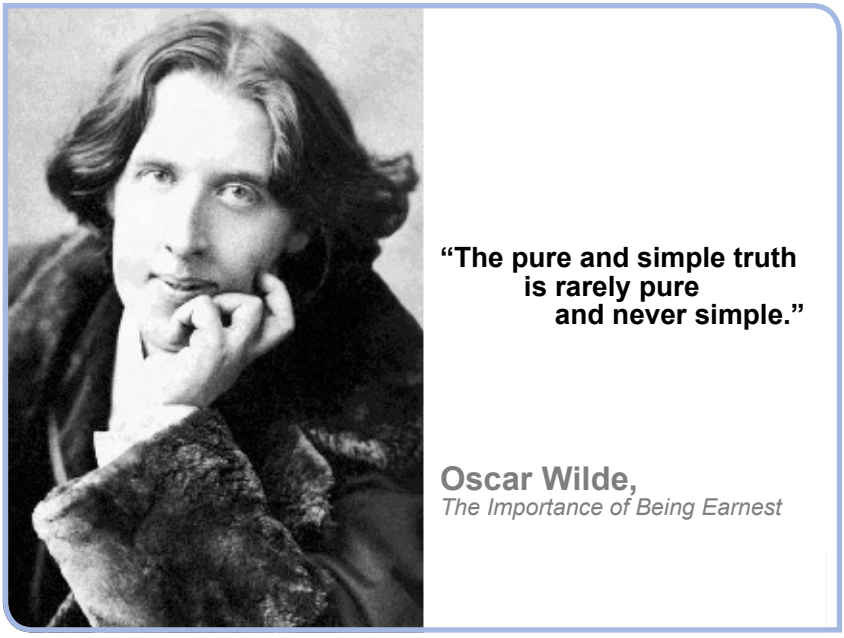
So that's the end of my talk. I want to give credit to two managers: Tim's manager, Mike Sendall, and my own manager, Les Robertson, without whom a lot of this stuff would never have happened. Thank you.

Speech 1.3 Clean care is safer care

Didier Pittet,
Director, Infection Control Programme, University of Geneva Hospitals and Faculty of Medicine ; External Programme Lead, WHO First Global Patient Safety Challenge

I am very happy to be standing here before physicists and engineers. I guess I will look like somebody coming from another planet!

Every one of us has been or will one day be a hospital patient, right ? Now, what do you expect from hospitals ? As a patient, you expect them to leave you in a better shape than when you were admitted. Unfortunately, this is not always the case. As Oscar Wilde would say, the pure and simple truth is rarely pure and never simple (see Slide 2).



SLIDE 2

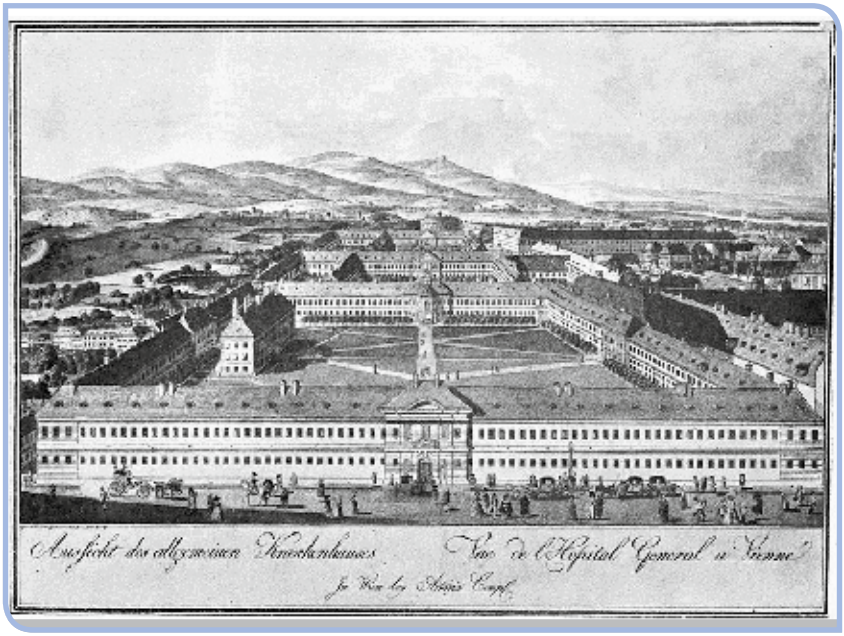
Once you get into hospital, efficient care is complicated. It can go wrong and, actually, you can get harmed by what is done in a hospital. Hospital infections occur very often. Every day, at least half a million patients catch infections while seeking care and that was of course not the reason for which they went to hospital.

Every year, sixteen million patients die of hospital-acquired infections. In the US alone, at least 200 000 deaths occur each year, the equivalent of a 747 airliner crashing every day or a death every three minutes. In our developed countries, this is the second largest cause of death and the risk is even 20 times higher in the rest of the world. So, as you will understand, these are very real complications for very modern hospitals, and even more so for the very modest one that you can see at the bottom of Slide 6.

SLIDE 6

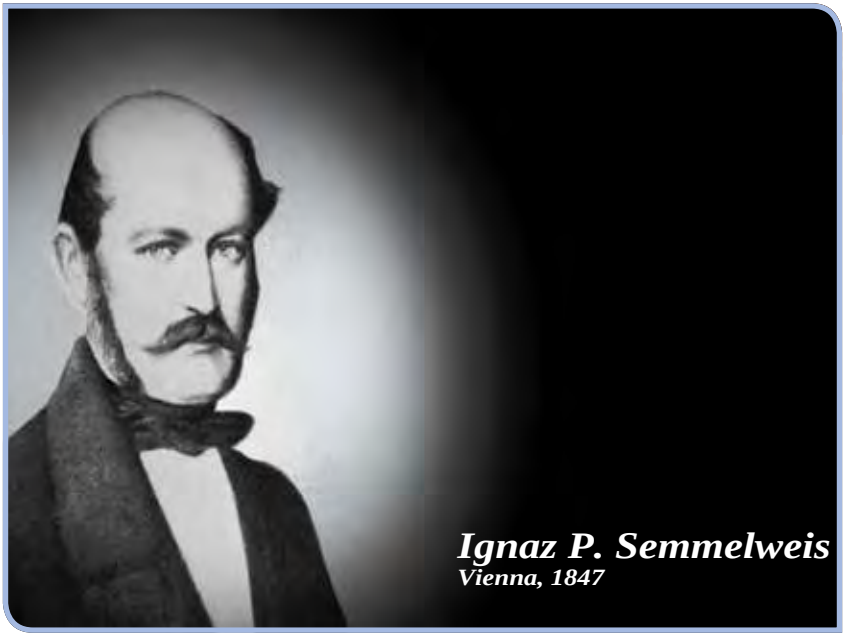
But there is no hospital, no country, and no healthcare system in the world that can claim to have solved the problem. Now this is not new. Let's go back in history.

We are in 1815, in Vienna.



SLIDE 8

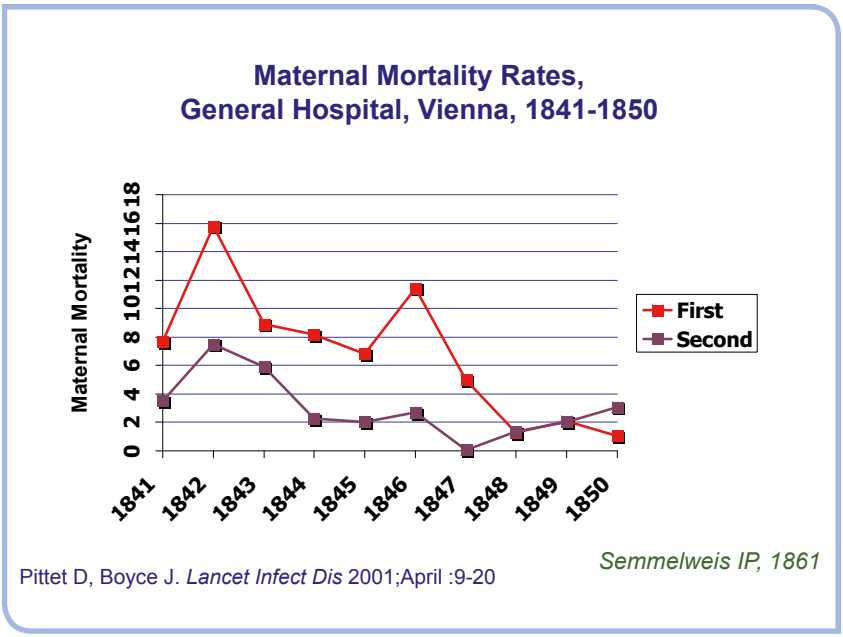
At the time, this hospital (see Slide 8) was the best place in which to learn medicine. Now, at the time, hospital delivery was the equivalent of a death sentence for a woman in labour. Up to 40 % of women would die during childbirth at the hospital. The disease was very well known but not its cause. It was believed that poisoned air would kill women in the room. There was, however, one man who didn't believe that and he began to understand by looking at the data of the hospital where there was some "sort of standardization". This man was Ignaz Philipp Semmelweis (see Slide 9).



SLIDE 9

He realized that, probably, at the time Pasteur had not discovered anything about microbiology, the hands of healthcare workers were carrying the disease. So he asked and enforced the first standardization, but we will see that this was a failure.

He instructed doctors and medical students to clean their hands while they were taking care of women between the time they were actually performing the autopsy on the woman who had died from childbirth and performing the delivery on the woman who was giving birth. Of course, today we all understand that, without cleaning their hands between these two operations, they were actually cross-transmitting the disease. But at the time it was not understood. Now, here is the result.

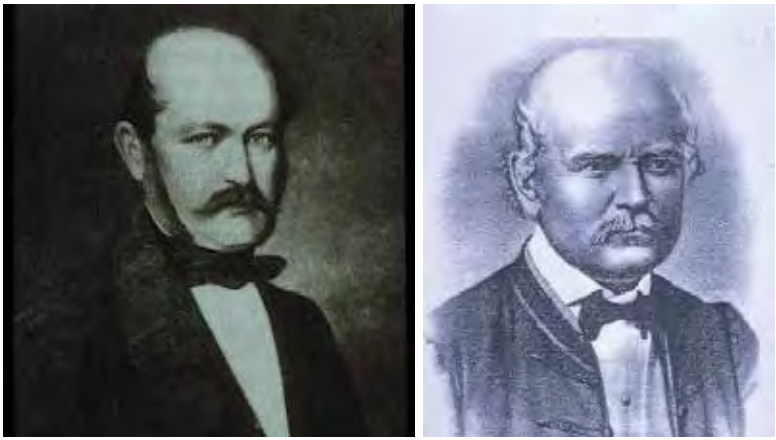


SLIDE 11

As shown in Slide 11, Semmelweis achieved a dramatic drop in maternity mortality in this hospital in Vienna and should have been a hero of his time, right? But unfortunately, when he presented the data in front of the faculty members in Vienna – these are the faculty members, all the professors, and Semmelweis is not among them – they didn't believe him (see Slide 12).

SLIDE 12

Not only that, Semmelweis was actually fired. He lost his job! Of Hungarian origin, he went to Budapest where he made the same observation ; the same intervention achieved the same magnificent impact, but again he lost his job. He actually ended his life in an asylum for sick people, taken there by his wife and his best friend.



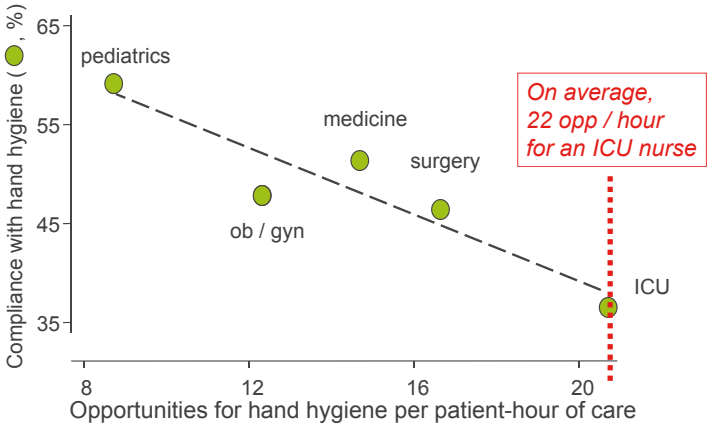
Ignaz Philipp Semmelweis before and after he insisted that students and doctors clean their hands with a chlorine solution between each patient

SLIDE 13

This is a picture of Semmelweis, taken two years before he ordered a chlorine-based antiseptic solution to be applied on hands and two-and-a-half years after, now a broken man. As you can see, he looks like he aged ten years between the two pictures (see Slide 13).

Now you understand that hand hygiene is the way to prevent healthcare-associated infections, hospital infections. The problem is that healthcare workers' compliance with this practice was very very low, around 40 % only. Why ? That's the question we asked ourselves, together with my team, 20 years ago at the University of Geneva. To understand, we went into all the wards, day, night, on week days and weekends, and observed the practices of the hospital. And guess what we found ? This is summarized on the only scientific slide that I will show you. In contrast to what physicians usually do, this is a very simple slide (see Slide 16).

Relation between opportunities for hand hygiene for nurses and compliance across hospital wards



adapted from Pittet D et al. *Annals Intern Med* 1999; 130:126

SLIDE 16

On the horizontal axis, you see the number of times a nurse should clean his or her hands per hour of patient care. On the vertical axis, you see the compliance with the procedures. As you can see, it's easy to understand why the practice of hand cleaning was so low when you went to the medical care unit. A nurse in the Intensive Care Unit (ICU) should, on average, clean his or her hands 22 times per hour and that's only an average of a very large number. At that time, the standard was to wash your hands with soap and water. Now just imagine, here is the patient, here is the sink, if you allow me. I'm leaving the patient to go to the sink, I'm turning on the water, rubbing on the soap, washing and then drying my hands. This procedure would take between 1 and 1.5 minutes. Now think about it : 22 times 1 to 1.5 minutes to wash your hands. It means that a nurse in the ICU should spend over 30 minutes per hour just washing hands, which is totally impossible. We needed something else. We needed a solution, a substance, to change the behaviour, and this substance was alcohol. So at that time, we got our act together : " 20 seconds ".

The solution could be made immediately available at the point of care. We could use it at the bedside even while talking. We said "let's change the system" and that's what we did.

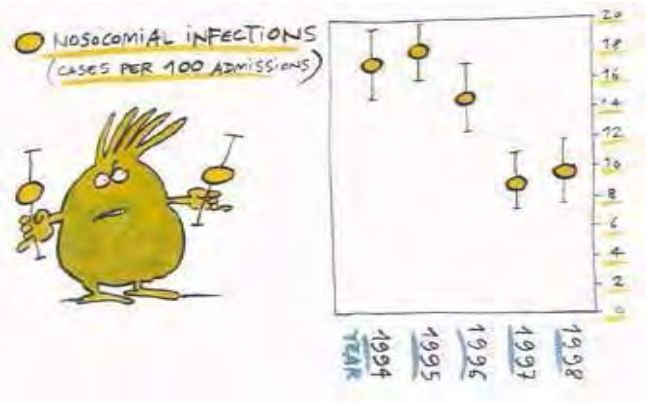
Twenty years ago, we said soap and water handwashing was to be considered an action of the past. The alcohol-based handrub should become the new standard of care. This meant implementing system change. At that time, I said "OK, let's do it!" One would think that giving an alcohol-based handrub bottle like this to each of our healthcare workers would be OK (see Slide 19).

SLIDE 19

We would take it out of our white gown and say "please use it". Now, would this make a difference according to you? Actually, no. Now let's take another very simple example of your daily life. Does the fact that your car is equipped with a seat belt make you fasten your seat belt, honestly? It does not. Well, you need awareness-raising campaigns, police controls and some of us need to be reprimanded before we change our strategy, which is what we did at the University of Geneva. Not only did we give the

alcohol-based handrub bottle but we taught people how to use it. We used posters on the walls of the hospital to change behaviour. We monitored the practice and fed back the performance of the healthcare workers to get them to change their performance. We developed a "climate of safety" around hand hygiene. This is what we obtained.

Hospital-wide nosocomial infections; trends 1994-1998



www.hopisafe.ch

Pittet D et al, *Lancet* 2000; 356: 1307-1312

SLIDE 24

In three years, we reduced healthcare-associated infection rates by 50 % in our institution, saving hundreds of lives and saving our hospital large costs, around 24 million Swiss francs (see Slide 24).

Well, of course we published, "publish or perish" is the same proposition as it is for physicists, right? We published in *The Lancet* in 2000. Alcohol-based hand cleaning was then used in single hospitals and in several hospitals in Switzerland. Then the UK embarked on the campaign on a national scale. The World Health Organization (WHO) asked whether we could imagine a strategy to make the campaign universal, so we launched

a strategy at WHO headquarters here in Geneva on 13 October 2005. We actually asked ministries of health to sign pledges to embark on the campaign. Today, 170 member states of the United Nations are part of the campaign and many many hospitals are participating.

To educate people, we developed a tool that is "My five moments for hand hygiene". You have only five moments during patient care whereby you should actually clean your hands and this is what we developed and made universal. Of course, we translated the strategy.

SLIDE 30

I cannot tell you whether this is correct in Arabic, I don't know Arabic, but it has been translated by friends who are experts in the field (see Slide 30). We actually have two main posters that are now used all over the world (see Slide 31).

SLIDE 31

"My five moments for hand hygiene", when do I have to clean my hands and how to do it.

These are new procedures that are standardized and, as you can see on Slide 32, it has been used also in this very modest site in Ethiopia.

SLIDE 32

Local clinic in Turmi, Ethiopia
The Hamlin Fistula Hospital in Addis

SLIDE 33

In very very remote places around the world, you recognize our posters that have been adapted (see Slide 33). One of the messages to make people adopt the strategy is that, even if you give them a strategy, you should let them adapt it. Nowadays, some of the most famous journals in our field of medicine and union of medicine let us reproduce freely articles on hand hygiene (see Slide 34).

VIDEOS IN CLINICAL MEDICINE

Hand Hygiene

FREE AVAILABLE at http://www.nejm.org/doi/full/10.1056/NEJMvcm0903599

OVERVIEW

Health-care–associated infections are a threat to patient safety and the most common adverse events resulting from a stay in the hospital.[1] Approximately 5 to 10% of hospitalized patients in the developed world acquire such infections, and the burden of disease is even higher in developing countries. Proper use of hand hygiene is a critical in the prevention of these infections, but compliance among health care workers is most often below 40%.

Hand hygiene serves many purposes in the health care setting.[1] It prevents both endogenous and exogenous infections in patients, contamination of the hospital environment with potential pathogens, and cross-transmission of microorganisms between patients. When used in conjunction with the appropriate protective equipment, it also protects health care workers from the hazards of occupational infections.

EQUIPMENT

Essential equipment for the performance of adequate hand hygiene includes an alcohol-based hand-rub formulation, or soap, water, and drying agents such as disposable paper or cloth towels. Alcohol-based hand rubs with optimal antimicrobial

SLIDE 34

You should not have to pay for being taught about hand hygiene. You will find it on the WHO Website – another way to standardize (see Slide 35).

SLIDE 35

What is the evidence of success all around the world? At WHO, when you start to develop guidelines that are evidence-based, you need to validate them and that's what we did between 2006 and 2008, using all available instruments to ensure that this validation process could work – using pilot sites and complementary sites all over the world. We tested the strategy from very modern hospital settings to settings with very limited resources in a very multicultural environment.

An example of the multicultural aspect of this strategy is shown here (see Slide 41).

SLIDE 41

We launched the strategy in Saudi Arabia with the King of Saudi Arabia, the ministry of health and so on, and it looked like we would be very successful. By now, we were facing a very specific question. We all know that Muslims cannot drink alcohol. But it was more complicated than this. Some healthcare workers in the Muslim countries were afraid to apply alcohol on their hands, fearing that alcohol may be absorbed through the skin, which was not in accordance with the Coran. We could tell many stories, but one in particular concerned a young female Muslim healthcare worker in the UK, who was still living with her parents. When the father learned that she was using alcohol every day at work, she was thrown out of the family home. So we went to the Kingdom of Saudi Arabia where we worked with Muslim clergy and Muslim scholars. We reviewed the Coran and looked at everything that concerned alcohol and went to the Muslim league, which

approved the use of alcohol by Muslim healthcare workers. Today, the campaign is extremely active in Muslim countries. Universal system change was something that was very important for us and following this story, equity and solidarity was something that was extremely important to develop (see Slide 43).

Kingdom of Saudi Arabia June, 2006

Lancet 2006; 367:1025

SLIDE 43

Now, I was visiting Kenya, a very modest hospital. We are, as you may also recognize, in a surgical ward.

SLIDE 48

On Slide 48, you see a nurse applying the alcohol-based handrub to her hands.

SLIDE 51

It was very strange to see that this handrub was being locked away, so I asked "Why? When do you use the alcohol? What is the standard and how much do you pay for it?" Of course, she didn't know; we needed to go to the administrative office. Everything was written by hand and guess how much they paid for it? They paid 2.5 times the amount paid in Boston or in Geneva and, for us, that was too much (see Slide 51). So we made a special product that we gave to the WHO and today it is called a WHO alcohol-based handrub formulation, which is made out of local by-products.

Actually, everywhere in developing countries, it is made either from sugar cane, manioc, potatoes and so on, at very low cost. You squeeze the sugar cane, you extract the sugar, you take the left-overs and you develop alcohol. And here is my friend Losami Benghali, a pharmacist in his very modest pharmacy in Mali, producing alcohol-based handrub at very low cost (see Slide 52).

Today, it is made in more than 50 poor countries in Africa.

SLIDE 52

Among the vision and the perspectives of the campaign, we needed to develop standardization at every step. It's important to maintain focus on the patient who is the one you want to protect above all. Dirty hands have a human cost, so we are involving patients in the strategy. This way, it is very difficult to standardize but it is clear that this is what needs to be done. I cannot resist showing you this image of the social security system in Mexico where the system is covering a patient population of over 50 million.

SLIDE 55

While the patients – pregnant women coming for check-ups, children for their injections and so on – are waiting in the hospital, social workers teach them how to clean their hands with alcohol-based handrub that is produced locally at very low cost (see Slide 55). Clean hands save lives and this is something that everybody should know.

We have the privilege of knowing French writer Thierry Crouzet who wrote a book about this adventure. For those of you who are interested, the book is in your bags today. Thierry Crouzet has donated this book so he doesn't actually reap any profit from it. It has been translated and was published on 5 May, which is the day hospitals all over the world celebrate hand hygiene (this is done at least once a year). The book was originally translated into six languages. Today, it is available in nine languages and has been translated by many people all over the world free of charge because the book has been given in the spirit of the economy of peace. Today, every time a book is bought from a bookshop, a

bottle of alcohol-based handrub is given to healthcare-associated infection control centres in developing countries.

"Clean hands save lives" is certainly one example of standardization achieved through human behaviour. We would all like things to be standardized everywhere around the world when this brings benefits to people and to the environment. Thank you very much for your attention.

Speech 1.4 Riding the media bits

Leonardo Chiariglione,
Chairman and Co-founder of the Moving Picture Experts Group (MPEG), a working group (WG 11) of ISO/IEC JTC 1/SC 29

"Riding the media bits" is the title given for this presentation of mine. Actually, it also has another origin but we will not talk about this. So, I very much appreciate having been invited to this conference. I also like very much the conference's questions because I have answers and I would like to start with answers. Maybe I should do this at the end but let's start with this. How does standardization relate to innovation?

Well, connecting standardization to innovation has always been my approach. Standardizing what exists is just for the notary public. I mean that, when something happens and people then come and say "can you put a stamp here and make it a standard", I say "come on, I can give you the address of a notary public and there will be a job for you". I think that standardization is not about standardizing the existing but about standardizing what is coming next. Then comes the question: "The traditional view is that standards and innovation are at odds with each other, but

is this true ? " Here you are touching my most profound belief that standardization is an integral part of the innovation process. Innovation comes from a point that is often hard to define and then you get something in your hands. All this is a long process and standardization is an integral part of innovation. We believe that the misperception of standardization being at odds with innovation may have significant negative implications on innovation management and innovation policy and, here, I elaborate on what I was saying before about this process : you have an idea, you have IPR (intellectual property rights). I am going to touch on this because, when you talk about innovation, you have to talk about IPR. IPR does not necessarily lead to money, of course, but IPR is absolutely linked to innovation and therefore to standardization.

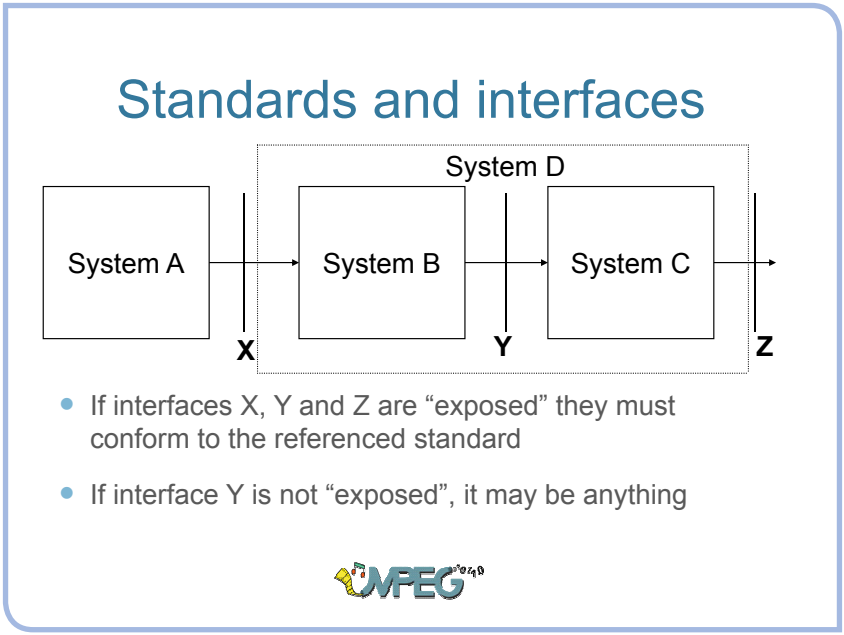
So let me start with definitions of a standard. Of course, I do not dare, or at least not immediately, to give my definition, so I will start with the Webster's dictionary. I have found two of them. One is that a standard is a " conspicuous object such as a banner, formerly carried at the top of a pole and used to mark a rallying point, especially in battle, or to serve as an emblem ". It's a reference point ; you have a pole, you have a banner. " *Oh where, should I go ? There, oh no, no, no, I prefer that one* ". That is a definition and I like it very much.

The next one I don't like so much. It's something that is established by authority – *authority, what a terrible name !* Custom ? *Sure*. General consent ? *Oh yes !* As a model or an example to be followed ? *By all means !* This doesn't mean that the authority doesn't have a role to play. In the case of the former speaker, I would say that there should be some very strong regulations imposing behaviour in hospitals because, as you know, it may have a terrible impact on people's health. Then the Encyclopaedia Britannica – it used to be an English product, two or more centuries ago. Now I think it is owned by an American company, but it very much carries the British spirit... Well, it says that a standard is something " established to permit large production runs " – this is very much an industrial-based view – " of component parts that are readily fitted to other parts without adjusting ". This is a very

good definition. So, my definition of a standard is not necessarily linked to innovation, as I have said. It's a "codified agreement between parties who recognize the advantage of all doing certain things in a certain way". This is what a standard is for me and, in my little environment, I try to promote this idea.

What I say is that the actual process, whether *de jure* or *de facto*, is not really essential. What is important is that it is fair to all parties concerned and carried out to match the needs of users. Of course, if you bear the name of ISO or ITU, these major standardization bodies, your life may be better, but not necessarily so.

Before talking about what I should have done at the beginning, let me take this other picture which I like very much because, as it is said in the gospel, "here is all the law and the prophets".

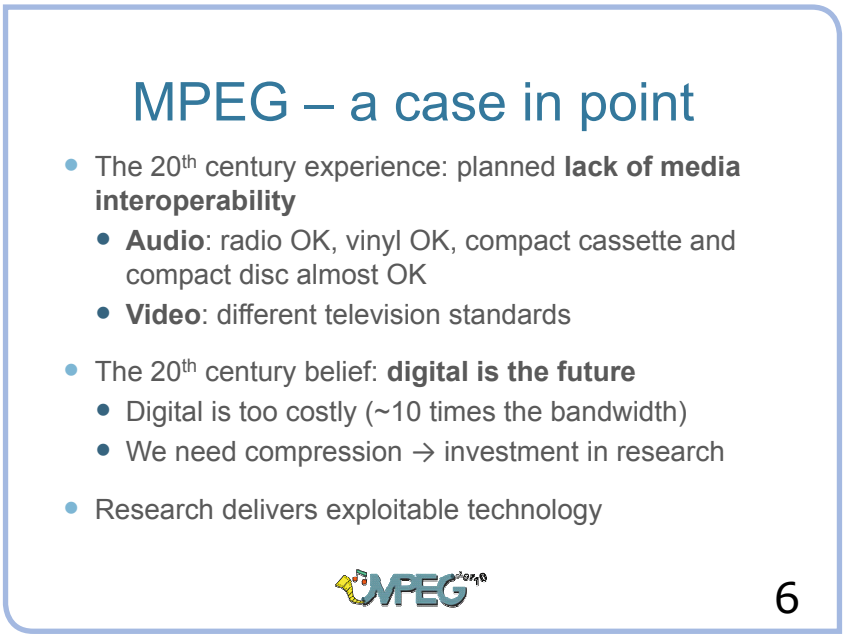


SLIDE 5

I think that here is all the law and the prophets of standardization. So, what is a standard and what are the interfaces? As you can see on Slide 5, you have a system A and a system D and you have an interface X in between. Well, the standard is just about X,

about something that actually does not exist. It's not system A and not system D, it's X. It's even more interesting if system D happens to be composed of two systems: B and C, and you have an interface Y between the two. If you claim that system B exposes an interface Y and that is a standard, then fine. But if you don't say that, what you do in system D is very much your own business. This is a consequence of the initial assumption.

I believe that MPEG is a case in point of what this conference is about and Slide 6 talks about the experience that led to the establishment of this group.



SLIDE 6

It was essentially a reaction to what lasted throughout the 20th century, which I call with strong words "planned absence of media interoperability". This is really true if you think that television started in the UK, then it was deployed very strongly in the USA, then it came to continental Europe and then there was colour. So, in the UK there were 411 lines and in the USA 525 lines, in continental Europe 6 245 lines but the frame frequency was

different. If you look at the ITU-R recommendation and television standard, you find pages, pages and pages where there are footnotes that say: "country X, Y, Z reserves the right to change the frequency tolerance of this". That's great! The future of the country hinges on that footnote which, forgive me, is so stupid. We *had* to do something about it.

With audio it was different. It's very good to see that, from the very beginning, it started as a global system and has continued to be so. Vinyl was OK, compact cassette and compact disc almost OK – but the story about video is just sad. The belief throughout the second half of the 20th century was that digital was the future but it was too costly. I spare you the calculation but if you convert into bandwidth, it's about ten times the bandwidth of an analogue signal, so it's not really a good deal but, if you apply compression, then it can become a great solution, much more convenient than analogue.

The fact that you are seeing more and more of satellite channels is because we are doing more and better compression, and you get more and more information. I don't express an opinion on what is inside the information because that is not my business, but there is no doubt that we are giving the means to provide more information. So, because we needed compression and because the problem looked so complex, every company in this business, or supposed to be in the business in the future, every university, everybody talked about having made investment in research and they had filed patents by the thousands. In the end, after 25 years of research or so, exploitable technology was delivered. In AD 1987 – I'm taking a snapshot here – companies were trying to exploit research independently but, if there had been International Standards for this technology, we could have achieved global interoperability, a dream against the planned lack of interoperability I was complaining about before. The nice by-product was that we could create global markets.

Frankly, my goal was the former but the main message was the latter. Industry was interested in creating global markets and, actually, they did it. Second point, in a world where all information

would become digital, whether it be in the telecommunication or the broadcasting business, digital recording, consumer electronics or IT would make no difference. So it was important that the standards be industry-agnostic and hence not "ITU" because it is a specific standards body. IEC is also a specific standards body. By the way, my employer at the time was a Telco. So I decided to call upon all the players. The customers would be manufacturers and service providers across the range of industry and the workforce would be the researchers, either working for customers or independent.

Now, let's move to the critical point. I am sure I will be criticized but you should at least appreciate the effort I have made in bringing it up. Before standards, we had to talk about IPR because if standards are about exploiting innovation and transforming it into usable technology for products, then IPR is part of the story, and here I am going back to what I call "*the source of wisdom*". I will read it for you and, at the end, I will ask if you detect the source of this wisdom.

"*As I know that many have written on this point, I expect I shall be considered presumptuous for mentioning it again, especially as, in discussing it, I shall depart from the methods of other people. But it being my intention to write a thing which shall be useful to him who apprehends it, it appears to me more appropriate to follow up the real truth of a matter than the imagination of it ; for many have pictured republics and principalities which in fact have never been known or seen…*"

Has anybody detected the source ? It is Machiavelli. Of course, I'm not going to use Machiavelli for the purpose of killing my competitors, that's clear. But the point here is really that we have to take a practical approach. How can you think of developing a digital compression standard when hundreds of companies and universities have filed patents in the field for the last 25 years, let's say 20 years because at 25 years they are usually no longer valid. What do we say ? Do we try and develop a royalty-free standard – I'm sorry, *Type 1* standard, but many people here would not know what a *Type 1* standard is, so I use the term *royalty-free*

standard – or you say "OK, we take in every good idea that exists irrespective of whether there is a patent or not".

This is what we did and we have been criticized for it, but I call for the help of the "Florentine secretary" as he was known. We have to deal with IPR if the standard is to be effective. Then, we have to deal with patents. There were thousands of them and today there are many more: so we developed standards seeking the best performance because – although some of my friends in the legal department might disagree – in the end, the cost of the IP is just related to the standard.

What I mean is that, if there is one patent, it costs 100, if there are 20 patents, it still costs 100. It's just a matter of how many patents get in and then it's somebody else's business to see how they make slices of the pie. However, here is another important point, more "vital" than important. Without it, MPEG would not exist. It is this. If there are too many patents – and all patents are declared to be licensable in fair, reasonable and non-discriminatory terms – we are not going to do much because, if we have 20 patent holders, how can a user go and knock on the doors of 20 independent patent holders and negotiate? That was not going to happen so we needed patent pools to expedite the definition of licensing terms, but we hoped that the rights holders would have an open mind. This is a hope that does not always come true because companies are often reluctant to consider new business models.

For a standard to which patents applied, MPEG 2, one originally had to pay USD 4 apiece. Easy, but what if it's a service on the network? No pieces. This is not necessarily my problem, but globally it is a problem for the success of our standard. I would like to tell you more about the process that we follow in the MPEG group to foster innovation and to manage these issues, but I understand I no longer have time. I hope we will have other opportunities in the future.

Let me just say that there are many ways to "skin" IPR, one of the most critical issues in innovation. The first MPEG standard was approved 22 years ago, and the second standard 20 years ago,

actually 20 years ago plus two days. MPEG 2 has therefore passed this magic threshold of 20 years.

An important question is : Is it possible to develop " good enough " Type 1 (aka royalty-free) standards ? Some companies develop standards and claim that they are royalty-free. Can we generate some real, powerful innovation on this basis ? Today, patent pools are the interface. They collect money on behalf of the rights holders, and then distribute it to them. If managed wisely (a single interface for the licensees, small fees per unit of product or service and simple agreements among the rights holders), this approach has proven to be very effective. There are other interesting models, and they will come out in the future.

Let me conclude by talking about other challenges. We have already developed five generations of video coding standards, and maybe there is more to do. I don't have anybody working for me in MPEG but, at the same time, I have thousands of people working for me " virtually ". When the standard is done, what should I do ? Lay off the workers ? And in three, four or five years' time call them back ? This is a problem of resource management, a serious one. It's my problem but I wanted you to be aware of it. It is another critical aspect of the standardization process, particularly important in relation to innovation.

This wraps up my speech. You will find more about what I said today on the Website **ride.chiariglione.org**. Thank you for your attention.

Speech 1.5 Technology projects and standards in the aviation sector

Ismail Albaidhani,
Director, ISO Academy[4]

Good morning, Ladies and Gentlemen. As already mentioned, I'm fully aware I'm between you and the coffee break so I'll try to be as brief as I can. Just a little bit about myself. Before joining ISO, I came from an industry where I spent over a decade really just seeing us implement standards to innovate the way we work. That's really what we were doing all the time, so I thought there was something to be shared here from the 15 years in the aviation sector. We've seen great speakers talking about all the social implications of standards. I'll try to touch on some of the socio-economic benefits that the air transport industry has gained from standards. So, buckle up and be ready to go up in the air.

A bit of history about the current airline business

Exactly 100 years ago, in 1914, the former Mayor of St. Petersburg, Florida, in the USA, decided to buy a ticket and this decision has basically changed our lives till today. He took a small flight with a bi-wing airboat that flew from St. Petersburg to Tampa, Florida. Those of you from the US will know that this is a short distance. But that decision was really the birth of the commercial aviation or scheduled air travel as it is defined today, contributing to almost USD 2.2 trillion in economic terms from

4 Mr. Albaidhani was director of the ISO Academy at the time of the conference. He left ISO in August 2015.

the passenger and cargo segments. On the flip side, and this is really quite interesting, how many of you use paper tickets, just by raise of hand? I think the next generation – who is this young man here, what is your name? James, you will not remember such tickets because I'm sure you will never use a paper ticket in your life. But many of us in this room have used paper tickets and, like Abram Pheil in 1914, we continued to use a paper ticket for almost 80 years. As it may even have happened to you, a passenger who lost a ticket had to go to a travel agent, reprint and almost pay the same price for a new ticket. This was on top of the cost to the airlines of printing and maintaining stocks, and distributing to travel agents. Interconnectivity was limited and costs increased quite dramatically.

So an airline in the USA, United Airlines, decided to change it a little bit and, 80 years later, in 1994, they introduced the electronic ticketing concept. They introduced it as a competitive advantage to the airline, as a new service and to reduce operating costs. Shortly afterwards, however, the airlines in the US realized it wouldn't work because airlines are a much more interconnected business. If a customer with an e-ticket flew with, say, United and was not recognized as a legitimate passenger at another airport or country, the airline would lose that customer. So they actually regrouped airlines from around the world under the IATA umbrella. They took the lead and a project was created to introduce electronic ticketing globally, which was to become the trigger for many innovations in the air transport sector.

There were some key challenges to the e-ticketing concept. One was lack of understanding – everyone defined electronic ticketing differently. In the USA, understanding differed from Africa and the Middle East, and airports thought about it differently from travel agents. So that was one of the key challenges. Another challenge was the technology and infrastructure. Aviation players in the USA and Europe were so technologically advanced compared to some developing countries that didn't have that same infrastructure to implement or transform their back office and front office systems. There was also a human

factor, one of fear. Many of you will remember that, as a passenger, you would be very reluctant to go to the airport with just your bag without having a paper, a printed coupon, and go on your journey. Travel agents, which are an important part of the value chain, actually feared that their business would disappear completely. Their business was taking a paper ticket from the airline and distributing it around the world on behalf of the airlines. So they were quite severely resistant to the idea. Of course, there were some governments – I was part of this project in the Middle East and North Africa, and I've seen governments issuing laws forbidding airlines to use electronic ticketing for security reasons, through fear that people would just show up and get on the airplane without being known. Lastly, implementation. Even if all four items above were agreed upon, there was an issue about how to get everybody from around the world – from the small island in the Caribbean all the way to Asia, the Middle East or Africa – implementing that same project in the space of four years as 2008 was set as the industry deadline to transform the whole value chain from paper to electronic.

I'm summarizing the key solutions that were really implemented and helped trigger that transformation. One is the "Global Standard". It was agreed that there was a need for an electronic ticketing global standard that would help everybody around the world understand what electronic ticketing was, how it could be implemented using the different capabilities in the market, and whether to upgrade or connect with what existed.

The second part, which is equally important, is project management and I think this is something that is extremely important, at least from an industry point of view. You can have the best standard in the world and this is great for making a definition. But if you don't take it to the level of implementation, it means there is something wrong with that standard you're creating. People need to use it, otherwise it's just a document on the shelf. A global team was set up in every region, country and in every airline to make sure that the stakeholders in that country were able to understand the standard and implement it.

And an impact assessment was ongoing to determine the benefit of that implementation and drive the momentum forward. For the airlines, it was clearly cost saving but they couldn't achieve it alone. They had to open it up to everybody. The cost of one printed ticket was USD 10 and the cost of one e-ticket was USD 1. So the industry saved about USD 3 billion just from implementing e-ticketing in 2008.

Improved revenue and distribution management was another benefit. As you see today, it allowed airlines to bundle/unbundle their products and services. You are able to go to the Website and choose what you want from the airline, as opposed to the past when everything was tied to your paper ticket. The phenomenon of alliances that you see around the world today, the mergers, the acquisitions and cooperation between airlines have been simplified and accelerated thanks to a small trigger that was just a transformation based on a standard implemented globally. There were some collateral benefits. Passengers who were a bit reluctant to use electronic ticketing, due to habits more than anything else, have actually been the biggest advocates for it and – after realizing the benefits of booking and checking in from home instead of queuing at airports – have been asking airlines to introduce e-ticketing more and more around the world.

Airports have started thinking about re-designing their infrastructure. Especially if they are new, you will recognize the ATM lookalike machines in airports around the world : they are the common " user self-services " kiosks. These user self-services came as a sub-product of the electronic ticketing because airlines were able to integrate their systems at the back office. Travel agents, who really feared for their existence after electronic ticketing transformed their activity, also had to evolve. In the past, travel agencies were enterprises like grocery shops that you find on each street corner and operated in specific local working hours. Today, travel agents are able to maximize their business through around-the-clock e-commerce and save the costs of having physical presence. They are less and less available as physical offices and more and more available as e-businesses with more accessibility to

airlines electonic inventories from around the world : again, a result of e-ticketing standards implementation.

Even governments today, advanced governments, are using electronic ticketing to receive advance alerts concerning passengers' information. The movement of passengers through customs is facilitated, based on history and records, so I think there are also benefits for government and security that have been achieved through the standard.

In summary, I wanted to highlight how important a simple but very important global standard was in transforming the way we, as travellers, are behaving and travelling around the world. There are many other examples, but I will stop at this stage. Thank you very much.

Session 2
Innovation and business strategy

Chair's remarks

Chair: Lucio Baccaro,
Professor of Sociology, Sociology Department, University of Geneva, Director of the UNIGE/ISO Master programme "Standardization, Social Regulation and Sustainable Development"

Welcome to this second session which is entitled "Innovation and business strategy". This is a session in which we explore the extent to which standards contribute to corporate innovation, and business strategy in particular. Let me briefly introduce myself. I'm Lucio Baccaro, Professor of sociology at the University of Geneva and Director of the Master's in Standardization, Social Regulation and Sustainable Development that the University of Geneva's Faculty of Social Science is running in close cooperation with ISO.

We have three highly distinguished speakers here to discuss what I think are going to be best practices concerning the role of standards in business innovation. I will introduce each of them shortly but, before I start, let me just say a few words about this Master's run in partnership between the University of Geneva and ISO.

First of all, I think that I can fairly state that this is a "one of a kind" initiative. There are several educational programmes in the field of standards but this one is focused on understanding the social processes by which standards of various sorts contribute to sustainable development.

Business innovation is part of the curriculum and we have a series of courses directly taught by the ISO officials and by speakers invited by ISO. We are also interested, from a broader perspective, in how standards contribute to social innovation and, in particular, how standards manage to activate governance mechanisms by which various stakeholders contribute to thinking about and helping to resolve social challenges that are important for sustainable development.

Having said that, I would like to welcome our three speakers.

Speech 2.1 Bringing radical innovations to the marketplace

Lars Montelius,
Director General, International Iberian Nanotechnology Laboratory (INL), Professor of Nanotechnology at the Sweden Nanometer Structure Consortium at Lund University

Thank you, Mr. Chairman, for your introduction and thank you for inviting me here today. My name is Lars Montelius. I'm a professor at Lund University and I'm also Director General of INL. I have also started several companies and was Chairman of the Swedish mirror committee to ISO/TC 229, *Nanotechnology*, for some years, until this summer actually. So, I will talk about bringing radical innovations to the market place.

A good start to address the theme of innovation and standards is to ask this question: When you have an idea *of what to do*, what *should* you do?

I will try to guide you through using some cases of best practice and will speak about various kinds of activity and perspectives: those of a big consortium, a small/medium-sized enterprise, and of my university. But before doing that, I would like to share one slide about the organization in Braga, Portugal, where I am now Director General (see Slide 3).

SLIDE 3

Like CERN, it is an international institution. It has 4 000 m^2 to 7 000 m^2 of land and a state-of-the-art building. The remaining equipment will be installed by spring 2015. We have about 100 people working there right now. The institute is designed for 400 people, so it will open up collaborative projects in the area of nanotechnology, not only science but also societal aspects. I would like to invite you all to look at the Web page and see whether we can engage with each other – and maybe the ISO committee could come there for a meeting or a conference. We have excellent conference facilities, an indoor auditorium, and all that is needed.

Coming back to the previous point, if you have a good idea of something you would like to do, you will probably want to sell it and, in order to do that, you have to have something to offer that is better than what others have. Or you may want to open a new market, which is even more difficult. It could be that you have a company for which you want to increase the market share and the threat is, of course, that your product is not unique or, if it is,

maybe customers won't buy it, so you have issues that need to be dealt with in a strategic way.

Most big companies think protection is required and we heard in the previous sessions about IPRs and their relation to standards. Let me recall that you have principally three protection tools (see Slide 4).

SLIDE 4

You have trade secrets – you don't say anything. You are convinced that you know everything better than anyone else. That's one way, perhaps not a good way, but it is a way. Then, you have the patents and all that is related to patents, but we are not going to discuss that today. Next, we have the standards and standards can be used in many different ways. I would say there are at least two, three or four different ways to deal with a standard, to enforce it and to bring innovation into a product or a service.

So, for a company one has to ask: "Which way should I go?" Should I follow the first, the second or the third – and this is what is difficult. I will start by one learning experience. It is not my own

but it's the experience coming from the part of Sweden where I used to live. It's a sector that has been and still is extremely important for society. A sector where standardization was absolutely instrumental for its development. The question is, "which one?" I will give you a hint. It originated from or – as a minimum – a big contribution came from my part of the world, in the southern part of Sweden.

So what is the sector? Well, it's mobile communication; and then you say "OK, it's mobile communication in Sweden, what's that got to do with it?" Maybe some of you know, maybe some of you don't know the standard we are going to talk about, because it's not about mobile communication, that's only the sector. What is the standard, in what area is the standard? Can I have one example or one suggestion? I think there's something you all use every day, frequently (or maybe not...). The idea was to avoid the need for the RS 232 cable between different electronic devices and it was started in 1994 by a Swedish guy. His name is Nils Rydbeck. He used to work at Ericsson which had its mobile centre in Lund, and then Tord Wingren, a good friend of mine, started to write the first version of the standard for this technology; then later came Sven Mattisson and he actually coined the name of it together with a Canadian in a bar. You still don't know? It's Bluetooth!

And you know what Bluetooth is? You know of course, but the name, where did it come from? From the Danish King who lived around the year 1000, who united Denmark. He standardized Denmark and he christened Denmark. His name was Harold Blåtand and Blåtand is Swedish for Bluetooth – the rumour is that he had one dark tooth. The Bluetooth logo is his initials, H and B in Rune script. The reason for this was that this Canadian and Sven Matisson were both reading a novel about the Vikings. Blåtand had united Denmark; they were going to unite the world so the symbol seemed appropriate. Of course, Bluetooth is something that has been extremely important and we use it in many different ways.

It is just one example of the different types of new technology that are emerging, and Bluetooth was instrumental in this. However, it would never have happened had it not been for actors who decided that they should work together on this. In 1998, a small consortium with Ericsson, IBM, Intel, Toshiba and Nokia started the SIG, the Bluetooth Special Interest Group. Now, 24 000 companies have joined this special interest group to develop standards, different kinds of standards. Without this consortium in the beginning, Bluetooth would never have happened and, in the end, it had nothing to do with the RS 232 interface between different devices. As we use Bluetooth today, it is much more of a communication protocol between different units. I think this is a nice symbolic standard that actually drives innovation because, without the standard, the innovation in many different sectors would not have happened. Of course, things evolve and it might have happened anyway, but not in the same way.

Let's talk about another sector also of large importance for today's society, in which standardization is absolutely instrumental and which will go through a spectacular change in the next few years. What sector is it? Any suggestions from the audience? What could it be? It's related to the Nobel Prize of physics in 2014. LED lighting, you are right. As you know, the lighting sector is extremely big and very important. I would even say that it was the possibility to bring daylight indoors at night time that really enabled industrialization to take place and to have factories, etc. Artificial lighting has built our modern society.

That said, I would claim that the lighting sector has been rather "stupid" so far – I hope there is no one from the lighting sector in the room who will kill me later! Principally, the lighting sector is about more or less light and that's it. You turn it on and you turn it off. When you arrive at the office in the morning, you turn on the light. You stay in the light for 8 hours, 12 hours or 14 hours, depending on how much you work, and then you turn it off and go home. Rather stupid. In many places you have the dimmers that allow you to lower the intensity of light, but that's it.

We all know natural lighting is nice. I think we can all enjoy the sunset or the sun coming through the green trees in spring or so, like in these pictures on Slide 9.

SLIDE 9

Natural light is nice, it changes all the time, 24 hours a day, and seven days a week. And what is happening now? What is happening is that we are transferring from artificial light to creating natural light using LEDs. With LEDs we can recreate all the wavelengths that nature has given us for billions of years. We are used to living together with these wavelengths and these intensities that change throughout the day. We can actually recreate them. This could be the case in the future, and we know a number of things already. Take plants, for example. In our homes we have UV absorbers in our windows and our plants are not so keen on them so we have to have artificial lighting in order for them to grow better. For example, the spice industry uses LED-equipped laboratories to enhance the growth of spice. We know for sure that

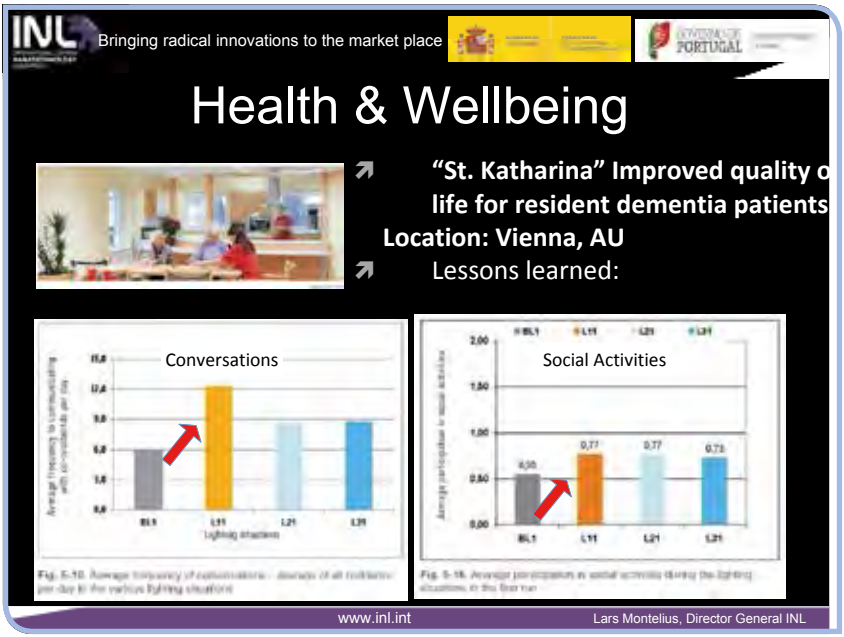
different colours can affect our mood like this bright colour that helps Alzheimer patients to sleep better at night (see Slide 12).

SLIDE 12

This is a fact. We know that red colours put you in a more excited mood. It's a fact. We know that we have a circadian rhythm. This is the rhythm that is responsible for the jetlag we feel when we travel from west to east. We don't get jetlag when we travel from north to south. It has nothing to do with the higher altitude or anything like that. It only has to do with the lateral movement and the change of the day and the circadian clock, which is an internal 24-hour clock. It's not 24 hours per day, in fact it is a little less, which means it has a phase. This is the reason why young people who stay up at night watching their iPads can't go to sleep because the bluish light in the iPad stimulates the third photoreceptor in the bottom part of the retina that was discovered ten years ago. The light resets or changes the circadian clock and if you do it in the wrong phase, you either become more tired or more energized. And, of course, if you are energized before you go to

bed, you can't sleep. Incidentally, this is causing problems within our schools because young people are not getting sufficient sleep.

Here are some positive results that lighting has on health and well-being (see Slide 15).

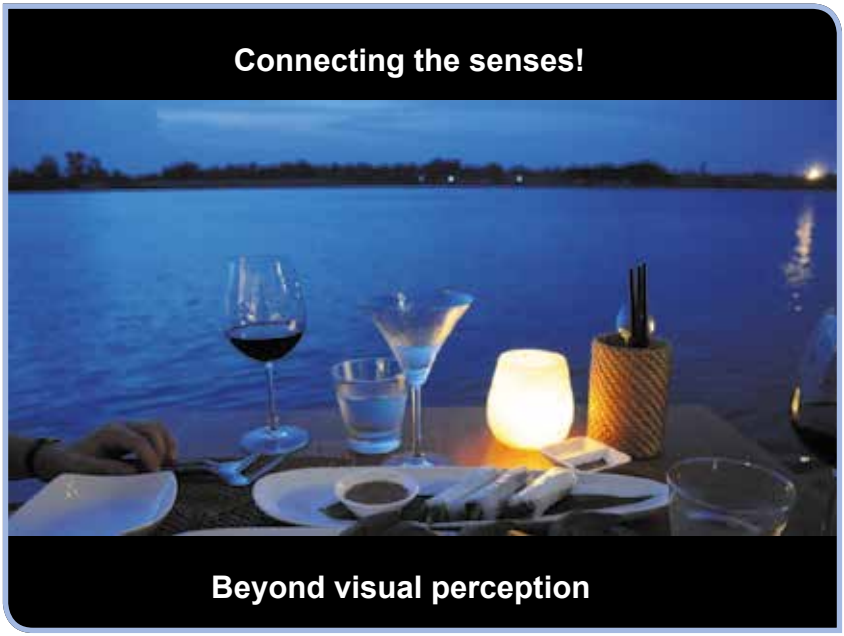


SLIDE 15

The right lighting in this residence for dementia patients can double the number of spontaneous conversations taking place, not just by 5 % but by 100 %! Not small numbers, right? If you talk about education and productivity, we can increase reading speed by 35 %. We can drop the frequency of errors by 45 %, a factor of 2. We can reduce hyperactivity by 76 % by using the right light. We seem to have a worldwide problem in schools with the influence of mobile phones, and with having to keep up with what happens on Facebook, etc.

We have too many inputs, but the right lighting can help to calm everything down. The problem, of course, is to know what the right lighting is. The physical reason is the third photoreceptor in the bottom part of the retina, which is sensitive to the blue

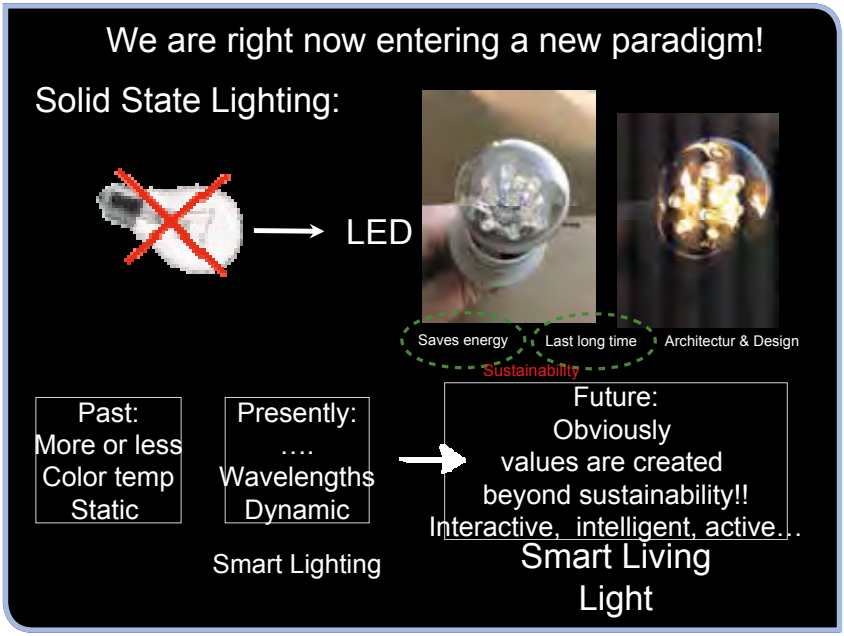
light of the sky. It is not sensitive to colours coming directly, but sensitive to the skylight and this is the reason why you shouldn't use a LED screen after 8 o'clock in the evening or so. So I think we can all enjoy this kind of environment.



SLIDE 18

Nice pictures connect the senses (see Slide 18). We feel things by seeing things. We are not unaffected by what we see. By the way, the reason that blind people can sense daylight and night-light or no light is this third photoreceptor. This has been proved through the testing of blind mice, which has revealed that they sense a difference.

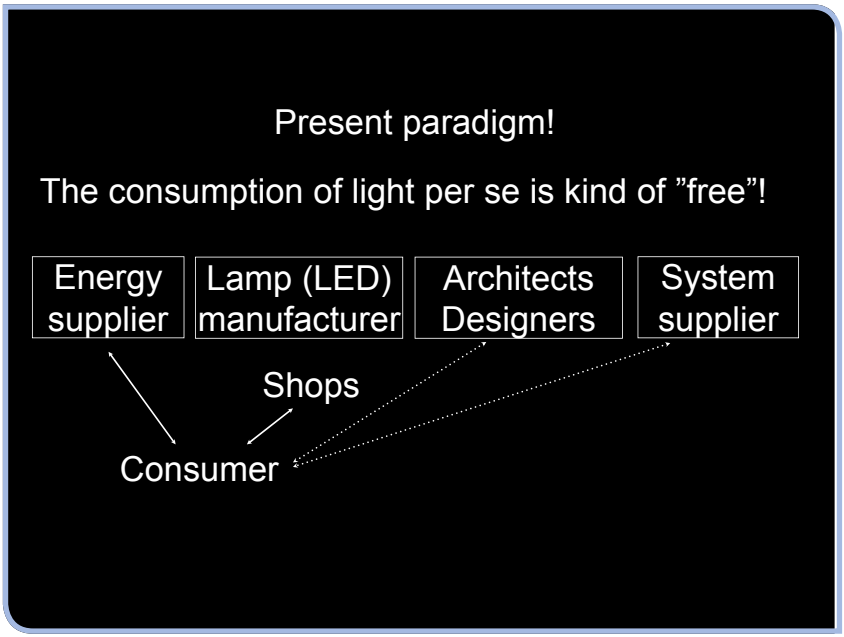
Right now, we are entering this new paradigm where it is possible to have dynamic wavelengths (see Slide 19).



SLIDE 19

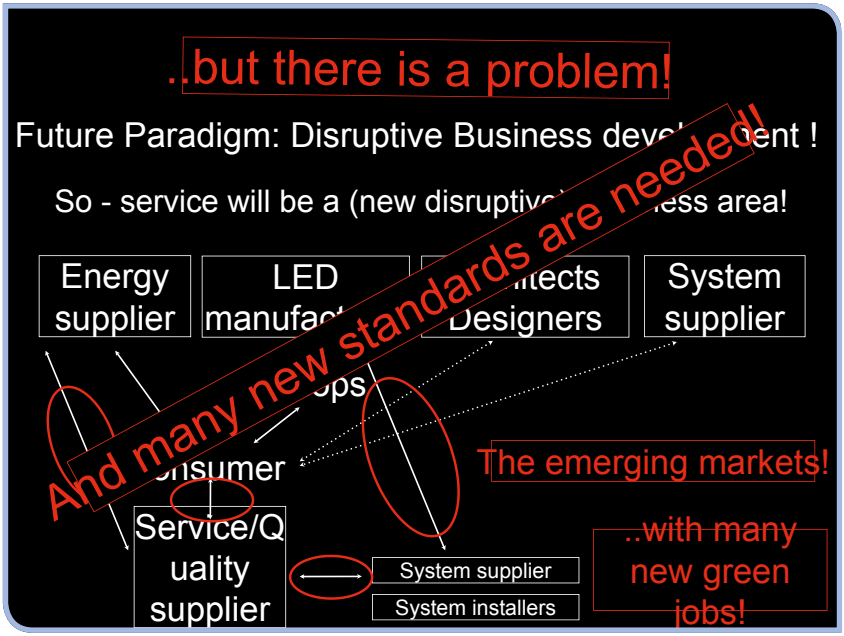
Some people call it smart lighting. I would like to take it one step further and call it *smart evening light* because the lighting should not be smart. It should be adapted to the situation and it should give you the right light at the right place for the right activity and, in order to do that, there have to be a lot of innovations.

I will tell you my understanding of the present paradigm in the lighting sector. Slide 20 shows how it is today.



SLIDE 20

As consumers, we go to the shop, we buy some lamps, and then we pay the bill to the energy supplier. Maybe we build a house or something similar and we have some negotiations. However, the consumption of light per se is free because when you pay your electricity bill, you may say “ hmm, this is a bit high because I never turned off the light ” but it is not a direct relation to the *use of light*. Your consumption is mainly limited to when you buy the lamp in the shop. The rest is basically free, you turn on and off for free. So we are now facing this disruptive business development. New kinds of things will come on the market and here are just some examples (see Slide 21).



SLIDE 21

The very simple example we had earlier, where the manufacturer sold the lamp to the shop and the consumer bought it, now becomes much more complicated. We will have service suppliers, system suppliers, system installers and energy suppliers to deliver energy and quality of service to this system. What does this mean? Well, in a nutshell, it would be the same as with our mobile phones. The mobile phone, if you like, is the lamp and we have a service provider that gives the intelligence to the telephone, i.e. what we can do with it. So we will probably have the same in the future. We will have agreements with service providers who will give us the light just as consumers have an agreement with service providers for their mobile phones. This is a totally different concept because what used to be a product – the lamp was a product, lighting was a product – now becomes a service and the big companies that are producing light are not used to thinking in terms of services.

Let's take an energy supplier, for instance. They have very many customers and they are the companies in the world that

have the least good interaction with the consumer. You get the bill, that's the conversation from the energy company. Still, you used the service. I think in future, the energy company may take on a role in this new type of business. Maybe they will bundle different types of services so they can deliver quality or maybe even a system to the consumer, the consumer being an individual, a school or a hospital, whatever.

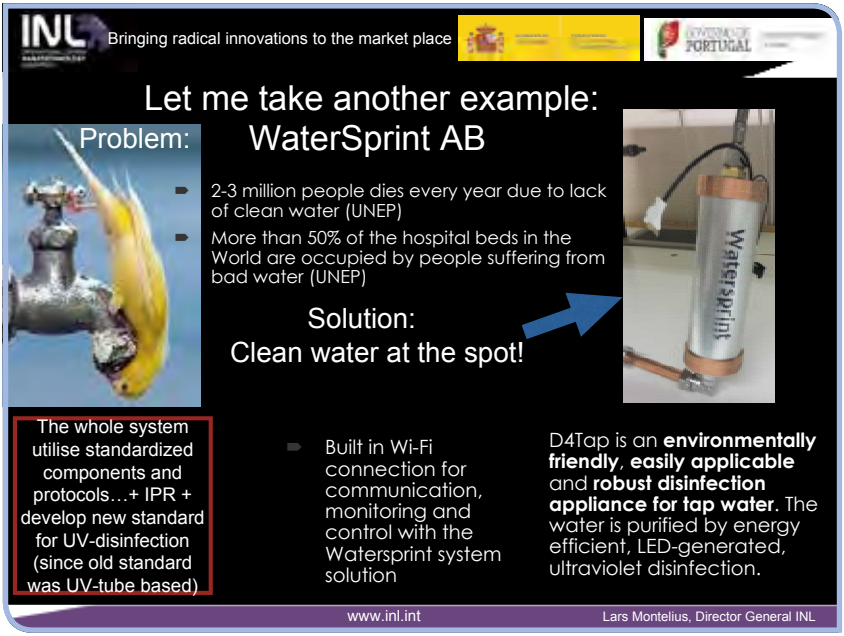
Something will happen and this means that we will have to develop very many new standards. Only yesterday, I learned that BMW have now made a light pole where you can charge your electric car while it provides light for the city. It uses LED light, of course, and it is a light pole... and so they are entering the city lighting market. It's a car manufacturer! They're going into a new business and they're doing it seriously. They presented it last week in a conference about future cities. So there will be a lot of new things happening and the problem is "who is taking charge of the standards?" Because this will be a standard between you as a person and the provider, e.g. I will have sensors on me, I will communicate with the lamp, the lamp will read me, the sensors will read the lamp and the information will be sent to a service provider. The provider will process the aggregated data and send it back to the grid deliverer in order to give me the light I need and there are many different possibilities as to the provider. It could be an electronic company, an ICT service, a light service, or it could be an enterprise involved in logistics or transportation.

So who is taking charge of these new standards? I think it is not only for this, but also for other areas that standardizers need to rethink a bit how they handle things in the white areas between different standards organizations or different standards committees. Now here's a little amusement.

SLIDE 22

We have heard about MPEG, digital audio and digital video, and I say that we are now at a time when we will have digital light. Someone will invent the Spotify light (see Slide 22). I don't know what that is but someone will do it, and for this thing to be developed there will be new standards and new questions about what kind of standard it should be? Should the standard be electronic, photonic or something else?

My third example is a small company, WaterSprint (see Slide 23). I am working on the problem of clean water. Two to three million people die every year due to lack of clean water. More than 50 % of the hospital beds in the world are occupied by people suffering the effects of bad water. The solution seems obvious, clean water at a spot. This company, WaterSprint, has embedded nanotechnology into its products.



SLIDE 23

The device on the right side of the slide is a small unit, about 10 cm in length and about 3 cm to 5 cm in diameter. It has integrated nanotechnology, enabled LEDs for UV light radiation in order to kill bacteria or break the DNA of bacteria while the water is running through the pipe. It works at full speed : 10 l/min, producing UV only when there is a flow, so it is very energy-efficient and, consequently, much less expensive in energy as compared to other UV systems which were UV-tube based.[5]

A Raspberry PI (small computer) is built into the system and it is WiFi-connected. It is robust and produces extremely precise data that can be useful for the city council or house owner, for example. In order to deploy the system on the market, the company, of which I'm a part owner, is extremely standards-minded because if we don't use standards, we don't think we can sell it.

5 The UV-tube incorporates a germicidal bulb suspended over water in a horizontal tube or covered trough. The bulb is just like a commercial fluorescent bulb, except that it lacks the phosphor coating and the glass exterior is replaced by fused quartz.

Of course, we also have IPR protection. However, the existing standards for water and water disinfection are based on UV-tubes not LEDs, which have a completely different spectrum so we're working now with the Swedish Standards Institute (SIS) to develop new standards for this.

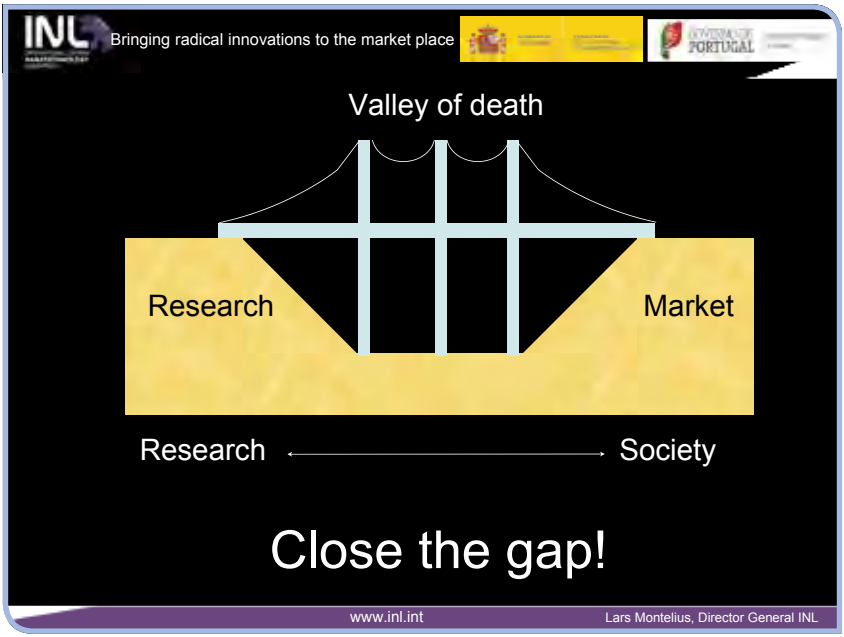
In essence, you already have a good idea and you want to do something about it, to sell it, I guess. You have trade secrets and patents and standards and you have to strike a very careful balance between each of these in order to define what your best strategy is. Fifty years ago, a good strategy was the trade secret. I don't believe in that at all now. I think what is important is to close the gap between research and the market, to actually work on how you can accelerate going from the research to the market. Most of this work is done in academia by university professors who, as they grow old, think that they can start a company – so it is sort of a linear process. And they may start a company or two...

But there is a lot of wealth in using the research we have gathered and in letting other people use that knowledge to start many more companies, or to deploy this knowledge to the market much faster. It has a lot to do with articulation, with how you speak. I give you one example in this comic strip (see Slide 26).

SLIDE 26

The question is "What are you doing?" And the man says, "I'm cutting stone." The answer is perfectly correct. As you can see from the comic strip, he is cutting stone. There is, however, a second answer to this and that is "I'm building a cathedral". Those who articulate "I'm building a cathedral" will probably be the winners if this was a review panel for getting research funding or risk financing.

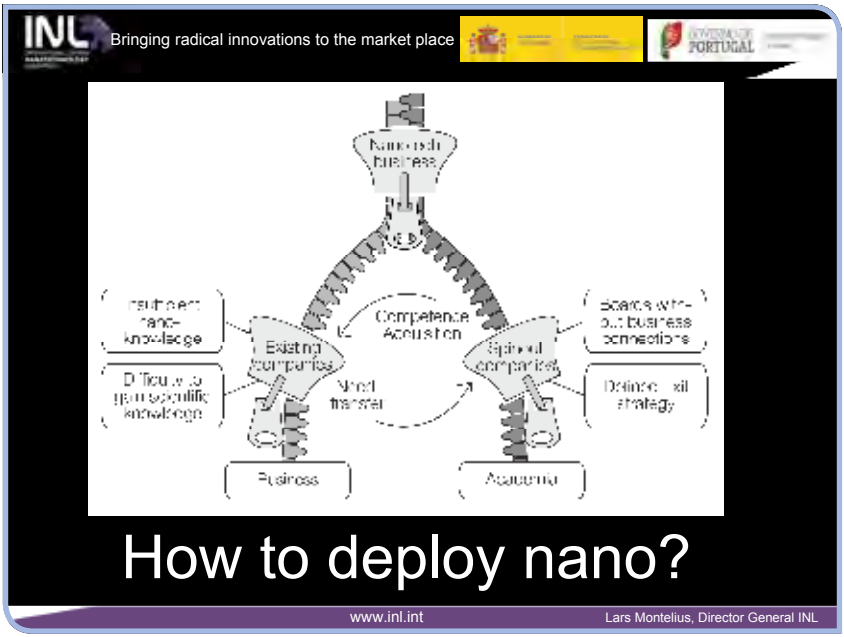
So the matter of articulation is extremely important and it brings me again to this "close the gap" imperative (see Slide 27).



SLIDE 27

The necessity to speak a language, to understand the two sides and to interact with each other, because it is "in the white spots in between", where you come out of the comfort zone to where innovation can happen. That is why there are so many innovations in Oxford and Cambridge, because they all meet at tea and discuss with each other outside their comfort zones. They're comfortable doing that.

Nanotechnology is a rather noble area in a way. I think the big launch was made in 2000 when US president Bill Clinton announced the first US national nanotechnology initiative. What has happened in nanotechnology is principally that research in academia has been in the right corner of this picture (see Slide 28).



SLIDE 28

It is a lot of knowledge of very few people who come from a strong research environment and who spin out companies based on 20 years of research or so. You have a board without business connections because they are friends who know you and you don't know the business. You don't have connections and you may also need some risk capital for which you need to define an extra strategy, so there's a hindrance, something preventing you from taking it to the real market. On the left side of the picture, you have the businesses. They have a lot of knowledge of existing markets and how they work. Their nano-knowledge may be insufficient, they don't know what to do in that field, and they don't even see the gap. They are not even aware that the nanotechnology is there and that they could employ it. The two worlds are creating a larger and larger distance between each other ; so it's time to close the gap, time to close the zipper.

In conclusion, what I would like to say is that standards are all around us. They are necessary and in a big consortium, such as Bluetooth, they are absolutely essential for its development. In a

small company, standards are also absolutely essential because they create consumer trust and enable a company to sell. In addition, standards create significant opportunities for spreading knowledge and developing new products, services and markets. With that, I would like to thank you for your attention.

Speech 2.2 Growth through partnerships and licensing technologies

Jens Albers,
CEO of Nanotron, Germany, an innovative company providing technology for the localization of the physical position and identification of persons and objects as well as for the installation of intelligent sensor networks

Mr. Chairman, thank you for the introduction.

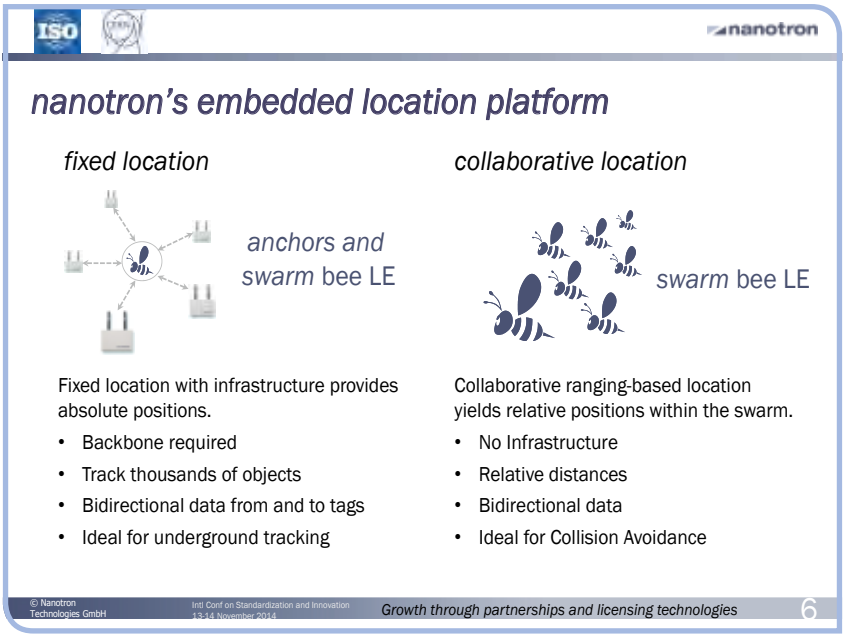
Good morning, Ladies and Gentlemen. I enjoyed the previous talks, and I want to showcase the experience of my company, Nanotron Technologies, and how we are growing through partnerships and by licensing our technology. I want to show that standards support innovation and that standards are part of our business strategy.

Let me give you an overview of my presentation. First, I want to tell you something about Nanotron Technologies. Nanotron is a small, innovative start-up in Berlin, Germany. We have invented the so-called *embedded location platform* used in IoT (Internet of Things) applications which are currently a bit of a hype scenario. Nanotron has created an ecosystem to provide a complete solution for products in these market segments. Our patents and standard activities support the implementation and utilization, and therefore the capitalization of our IP.

Nanotron was founded in the 1990s, about 20 years ago. We have developed and patented an embedded location platform, which includes an air-interface that has also been standardized for global tracking solutions in ISO/IEC 24730. Nanotron has developed the platforms "*protect*" and "*find*", which create virtual safety zones for people, animals and assets. The markets Nanotron is focusing on are the early IoT verticals and certain Auto-ID applications. Our core competence in the market segments that we serve concerns the ability to communicate data as well as bring location awareness to the end-user system. With such technologies, we can detect and prevent dangerous situations and improve productivity.

Infrastructure based on Nanotron's technology enables the user to locate and navigate independent of GPS. Nanotron has performed research on indoor location systems for almost ten years, and a lot of IP has been developed.

Our vision is to provide the ability to locate any smart device anywhere, given our embedded location platform with the two distinct platforms "*protect*" and "*find*".



SLIDE 6

On the left side of Slide 6, you see a fixed location infrastructure with devices such as routers, anchors and devices to be located. On the right side, there is a so-called *collaborative location* scenario with Nanotron's swarm devices for solutions without fixed infrastructure, in which we employ *swarm intelligence*.

To help your imagination about the versatile component that we are offering, see Slide 7.

SLIDE 7

The dimensions of the one Euro coin can be achieved by our product, however the price expectation by the end user is also in that range, which is a target that cannot be achieved yet. Nevertheless, pricing of such versatile components is crucial for market success.

It has been demonstrated in various market applications that our technology enables the smart objects of the IoT world to be *location-aware*. The ambition of our company is to provide location awareness at no extra cost, allowing for *smarter* objects for our IoT applications. As we all know, the Internet of Things creates

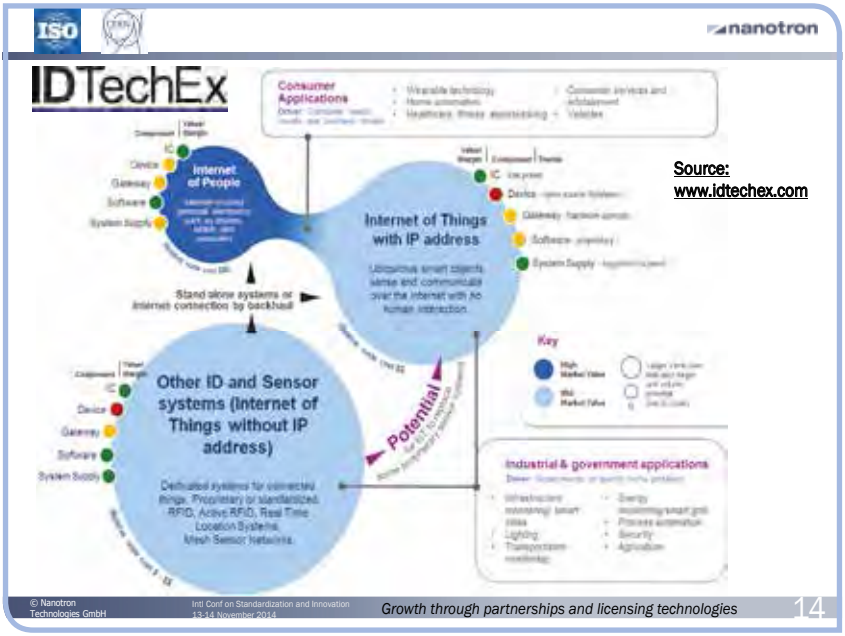
connectivity between all the devices around us, and enables each device to talk to every other device. In terms of IoT applications, there is a strong need for Real-Time Location Systems (RTLS), and the position of the devices needs to be known at all times. At Nanotron, we support and promote this kind of IoT-location system.

The advantage of an RTLS implementation, in addition to RFID (Radio-Frequency Identification) applications, is that users not only know where things are or what has happened potentially, but also know the actual position and what kind of conditions persons or objects are in. Questions like "how is my asset, how is my animal, how are human beings, and where is action or help needed?" are crucial in IoT applications.

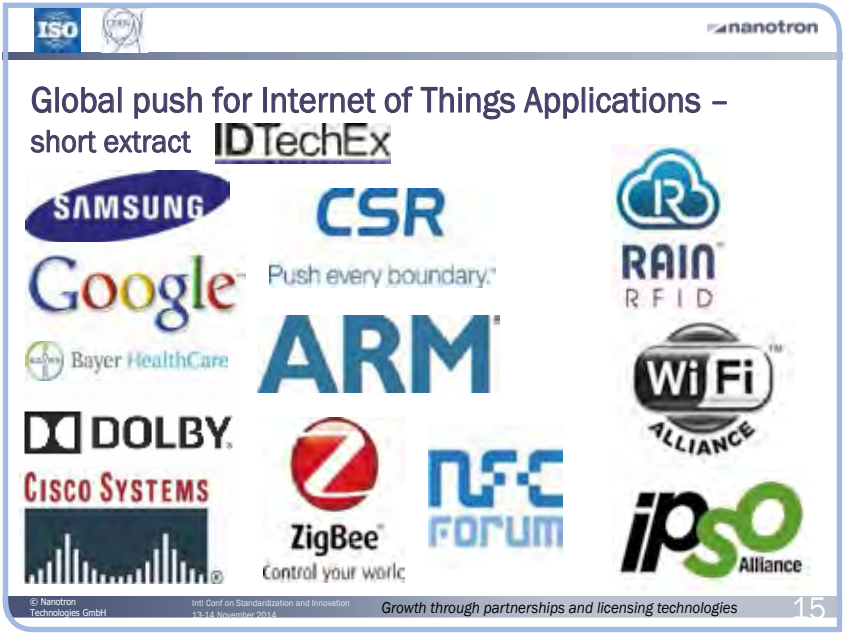
Certainly, in these emerging IoT applications, highly energy-efficient solutions are important. Not only because a change of battery is very cost-inefficient. Without energy to provide data, data and location information is lost. The need to identify and locate objects is a trend that becomes visible in the industrial market. In Germany, this trend is called "Industry 4.0" which describes an application scenario of cyber-physical systems that are basically an outlet of the IoT world, enabling automatic and unambiguous identification in order to support automated manufacturing.

In order to show the relevance of IoT applications, let's take a look on the Internet world today. The Internet of People is "limited" to a few billion people (roughly 8 to 10). In today's world, every person is surrounded by at least ten devices. These devices need to be smart in terms of providing data to the user.

The specifics of the upcoming applications can be derived from the IDTechEx promotional slide for their conference on this subject in the USA in November 2014. Slide 14 shows the complexity of IoT applications and the investments made to develop a user-friendly application that is ready for the market.



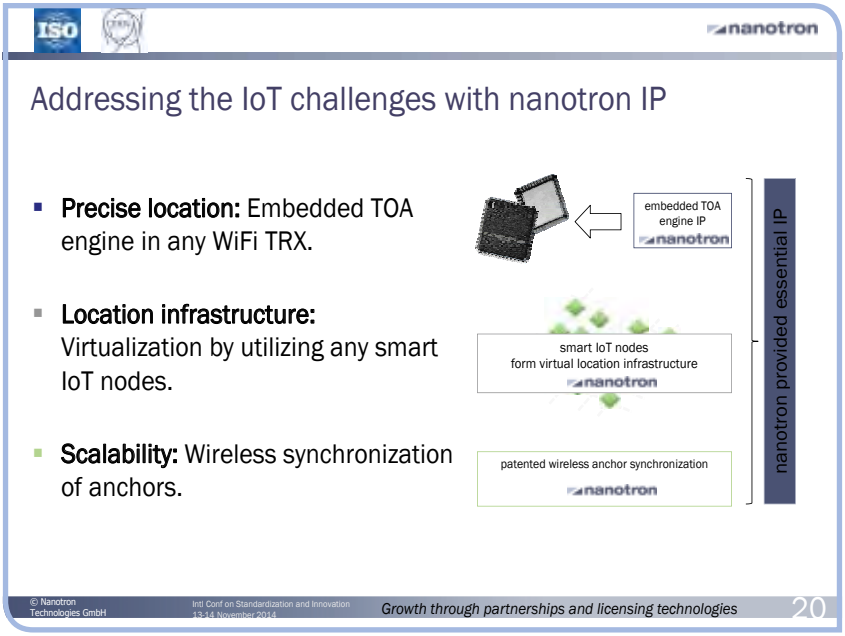
SLIDE 14



SLIDE 15

Technology innovators such as Samsung, Google, and also Cisco, who calls the IoT the "Internet of Everything", and others, are undertaking vast investments in the field (see Slide 15). Moreover, these global companies are the driving forces behind the consortia active in this field. Among them there are technology providers for Bluetooth and WiFi. At the Cisco IoT forum last year, Kaivan Karimi, Executive Director, Global Strategy and Business Development, stated that location awareness of IoT objects was still missing, but that it is critical to connect the physical world to the IoT data model.

Given the importance of the IoT applications, the kind of intellectual property Nanotron has developed, i.e. Nanotron's *embedded location platforms*, which is focused on location awareness, can be seen at the top of Slide 20.



SLIDE 20

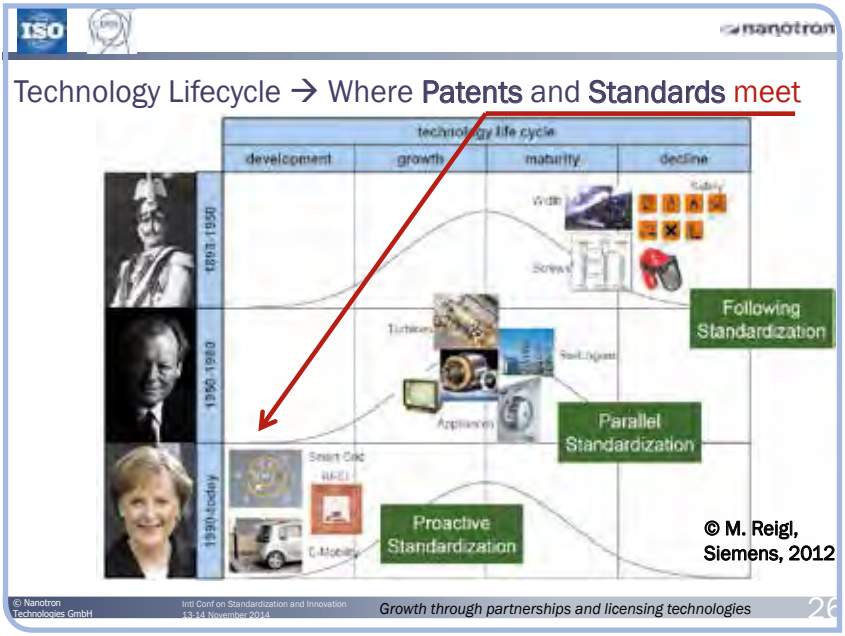
Furthermore, Nanotron has developed an IC-block to provide accurate location awareness, which can be implemented into any WiFi transceiver. This block just contains tiny 250K gates, but is

a powerful module to support location awareness. Additional specific software infrastructure to synchronize the data is under development.

From a business point of view, it is important to see the value chain of our company. We provide all location and sensor network data to system integrators. This also implies that Nanotron is in need of vertical market partners to provide the complete product to the end customer. This business model has been working with proprietary solutions targeting specific market segments. New market segments are now provided with the needed location awareness in the IoT world representing a much larger potential market.

In this respect, the relevant patents and standards need to be briefly covered from our perspective. Our IP strategy needs to be very competitive. Our patents, which also protect our inventions, are established for the valuation of our intellectual property and targeted at investors who have an interest in the company. We use standards to support interoperability among products and systems – in business terms, it is a way to develop markets by building ecosystems with systems integration partners who use our technologies.

Our standards strategy can be easily seen when taking a look at the technology life cycle shown on Slide 26, which was kindly provided by Markus Reigl from Siemens.



SLIDE 26

On the left side of the slide, different historical periods are shown represented by the respective chancellors of Germany. In the past, standards activities were performed at the end of the technology life cycle. Nowadays, proactive standardization is required even at a point before the technology matures, which is demonstrated by recent innovations such as RFID/RTLS, mobility, smart grids, or IoT.

The explanation for this early onset of standardization is that with standards, a much larger market can be created. Any company can enter into, and participate in, a much larger market with high-volume products and applications. Standards create a vibrant ecosystem of partners, who contribute with substantial resources to provide end solutions.

To conclude my talk, I have shown you that there is an innovative IoT market, which certainly requires standardized technology platforms. These do not yet exist, but they are being developed as a lot of different technology- and application-oriented consortia are driving in this direction.

IoT applications, as the next step in Internet history, require partnerships in order to exploit the entire market potential. We, at Nanotron, have developed algorithms and IP for IoT-location-aware RTLS applications. We are successfully licensing these technologies with our products to partners and customers. Our standardization strategy helps us to create ecosystems in such a way that software and hardware components are provided for the entire end-customer application. Finally, I conclude with the observation that our activity to drive standards in our market segments supports the capitalization of our patents and our IP and that, as a consequence, the standards drive innovation.

Thank you for your attention.

Speech 2.3 Standards, an innovation booster?

Alice de Casanove,
Standardization Coordinator, Airbus Defence and Space, France, and Chair of ISO/TC 279, Innovation management

Good morning, I'm Alice de Casanove. I work for Airbus Defence and Space and I'm also the Chair of ISO/TC 279 on innovation management.

First, I would like to present my company, the Airbus Group. Our CEO is John Enders. We have changed the name of our group – previously, we were EADS, but nobody knew what EADS was – and our main product is aircraft. I'm sure you are familiar with the Airbus aircraft so we decided to call the Group "Airbus", simple! And we are very used to seeing our CEO with a parachute.

SLIDE 2

Slide 2 is just to explain that we are a company that takes risks, like our CEO.

So, what do we do at Airbus ? Of course, we produce aircraft, civil aircraft and military aircraft. We also produce satellites such as " Launcher ", and I'm sure you've heard of " Rosetta ", the space probe. That's one of our products. We also build helicopters. Today, we are divided into three divisions : Airbus for the civil aircraft, Airbus Helicopters for the helicopters, and Airbus Defence & Space for military aircraft and space. We have a comfortable order book. We have nearly 100 patents filed per year and we have 144 000 employees. That's quite big ! You see, we have a wide range of products, which means that for standardization it's also somewhat of a nightmare because we have to take part in so many technical committees and so many organizations at the international, regional and national levels. That's very, very complex so, it's mandatory that we have a clear strategy about standardization.

How to build standardization ? We have to be aware of the level of involvement we want to have in standardization because when we do something, we have to do it very well, to do it right. We have the choice of having a proprietary solution or of being a follower, which means that we take a standard and apply it or we can also be a contributor. If we see that there is an interesting standardization initiative, we take part in it and then contribute. The other option is to be a leader. In this case, we say we would like to create this working group or technical committee on this topic. But you know, we don't have unlimited resources and standardization is very time-consuming and also expensive (in terms of human resources dedicated to the activity). So what do we decide ? Well, we follow the market.

I'll give you three examples where standards were essential for the development of our participation in a market. The first one is Google Marketplace. You are familiar, I suppose, with Google Maps and Google Earth. If you have such nice pictures of Earth, it's because there are satellites taking these pictures. But who builds these satellite and who operates them ? It's us ! It's good to see images, but when you see images from space, it's a very huge amount of megabytes. You have to process this image to make it understandable by human beings. But when you have images, you have to spread them on the market. And there we use Google Marketplace to facilitate the spread of our images. We need interface standards to connect to Google's maps. So that's the kind of standards we develop at the Open Geospatial Consortium (OGC) and they are also developed at ISO in technical committee ISO/TC 211, *Geographic information/Geomatics*.

Second example : regulation. Nuclear power plants are required to have communication means capable of working whatever the situation. For example, in Fukushima, they would have been very pleased if they had been able to keep in touch with the nuclear power plant after the disaster. But when you have a disaster, generally the only means of communication you can use is satellite, so the idea for power plants was to set up satellite antenna dishes. To follow the regulation, and to

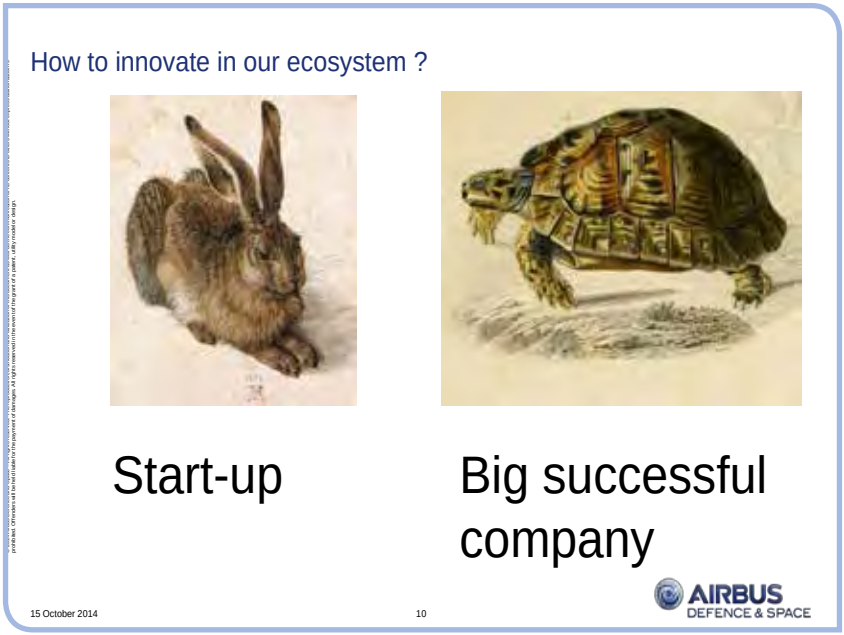
show that using regular communication means and satellite communication means were the same thing, we had to make a standard on the network conventions. So we made these standards to show that we can be compliant with the regulation using communication by satellite.

The third example has to do with certification. With the radar spectrum, we can develop a three-dimensional model of the earth. It's very useful for helicopters during rescue missions because when it's foggy or snowing, it's very difficult to land on the ground. With this synthetic vision, it is now possible for pilots to land safely. If you want to embed this 3D model of the ground, however, you have to be certified. You have to be certified against something and, currently, there is no standard for a 3D model based on radar spectrum images. So we are developing a standard on it, upon which certification can be based.

But let's come to the core part of my presentation : How do we use standards in our innovation process ? First, standards can be considered as the state of the art, the soil of your seed for innovation. Then, when you are developing your innovative project, you need to have partnerships and if you have partnerships, it means that you also need interfaces. Standards will bring you these interfaces. Finally, we come to the valuation of your product. In this case, you also have to organize your market and I think that's one of the key advantages of standardization. Standards can support the organization of a market, meaning that when you have a performance standard, it helps to bring clarity to the market and may eliminate those competitors who have very low-performance products. I have in mind a case where we contributed to the development of a performance standard and our customers used it in their request for proposals. They can indeed use this standard to say " we want a product with this level of performance ". As a result, some of our competitors providing very low-performance products were pushed out of the market.

You understand that there is an innovation process. If there's a process, it means that, behind, there's something that can be standardized. If we want to standardize something about

innovation management, we have to think about ecosystems. We see that there is a link between the company, its functions, its processes and the ecosystem, the environmental aspects, economical aspects and social aspects. If we have to consider these, we also have to consider who the players are. If you take a hare or a rabbit, for example, you see that it's a player which goes very fast, but which can also be weak and fragile (see Slide 10).



SLIDE 10

If one element is missing in the start-up's rabbit, it's dead – whereas the big successful company, if we compare it to a turtle, has a shield but it goes very, very slowly.

Generally speaking, the big successful company is able to mitigate issues very efficiently. So what's the best combination? Maybe the one shown on Slide 11.

SLIDE 11

It can be the best strategy, why not? But how can we do it? We have to be sure that both parties are able to talk to each other. Yet it's not really that easy to create a partnership. I take the example of a private company and a university. A private company will talk about business model, cash flow, image, market, customer, whereas for the university... what is important? Its lectures, funding, ranking, publications, students. That's absolutely not the same world. But what can we do? Have a common interface with standards! So the question is: "Why does innovation need management?" Because innovation impacts and, in turn, needs the contribution of all the support functions of a company, such as strategy, quality, supply chain, finance, and marketing. It has to work like a fabric, like a canvas. It means that you need organization and processes which guarantee that you have this canvas; and finally, you need to develop an innovation culture within the organization.

I mention innovation culture... What is it? It's habits! You have to take habits and finance. How are you going to govern risk?

Generally, when we talk about quality, we try to mitigate issues so as to have a "no risk" culture. Here, in innovation culture, we have to learn how to take risks and how to measure risk. So it has an impact on finance. How are we going to govern risk?

In human resources, what is the recruitment strategy that ensures that we hire creative and innovative people who have this sort of multidisciplinary attitude so that we have no more silos in the company? We also need to train our employees in an innovative way. And how are we going to change the company culture to build and spread this innovation culture?

That's what we do in ISO/TC 279 on innovation management. This is a new technical committee and the goal is to develop tools and methods that support the development of this innovation culture. We are quite young. The committee was created last year. For the moment, we have agreed on the work structure, that's a good achievement. We have four working groups. One will work on an innovation management system; the second on terminology, to ensure that we share the same definition of innovation and that we differentiate between innovation and innovation process.

We are very lucky because we have the Chair of working group WG 2 with us here today... Magnus, raise your hand. Then there's working group WG 3 on tools and methods, because all tools and methods to be mentioned in the innovation management system will be detailed in WG 3's document. Finally, we also need the assessment because when you publish a management system standard, people will ask, "Do I need to change something in my company?" This means that, maybe, before I get an assessment of what I'm doing, I need an assessment of my policies. So we also work on the self-assessment of an innovation management system. You see we are very nice people and we are waiting for you!

What kind of standards are we going to publish? As I already said, something about terminology, standards on an innovation management system – which means what the processes are and what type of organizations we recommend to foster an innovation culture – and some standards on tools and methods, intellectual property rights management (we have seen that this is

key), collaboration management (for example, how to manage your intellectual property in a collaborative environment), project monitoring (for instance, when you create an innovative project with a partner, how do you monitor it to be sure that both parties take advantage of this partnership, which is not always the case).

When are we going to publish the standards ? Well, in the middle of 2015. You are kindly invited to join us and take part in the work because, after all, although the ISO 50500 series will be interesting, the most interesting part will be in the debates that we are going to have in the working groups and the documents that we are going to exchange.

That's the end of my presentation. Thank you.

Session 3
Innovation policies

Chair's remarks

Chair: Thomas Kalling,
Director, Institute of Economic Research, Lund University, School of Economics and Management (Sweden)

My name is Thomas Kalling. I am a professor of organization studies and I am the head of the Standardisation Research Centre that we have at Lund University in Sweden, where I come from. I'm going to chair this session, which covers a very important aspect of the relationship between standardization and innovation, which is "Does standardization have a role in the framework of innovation policies and, if yes, what is it"?

We have four distinguished presenters here today. The first one is Mr. Barton J. Gordon, from the USA.

Speech 3.1 Standards and innovation policies from the US perspective

Hon. Barton J. Gordon,
Former Chairman of the House Committee on Science and Technology, House of Representatives, USA

Welcome everyone from Washington D.C. As mentioned earlier, my name is Bart Gordon. When I was first elected as Chairman of the Science and Technology Committee in the United States Congress, a reporter asked me what was my area of science and I told her that it was political science. I was taking good ideas from smart people and trying to implement them into good public policy. And probably, many of you standardizers may be surprised to know that a lot of policy makers don't go to sleep every night dreaming about standards, so I want to try to talk to you a little bit from the standpoint of a policy maker and how they're looking at standards.

You know, I think sometimes standardizers consider standards to be an end in themselves, whereas we policy makers see standards as a means to an end. Standards help us to accomplish goals that we would like to achieve and so, really, policy makers don't care about the standards themselves. They care about what standards can do for them in trying to implement that public policy.

Just as CEOs by and large don't care about standards in themselves; they do care about how standards can make them more efficient and more profitable. So let's take a look from a policy maker's perspective of standards and innovation, and I want to start really with these two key messages. Standards are a powerful tool to foster innovation. From a policy maker's perspective,

they are a means to an end. Policy makers are motivated in using tools that have broad acceptance and are aligned with existing best practices, rather than articulating policies and approaches that might be met with resistance. Secondly, the intricacies of standards and standards development are often too much of a "nuance" for high-level policy makers to get to know in detail. The standards community can really help by striking a continuing dialogue with high-level standards policy makers to highlight the impacts, benefits and, really, the implications of standardization. This is very important and this engagement is something that I hope, if you're not doing it yet, you will increase and do more.

So what about standards and technical innovation? In the USA, some policy makers in both the legislative and executive branches of government have recognized the important role that standards can play in adapting innovation through the development and adoption of new technologies. Standards play a key role in the approaches that the US has taken in fostering technologies such as the development of the end-to-end interoperability of the smart grid, cloud computing and cyber security for protecting our nation's infrastructure. I think you're going to see the smart electric grid followed by smart war grid and then by smart communities, and interoperability is going to be absolutely imperative. In all these areas, US policy makers recognize that a standards-based framework could provide a common and scalable approach that could be used by industry and government in a manner that is consistent with their existing business processes and approaches. Hence the adoption or use of this framework would not require a significant change in procedures that organizations already have.

Another element worth noting is that policy makers must recognize an appropriate role for the government. Rather than mandating standards or technologies, policy makers need to identify desired end goals and assign government agencies with a significant expertise in standards to assume the role of convener. Thus, you're not picking winners or losers but setting a direction. By assigning a convening role to an agency with experience and expertise in standards, and in working with industry and

government agencies as a neutral technical expert, policy makers set the stage for a conversation among stakeholders who would otherwise take much longer to convene on their own. For example, there were 22 different sectors that were brought together in the discussion about the smart grid.

Now let's take a look at standards in trade. Given how trade and commerce impact every individual, policy makers are very tuned into the benefits and impacts of trade. Policy makers need to recognize the role that standards can play in fostering trade and commerce. There is a strong interest relating to standards in many of the trade agreements that are currently being negotiated by the US and other countries. The Trans-Atlantic Investment and Partnership, or TTIP, is a very good example. There's probably only 3% or 4% of a tariff in general between the US and Europe and so, really, the TTIP is more about the harmonization of regulations and standards to make both the US and the EU more efficient. Policy makers need to recognize that common standards among countries can reduce the costs of doing business and provide tangible benefits to consumers and business. And with companies having global supply chains and global markets, International Standards that are broadly accepted provide important and much needed efficiencies.

There is also an international imperative. What this means is that the standards efforts have to be global in their nature. Policy makers have to balance a number of competing challenges or share a common agreement on developing effective standards that provide net benefits. Clearly, standards fall into that very space and standards organizations can play an important role in supporting efforts to provide tools to policy makers as they become more effective in considering standards and standards-related aspects when developing their policies. Standards or standardizers must also recognize that human factors must be taken into account. As we approach the "Internet of Things", for example, there need to be rules and a road for privacy. Again, for example, what do we share, when do we share it and with whom do we share it? And let me just conclude by saying there are approximately

7 billion people in the world and half of those that are working make less than USD 2 a day so, in a global economy, we have the option of either competing on wages, and seeing my 13-year-old daughter's generation inherit a national standard of living that is lower than their parents', or we can compete through innovation. And I think there's a very important intersection between standards and innovation which can lead to new industries and new products and more and better jobs.

Thank you for your attention.

Speech 3.2 Standardization to foster innovation

Roberto Paoluzzi,
on behalf of Marco Conti, Director, National Research Council (CNR), Department of Engineering, ICT, Energy and Transportation, Italy

Good afternoon everybody. I am replacing Prof. Marco Conti who is the head of my department. I pass on to you his regards – unfortunately he is not able to be here today – and also the regards of the President of the National Council of Research of Italy.

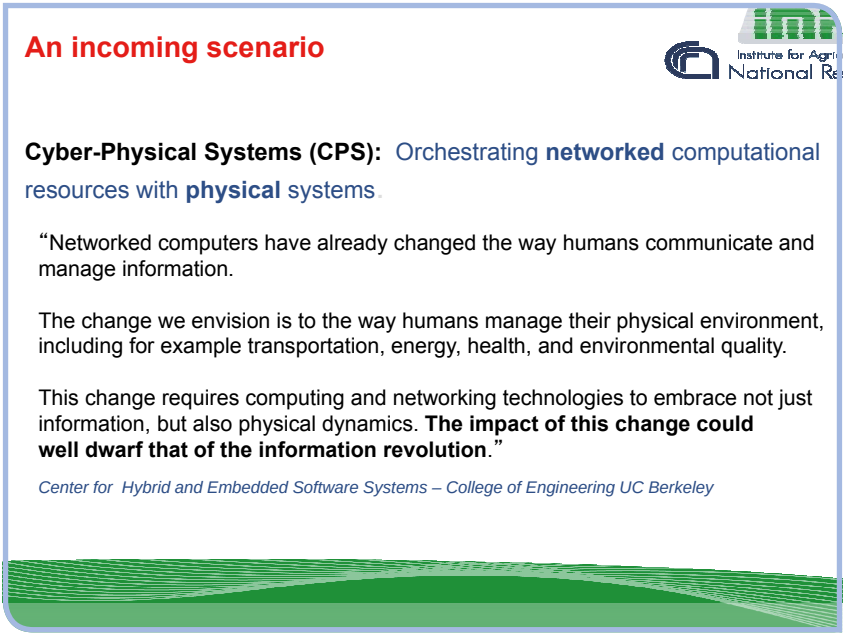
The department of Prof. Conti includes some 1500 researchers and 21 institutes spread all over Italy dealing with ICT and Technologies for Energy and Transport (DITTET).

I'm one of the directors of these institutes and it would have been easy to talk here about the big challenges in front of us that will force legislation to interact with standardization in order to deal with innovation – for example, to meet the challenges of feeding some 9 billion people by 2050, to address climate change and broad transformations of society.

However, I would like to stay at a more descriptive level, trying to identify how we could imagine legislation interacting with innovation and standardization to address specific issues.

An incoming scenario, potentially disruptive, as we have seen this morning through the presentations of several speakers, is that of cyber-physical systems (CPS).

The advent of CPSs is so pervasive that it will most probably underpin developments in almost every field. Networked computers have changed the way humans behave, but changes will be much bigger in years to come. Networking technology and communication technology now address problems related to our physical world: not "above it", but "within it". The impact of this change could well dwarf that of the information revolution.



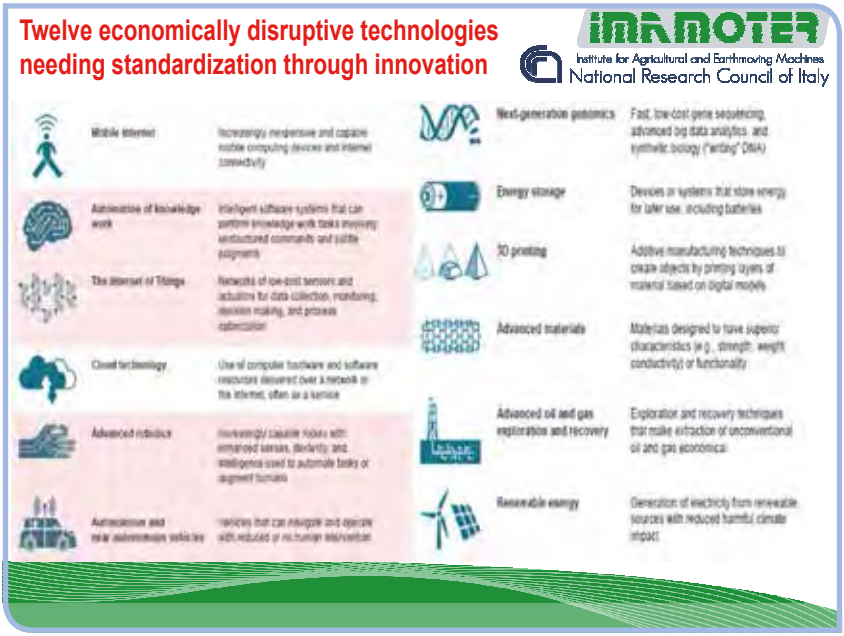
SLIDE 2

The statement in Slide 2 is taken from the Center for Hybrid and Embedded Software Systems, College of Engineering, at the University of Berkeley, California, and was presented some years ago, but we are now seeing these things happening in practice!

We have two big problems here. One is that cyber-physical systems differ from general-purpose software systems (see Slide 3).

SLIDE 3

They deal with the physical world, they deal with human beings, and they deal with non-deterministic environments. We have to identify deterministic rules to communicate. So, there is a problem in orchestrating the interaction with the physical world : timeliness, safety, reliability, security, privacy and adaptability. This is the big challenge underpinning all the other challenges we have to face in the future.



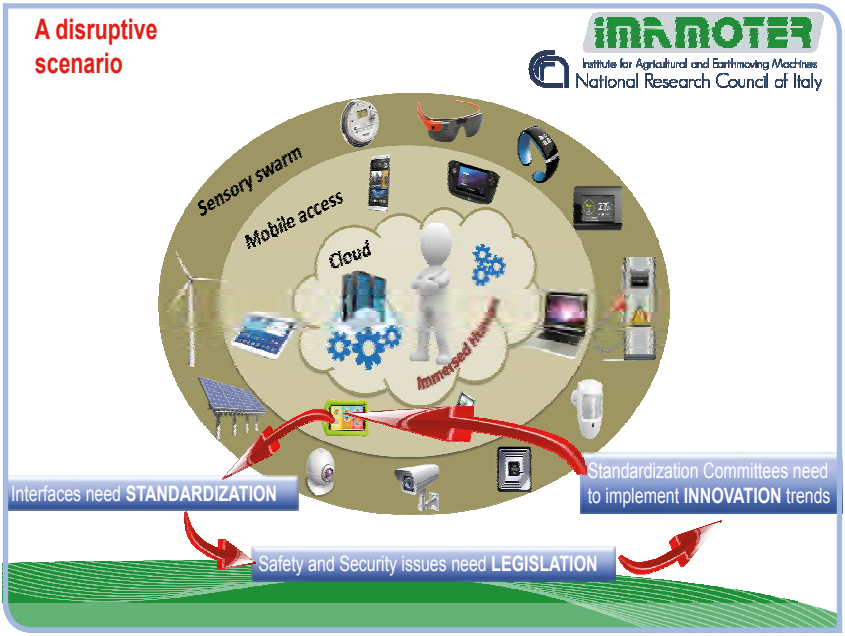
SLIDE 4

To show you how this can impact our life, 12 economically disruptive technologies are presented on Slide 4 : *Mobile Internet* – we live with it already ; *Automation of knowledge at work* – intelligent software systems able to interact with humans ; *Internet of Things* – we have already talked about it this morning, and so on. You can scroll through the list and will appreciate that all these technologies will really change our lives. I will not go into the details of each one, but I will try, through some examples, to show how these developments require legislation, which is synergistic with innovation and standardization.

One problem for all of us is that of security and privacy. We have already been faced with that. When you look at Google, when you switch on your mobile phone, you are already concerned about privacy and maybe you don't think enough about safety, which is another aspect of security. By chance, in Italian, we use the same word for safety and security, and so we tend to mix them.

But that problem was already foreseen by some visionary writers in the past. Already in 2002, Michael Crichton identified

those problems in his novel *Prey*. What is the scenario which is actually a disruptive one?



SLIDE 6

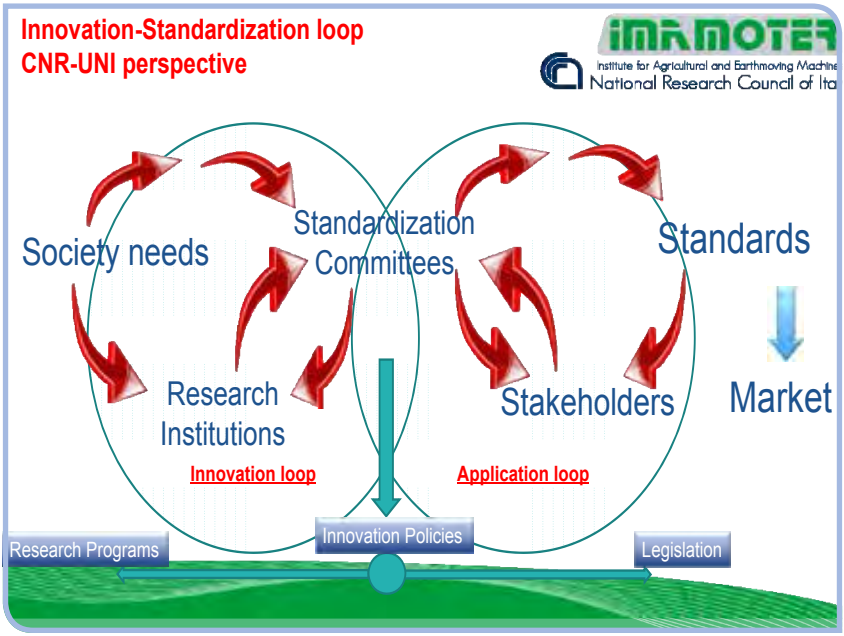
On Slide 6 you can see a centre with an immersed human who interacts with the cloud for exchanging information and interacts with machines for working. Around him, we have the whole cloud of mobile access and, around that, a sensory swarm, which means that we are going towards a world where components and sensors are not taken apart from each other. We will face a world where everything will be a sensor and maybe also an actuator and these need to talk to each other. Therefore, interfaces need standardization. We cannot imagine that scenario if we don't have rules to describe how each and every part of it talks to the other.

Of course, this implies safety and security issues. When you exchange information, maybe sensitive information, you have security issues, you have the privacy issue, you have safety issues. When you think of a human interacting with a robot – I mean the two working together – this has a big impact on safety. Therefore,

standardization committees need to support such innovations and this is not trivial because it is not a conventional part of their process. There must be a loop, otherwise we will never be able to solve the problem.

Looking at the past, we can consider what happened with GSM's cell phone technology. GSM actually became a standard, a *de facto* standard. At the beginning, mobile technology was based on different proprietary systems all over the world and this was actually one of the major threats to the development of a global communication network. Only when we moved to a globally accepted standard, as a technology driver, were we able to reach interoperability. Well, this happened in the past; we should do better in the future.

What's the vision that we have here? We have three main factors or players: *society needs*, that define what we need, *standardization committees* which are in between and *standards* which are what we later put on the market.



SLIDE 8

I will spend some time on Slide 8 because it links very well with something that was presented this morning by other speakers.

We start from this view where we can identify two loops. The first one is an innovation loop where "society needs" go to standardization committees and to research institutions. Researchers interact with standardization committees to develop innovation.

Then we have another loop, the application loop, where we actually put into practice what we try to standardize. We identify possible threats, maybe new needs, new things which are all played by the stakeholders. The involvement and feedback of standards users are essential in order to have something effective on the market.

In this way, we identify the role of innovation policies, a twofold role supporting the innovation side as well as the market side. They act in the overlapping of the two loops, where, at another level, we have the standardization committees that contribute to the development of the playing ground.

We try to apply this approach. And this vision of an innovation–standardization loop was behind the Agreement that the National Council of Research signed with the Italian standardization body in October 2014.

Of course, not all of the 8 000 researchers of the National Research Council take part in this activity but we have already appointed 153 researchers in 19 technical committees. Nine of them have a coordination role and we have set up a strict procedure for appointment to ensure that participation is effective in enabling the standardization committee to reach its targets and to tackle the problem of international representativeness.

What is the scope of the agreement? Pre-normative research and everything you need in the first innovation loop, starting from a societal need and trying to think of a solution to that need in terms of what a standard can do and, of course, scientific and technical content of the standardization work.

We have to avoid standardization being seen – as it can be in some areas, in some committees – as a protection tool which small companies can use to avoid their product being pushed

out of the market by leading companies, or, the opposite, leading companies forcing the market to a solution where they have proprietary knowledge and huge advantages.

Dissemination, information and training – agreements with universities, of course! Standards must become, and this is another issue that we try to promote through legislation, standards must become a tool for teaching at universities. I remember when I was a student – in another life I was a nuclear engineer, so I'm rather thrilled to be here because CERN was a sort of temple for me when I was a student, and actually it is my first time here – we studied standards. I remember the standards in the nuclear field; at the time they were our textbooks.

We lost that over time, I think. We have to recover that use of standards. Standards are a repository of knowledge and this knowledge must be used at university, but not only at university. I use the word "university" just to say that we have to use that knowledge for dissemination, for training, for education, and for creating a culture of standards.

Now let's go back to something more practical, to look at some real evidence of the scenario that I tried to present before. I will give you three examples, which actually are worked-out examples from the ISO technical committee that I am chairing. Use of non-metallic advanced materials in *Operators protective structures*, which is now a draft technical specification. *Functional safety in electro-hydro-mechanical systems for earth-moving machinery*; it's a working draft at this moment in time. And *Energy use test methods in mobile earth-moving machinery*, which is a technical specification right now.

There are many other projects which address pre-normative documents in critical research areas and our approach is common to all of them. We have established a framework for gathering data and identifying critical areas, which may not be covered yet by adequate knowledge, and we decide how to allocate resources for further research.

So, what happened to the non-metallic materials, advanced materials in operator protective structures? I won't go into detail

on the standards for protection of operators in earth-moving machinery, just let me tell you that existing standards prevent the use of non-metallic materials.

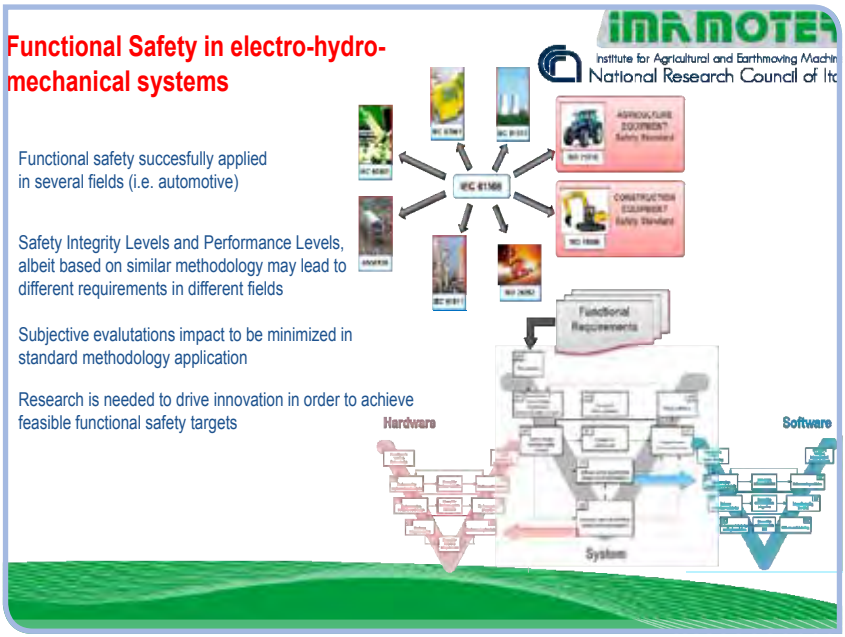
The standards were written for metals and they prevent the use of any other material – but that's not the reality. There are materials, such as techno-polymers, immerse composite materials and so on, that have the power to respond to the demand. Why should we hinder their use ? This potential indicates the need for a qualification procedure for " new " materials in the field because it's not enough to say that they have adequate mechanical strength, you have to say something more. A full document describing how to test the materials and qualify resistance to ultra-violet biological attack and other factors was developed, but there was a lack of experimental data to support it. Dedicated research is required to fill this gap.

I know that Europe is now looking very closely at the need for dedicated research and standardization through an agreement between the European Commission and CEN (the European standards body). This is a typical example of where dedicated calls for publicly funded research can be issued on the basis of a clearly identified need promoting research in the field and helping standardization to foster innovation.

Another, maybe different, way of identifying critical problems is to look at the functional safety in electro-hydro-mechanical systems, an issue which is not entirely new. Functional safety analysis is an established engineering technology and is applied successfully in the automotive field but it is not possible to transfer it " as such " to another field.

Therefore, the definition of *safety integrity levels*, *performance level* and everything which is implied by a functional analysis applied to special environments like the one presented on Slide 12 – where you deal with a structured environment and don't have a

fixed mission profile like with cars – is extremely difficult and can lead to different performance requirements or levels which are not within the boundary of feasibility of the technology in that field.



SLIDE 12

It is also prone to subjective evaluation because – this one is taken from an ISO standard – when you analyse the system at the software level, the hardware level and the overall system level, the methodology can leave the door open to subjective evaluation. We have to minimize those subjective evaluations in the application of a standard. This requires benchmarking and research to drive innovation in order to achieve a feasible functional safety target. It's beyond what we can do just working with pen and paper or computer and mouse.

Another one, as shown on Slide 13, is *energy efficiency in mobile earth-moving and agricultural machinery*. This was an idea that was presented at the summit of the manufacturers of agricultural and earth-moving machinery in Brussels a couple of years ago.

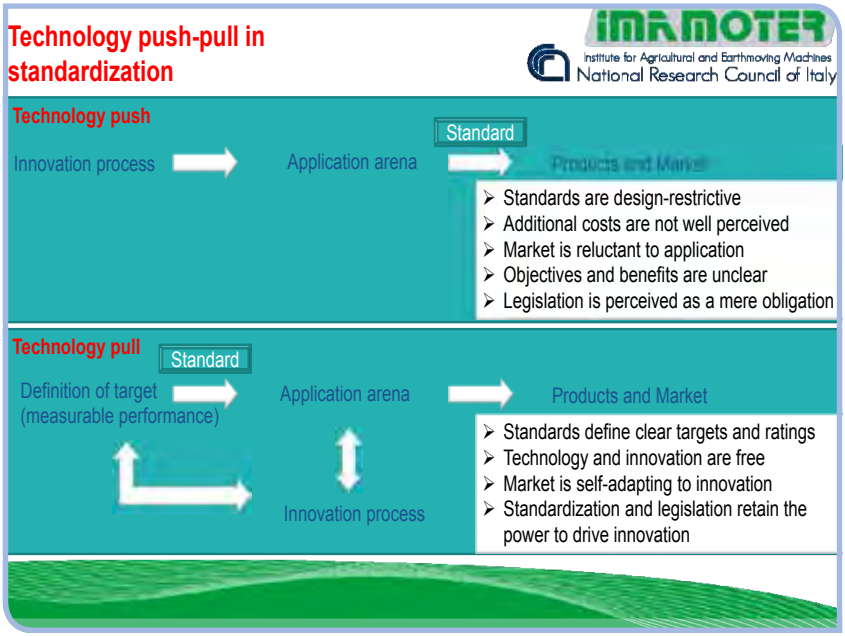
SLIDE 13

When I presented this view – inside the bus that drove all the CEOs responsible for everything back to the hotels – there was more or less a wrestling match. To understand why, you need to look back at what happened to home appliances. When the requirement for the energy level in home appliances was first introduced, 99 % of them had an energy rating which was rated B or below. After five years of implementation of that legislation, 99 % of home appliances were at an efficiency rate of A+ and it was necessary to introduce higher rating classes because of the tremendous effect it had on the market. That was a very wise application of legislation on standardization but it needs research if you want to apply it properly because you have to develop adequate rating classes, proper rating and test methods. We are working on that at the research level and ISO is already working on a proposal for a label concerning energy-using products in earth-moving machinery. ISO is trying to develop a testing cycles' reference standard to define the energy-efficiency rating for earth-moving

machinery. Of course, a lot of investment is needed to develop adequate knowledge and to record it in a database.

This is part of standardization costs, but we must not consider it a "cost". In fact, it is an investment and the return on this investment comes very fast. If you try to translate – what I told you before about the changes in home appliances – time and numbers into euros or dollars, you understand why investing in developing proper testing methods, from the point of view of society and of the legislator, pays back in just a few years. Preparing the presentation led me to think about the concepts of *push and pull* in technology because I think that trying to define technology *push* without considering its *pull* is nonsense.

It depends from which side you look at it. Let's imagine that you see technology as a push, as in the upper part of Slide 14.



SLIDE 14

If you consider the application arena from this perspective, standards are design-restrictive because they are at the end of the story. Additional costs (linked to these restrictions) are not well

perceived by society ; the market is reluctant to their application ; objectives and benefits are unclear ; and legislation is perceived as a mere obligation.

This doesn't work well. If we move the standard up earlier in the development process, we define a target as a measurable performance. We include the innovation process in the loop and, in this way, we get to the products and to the market. With standards that define clear targets and ratings, technology and innovation are left free to develop, the market is self-adapting to innovation, and standardization and legislation retain their power of driving innovation.

Just a final statement here. Integration of innovation and standardization provides clear and feasible targets for achieving the needs of society. A proper innovation policy must exploit the potential coming from standardization committees, seen as a " playing arena " where pros and cons can find the optimal compromise. I recall that engineering is the art of compromising. Innovation policy must use the **proper tools**, define the **rules** of the game and the **rating score**, but not the underlying technology, which is a matter of inventiveness and free competition.

Speech 3.3 Synergy of research, innovation, enterprise & standards

Andy Hor,
*Executive Director, Institute of Materials Research & Engineering, Agency for Science, Technology and Research, A*STAR, Singapore*

Enough has been said on standards, innovation, the connections between the two and even the justifications for these

connections. I don't think I need to say too much now. What I want to do is focus a little bit more on the session topic of today. We are in an innovation-standards conference and this session is about innovation policies.

If you put all these in a basket, you will realize that when you set policies you have to think about the sort of systems you have. What is the background, what is the structure, what sort of people do you have and what do you want to achieve at the end? If you think about all these, then you will know how I have constructed my speech. Let me present to you the structure in which we operate, how we try to drive an outcome from it and how we develop standards, innovation and research at the same time.

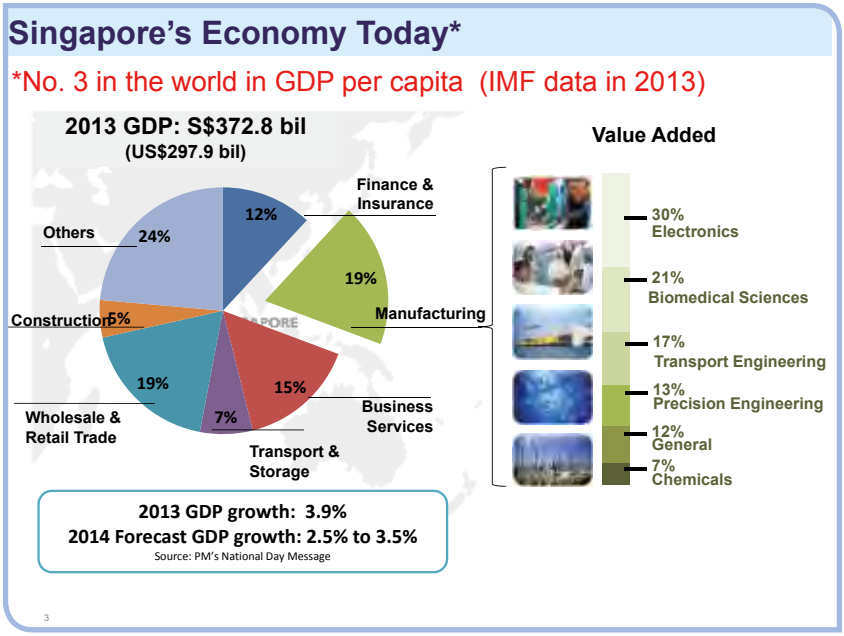
In case you think we come from China or Japan or somewhere else, we would like to tell you that we come from a very little place called Singapore (see Slide 2). Asia is huge by the way.

SLIDE 2

You go all the way down there through China and Malaysia to a little place called Singapore. Amazingly, actually, if you think

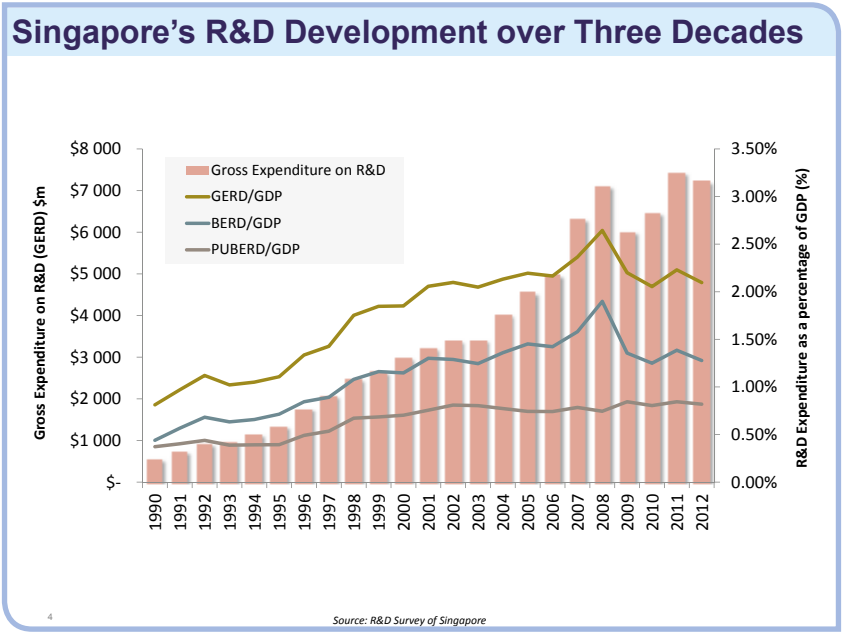
about it, if we put all these together, it becomes our strength and I hope that this is my first message to you. You can develop research, innovation, standards and enterprises in one pot, if you do it carefully, if you plan wisely, and you can accomplish something in the world.

Slide 3 shows some flattering data from IMF, if you look at it this way.



SLIDE 3

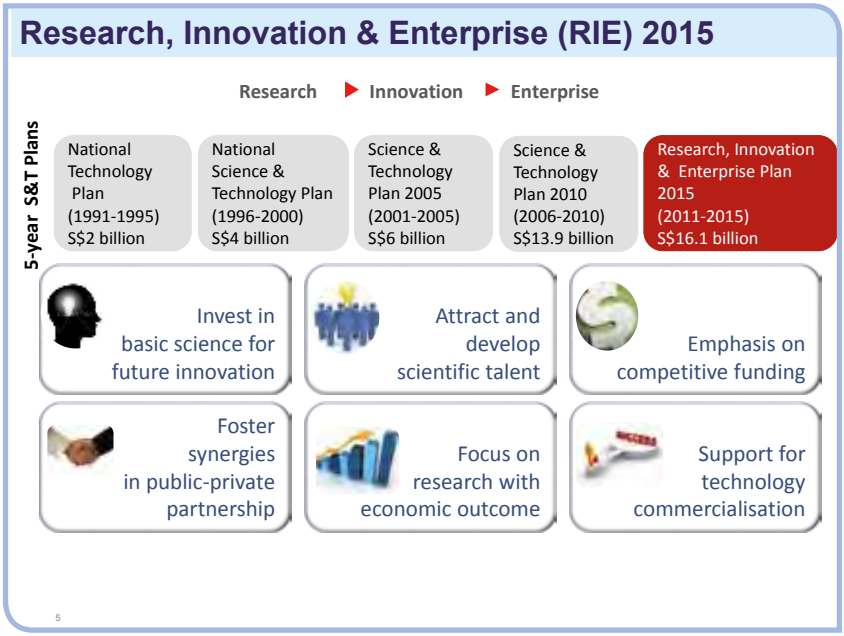
One important thing we try to do is to keep the manufacturing. I emphasize that this is our first priority. If you ask me anything about the secrets of Singapore – I will tell you a few today – the first one is that we keep the manufacturing and the second one is that we diversify into a whole range of activities that are related to our life and livelihood.



SLIDE 4

On Slide 4 you can see our investment in R&D, a common indicator if you like. I don't know whether there is a standard on this. In any case, you measure your R&D expenditure in terms of feasibility, how much you're prepared to pay. This is actually a collection of data over two to three decades. You have to sustain. You know Singapore is not Europe. Twenty years is a long time in Singapore's history. Going from 1990, this shows the evolution of R&D expenditures in dollar value and in percentage of GDP. If you look at the total, you can see it is a hard climb.

This is due to the government. The government is always a little bit more sustainable, a little bit steadier. The business expenditure by the private sector (BERD) depends on the economic outcome so, if you put it together, you go through ups and downs. However, as long as you sustain a certain level through public expenditures on R&D (PUBERD), you reach a total of about 2.3 % today in terms of GDP, which is quite respectable. We're not as high as Scandinavia and maybe Switzerland, Japan, and perhaps Korea, but we are getting there.



SLIDE 5

Another thing I want to emphasize is that you go through a five-year cycle (see Slide 5) and, in Singapore, in terms of funding, it started at a very low base of 2 billion Singapore dollars, which steadily moved to 4, 6, 14 and then 16 billion Singapore dollars. This is very difficult and requires a lot of determination and resourcefulness because, just like climbing, the higher you climb, the more difficult it becomes.

There comes a stage when you think about whether you still want to climb and what sort of price you have to pay. If you look at it this way, the six strategic directions in our national development plan for innovation, enterprise and standards, you can see there is a focus on research and its economic outcome.

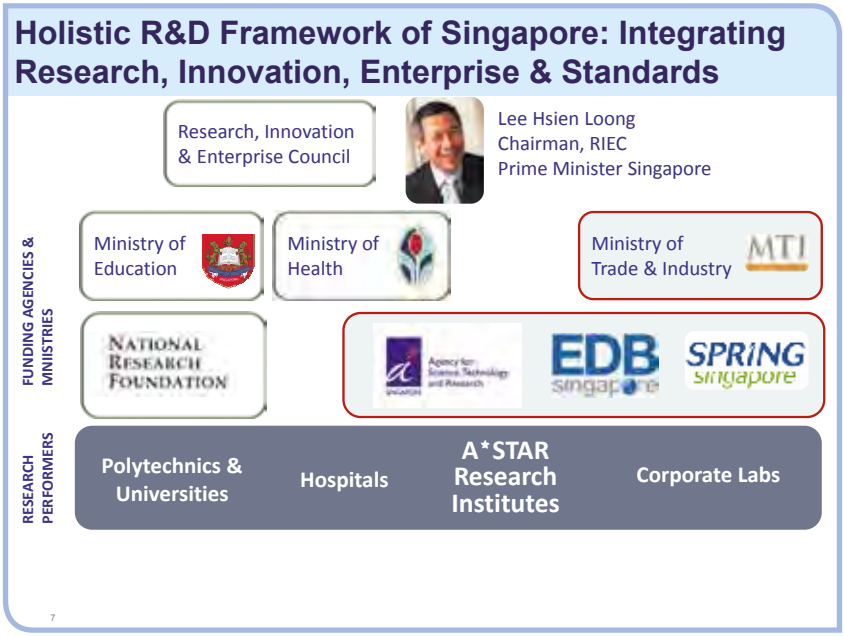
We support technology commercialization. This is a national agenda, so when you look at it this way, it is not surprising that we give innovation such a high priority and, of course, public-private partnership is a given conclusion.

Now, this is all we have.

SLIDE 6

Singapore is a very small place, but within that space you see that we have hospitals, universities, research centres, public organizations and corporate labs. You have everything, so this is how you develop what we call the whole government approach.

Slide 6 contains a very simple way of presenting how we approach research, innovation, enterprise and standards.

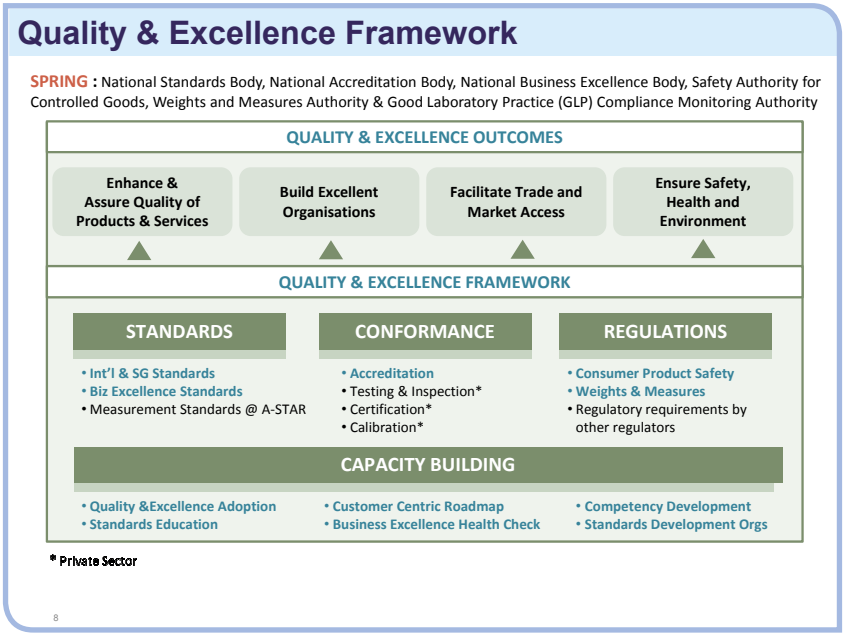


SLIDE 7

You have a Ministry of Education and this is directly under the Prime Minister's office (see Slide 7). It looks very simple, doesn't it? There's the Ministry of Health and the Ministry of Trade & Industry. It's also very simple. If you look down here, you of course have the National Research Foundation (NRF). I have colleagues here who can explain a little bit more about the NRF. Then you have three bodies – I will explain: SPRING, which deals with standards all the time. They eat with standards, they think standards and they sleep with standards. Then there is the A*STAR, a public-sector agency that promotes economic-oriented research to advance scientific discovery and promote innovation; and, finally, there is the Enterprise Development Board (EDB), a government agency aiming to promote Singapore as a global business centre; they are side by side under the same ministry. You don't even need to explain; they are inherently connected.

At the bottom you have the universities, the A*STAR research institutes, hospitals, laboratories – so let me tell you how this very simple system works.

My colleagues at SPRING gave me this slide.



SLIDE 8

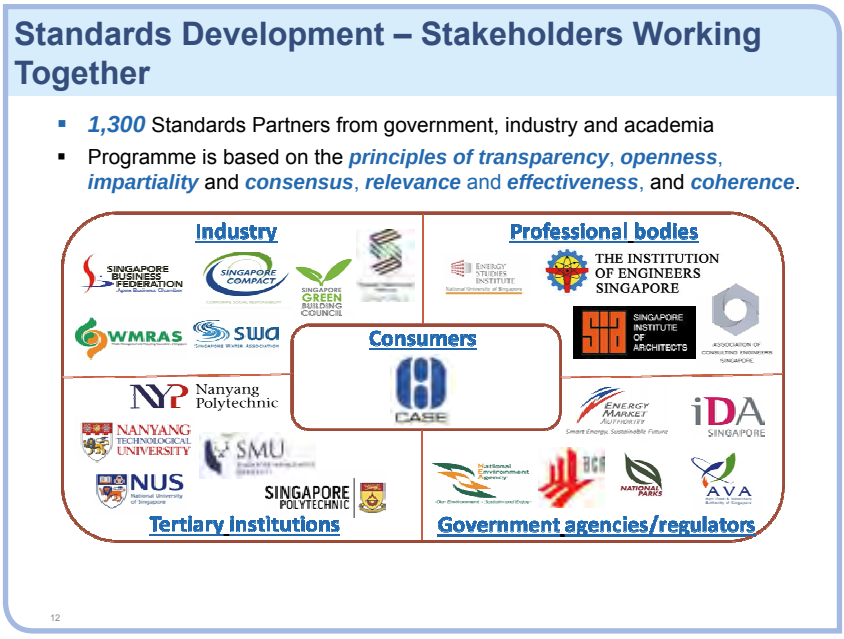
SPRING is a body looking after productivity in Singapore and it is tied closely to our SMEs (see Slide 8). Of course, standards are an essential ingredient. Without common standards, you cannot operate, particularly in Singapore where you have the multinational companies (we call them MNCs), the small companies (we call them SMEs), the universities, and the research institutes.

When you put all these together, you need a common platform and this is where standards come into place. So when you have all these elements, it becomes very clear to you. SPRING also takes responsibility in capacity building. Now, this is a little unusual but they have taken this on. It is extremely important and, therefore, under that, you have a Council which comprises key individuals from industry, senior management from government agencies and representatives of consumers. Through the Council, we encourage public-private partnership. This is another key point in our policy when we talk about setting standards.

Then the rest is rather conventional : you have standards committees, technical committees and working groups. All these become very natural and many of us are involved in different layers, but not as governmental officials of course. My colleagues here will tell you that many of the researchers, academics, industry people, consultants, and educators are intimately involved in the entire standardization process.

This is how we function as far as standards and innovation are concerned. When you look at standards development, we like to target a specific industry because different industries have different standards. Singapore lives on electrical engineering and electronics, for example, as well as on chemicals, building and construction. In addition, we have emerging sectors which include biomedical manufacturing and what we call the silver industries (targeting elderly people). All these require standards. There are a lot of things to do. There is a lot of innovation to do and life goes on in a very interesting way.

Again, let's go back to the organization (see Slide 12).

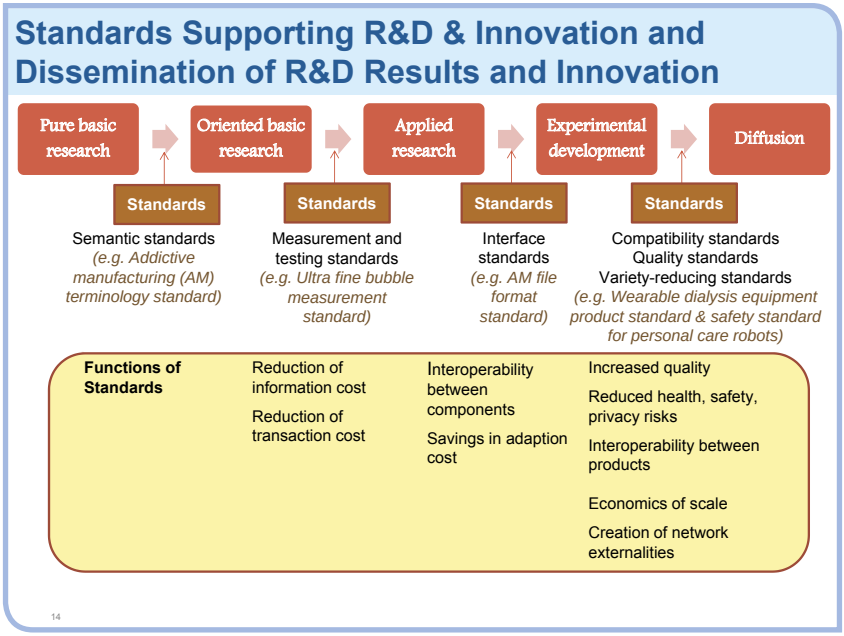


SLIDE 12

You see that when you put together industry, tertiary educational institutions, government agencies and professional bodies, you obtain a wide spectrum of expertise and setting standards is about getting professional consensus, getting public consensus in the whole exercise.

Therefore, when we reason about standards, R&D and innovation, first we see standards supporting R&D (I don't think anybody here would disagree). Then, we also see R&D providing input into the standardization process. And to complete the loop, we see how public authorities can use standards to disseminate new technologies for the society and to promote the economy.

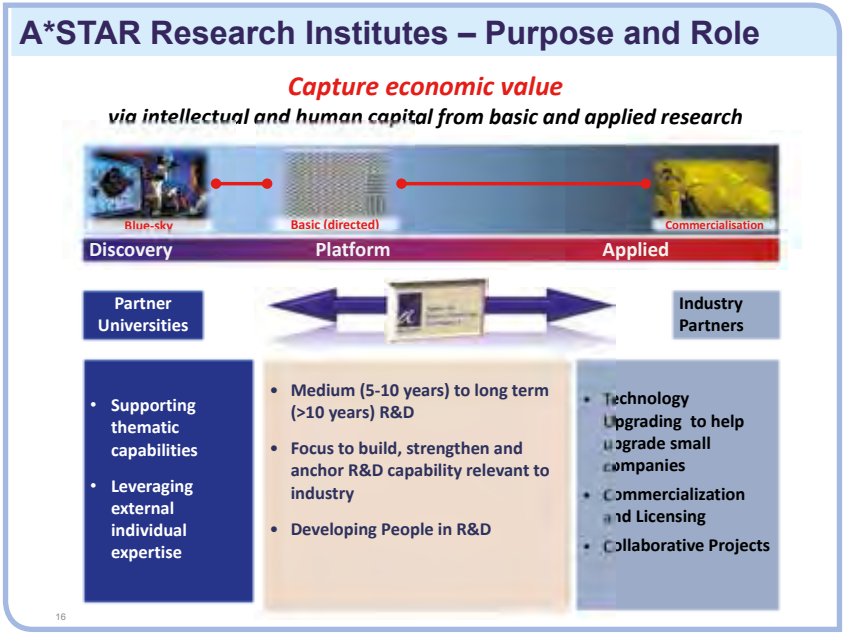
As you can see on Slide 14, in this framework, we are moving from basic research all the way down to the diffusion and experimentation processes and, in every step, standards are involved.



SLIDE 14

This is how policy and standards come together to drive innovation.

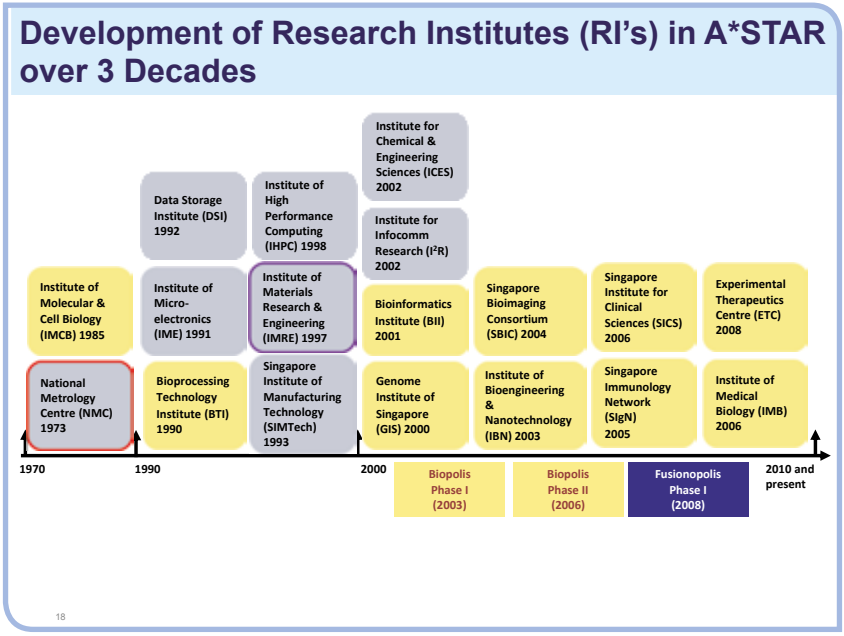
As mentioned, A*STAR – Agency for Science, Technology and Research – works side by side with SPRING in looking after standards and SMEs, but let's focus our attention for a moment on the Agency (see Slide 16).



SLIDE 16

Universities work a lot on discovery and industry talks about industry partners; therefore, A*STAR functions in a very interesting space. We call it *translational research*. In this regard, I have colleagues here who try to exploit new technologies and really look after our commercialization arm. They work side by side with engineering as well as with our Medical Research Council, where we have the research institutes. At the same time, we are developing the talents for the future; therefore, when you put all these into one organization, you see that communication becomes the key.

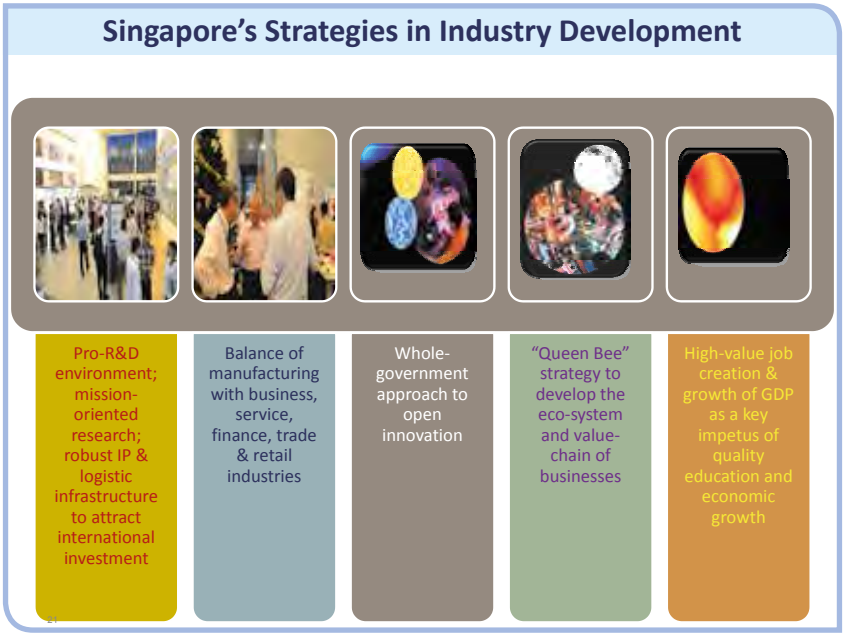
I think time is too short for you to look at this one but just let me tell you that, in Singapore, a lot is put into the planning. For each important area – whether scientifically or technologically important – we develop a focused research institute (see Slide 18).



SLIDE 18

So, looking back, 30 to 40 years ago, we already had the National Metrological Centre. Many of you don't know that. It tells you a lot. Even in the early days of our research development, we realized the importance of standards. We talked about metrology and we established this institute first, before considering different research organizations. That tells you how we go about it. This is a research community and we always look at standards, even when we talk about certain applications with excitement.

But I want to leave you with a few slides and Slide 21 is on our industry development strategies.



SLIDE 21

First, we want to provide a strong Pro-R&D environment, supporting mission-oriented research and offering a very robust IP and logistics infrastructure. This is how we attract international investment. Second, we intend to maintain a balanced research portfolio including manufacturing, business services and other sectors. Third, I think the whole government approach is a key to our open innovation. Fourth, we pursue a "queen bee" approach – everyone knows how a bee works – to develop R&D ecosystems and, finally, of course, we do want to create high-level jobs and contribute to the growth of Singapore's GDP.

In doing so, we work across different clusters and this is how, by setting a common standard, different companies come from Europe, North America, and Asia. They are able to cooperate, big and small companies alike.

I am running out of time, but let me give you a few final examples. The national metrology system has very clear mechanisms for tying to the international bodies in areas such as SI (International System of) units and down to the local governmental agencies as well.

Let me give you a good example. You might recall that, in 2003, SARS was a huge problem hitting a large part of Asia and other places. It's easy to imagine how, at that time, it was almost impossible to measure the temperature of all the people moving through the airport – but it had to be done. At that time, a standard research tie-in was quickly developed. The result was the development of the so-called thermal-image technical reference. After that, it became a standard and nowadays we commonly use it in the airport.

Let me share another of our secrets, if you like. By working with big companies, you have the advantage that they set standards for you. And by working with them, you know what you need to chase after. Therefore, it drives your innovation growth in research and we work it quite well. However, you always have to be careful and to maintain rigorous control and a balanced approach. This is the case, for example, when applying nanomaterials in personal care.

This area of applied research is scrutinized by regulators and consumer representatives. Is it legal, and in which countries and regions? Is it compatible with other ingredients? Is its presence at an acceptable level? What is acceptable? Is it within legal limits? How was it measured? What is the detection limit? By what? And so on.

Our approach to address all these issues is based on a sound combination of research and standardization activities – including the establishment of the National Technical Committee (TC) for Nanotechnology and our active participation in ISO/TC 229.

I would like to say a few final words about Singapore's "Water Story". When a country does not have enough water, it is a big problem. You have to develop water for your people and you have to put together a lot of research and innovation efforts. We have finally solved this problem and now there is something called "new water", which turns waste water into drinkable water. When

you do something so new and so sensitive, you need a full set of standards that comes with it – and we have developed all that.

As a result of these efforts, this technology is now marketable to foreign markets – for example, it is helping Saudi Arabia solve their water problem, bringing significant new business into the country.

In an urban context like Singapore (and actually in many other countries, as well), you have a nanomaterial problem in the water system. But we have developed a system to trace, monitor and analyse nanomaterials in the water system, contributing to international standardization in this field. This is another interesting example of how innovation, business and standards come together to benefit society.

Thank you for your attention.

Speech 3.4 Standards in European innovation policy

Leonor Pires,
Policy Officer, DG Research & Innovation, European Commission

Standards seem to be everywhere in European innovation policy. For example, in the context of the Commission's work on innovation in ICTs, standardization is important to ensure that products retain the ability to connect with each other, boost innovation, and keep ICT markets open and competitive.

With communication on a strategic vision for European standards, the Commission has proposed actions to ensure that the standardization system is fit for fostering competitiveness and innovation.

The Commission is working to ensure that standards support the innovation ecosystem and have a relevant role in research within Europe.

It is about this closer link between standards and innovation policy that I am going to talk to you today.

A new start for Europe

Over the past few years, Europe has suffered the worst financial and economic crisis since World War II. In a context of slow growth and high unemployment, unprecedented measures have had to be taken and Europe has spent several years concentrating on crisis management.

Now, more than ever, Europe needs to deliver on growth and new jobs to compensate what was lost in the crisis. Innovation is central for sustainable growth and for new jobs that create value.

Well-designed, timely European standards are an essential tool for accelerating the diffusion of innovations and work as a platform for further innovation.

Standards and innovation

Standards can support innovation in a number of ways:

- Existing standards can codify and spread the state of the art in various technologies, disseminating knowledge, both within and outside the relevant industry community
- They can facilitate the introduction of innovative products by providing interoperability between new and existing products, services and processes, providing a technological platform on which other innovation can take place
- Innovations can more easily gain market acceptance if they comply with existing standards for safety, quality and performance
- Standards can have an important catalytic role in demand-side measures to encourage innovation such as outcome-based regulations or public procurement of innovation

- Finally, standards can help to bridge the gap between research and marketable products or services. A standard can codify the results of publicly funded research, thus making them available as a basis for further innovation. This can be a highly effective mechanism for knowledge and technology transfer

The European standardization system: is it fit for innovation?

Emerging economies have a stronger role and the increasing speed of technological change has a big impact on global markets: they are moving faster and faster. Together with the shortening of innovation cycles, this could raise concerns about the capacity of the European standardization system to respond.

As standards need to keep pace with ever faster product development cycles, the standardization system also needs to be able to adapt to the rapidly evolving environment, facilitating innovation. We need a standardization process that:

- Keeps pace with the rapid shortening of innovation cycles
- Can ensure that the European industry remains competitive in a fast-changing global landscape
- Can be managed to address the key challenges lying ahead for our economies and our societies

Therefore, the policy responsibilities of the EU in the standardization process cannot be limited to supporting European legislation. In order to secure competitiveness, the standardization system needs to be fit for purpose.

We see three fundamental dimensions for standards in relation to innovation policies:

- Trends and foresight studies can help to anticipate the need for standards development, by linking emerging technologies and research needs for future products and processes to policy definition. Standardization needs are being anticipated through multi-annual programmes. The annual Union work programme for European standardisation, together

with the rolling plan for ICT standardization, covers the deliverables that the Commission intends to request from the ESOs (European Standards Organizations) in the coming year and the specific policies they support. They also refer to the Research and Innovation (R&I) priorities concerning standardization which are embedded in the EU funding programme for R&I, named Horizon 2020

- In areas of high political and economic importance, standards can be used strategically to accelerate the development of innovative solutions. Standards that contribute to innovations that tackle pressing societal challenges will be prioritized using the mechanisms set out in the flagship Innovation Union, such as the use of European Innovation Partnerships
- Standards should, as much as possible, include state-of-the-art scientific knowledge. Scientific activities can make a key contribution to the standardization process. For example, pre-normative research is a prerequisite in many promising industrial applications as a means of establishing a level playing field for industrial cooperation and a predictable regulatory environment for future market development

A systematic approach to research, innovation and standardization should be adopted at European and national level to improve the exploitation of research results, helping the best ideas reach the market and achieve wide market uptake.

A concrete example where the EU is implementing this type of strategic approach is Horizon 2020.

Horizon 2020

Horizon 2020 is the EU funding programme for R&I. Unlike previous framework programmes which were more research-oriented, Horizon 2020 has a renewed approach by covering the full innovation chain from research to market with a focus on innovation-related activities.

It is set to deliver new ideas that can contribute to growth and jobs for the future. It is a key tool in implementing the EU flagship initiative and has a number of new features that make it fit for the purpose of promoting growth and tackling societal challenges:

- The integration of R&I by providing seamless and coherent funding from idea to market
- More support for innovation and activities close to market
- A strong focus on creating business opportunities out of our response to the major concerns common to people in Europe and beyond, i.e. societal challenges

With the invaluable cooperation of CEN/CENELEC through Horizon 2020, we are working to build a faster and more efficient standardization cycle from research to standards by bringing these two worlds closer.

This means that more and more projects will include:

- Mapping of existing standards relevant for the R&I project
- Standardization gap analysis to assess if there is need for pre-normative research
- Development and implementation of standardization roadmaps that may include cooperation at international level together with the relevant standardization bodies

In order to bridge the gap between research and standardization, the participation of formal standardization bodies, namely national standardization bodies, within industry consortia is encouraged. Support could also be given to developing knowledge and incentive participation in existing European technical committees, with the goal of injecting innovative elements in selected standards projects.

Funding will be provided to finance preparatory and accompanying work for developing new standards or projects and/or independent experts' participation in a technical committee's work. When there is an interest in contributing to ongoing standardization activities, a "Project Liaison" can be financed as part of the project. This allows for a representative of the project to

participate in plenary meetings of the relevant technical committee and contribute to the work.

Introducing an integrated approach to standardization in EU-funded programmes for R&I can ensure mutual benefits. On the one hand, standards can help the research community push its innovations onto the market while on the other, research can contribute to ensuring optimum scientifically and technologically based standards.

Standards and SME policy

Another area where standards are used to support innovation is cohesion policy. Through structural funds, the EU's cohesion policy supports authorities and stakeholders to deliver growth, competitiveness and innovation in the various European regions.

The current economic challenges require particular focus on supporting innovation and improving the competitiveness of SMEs. One of the ways to achieve this objective is through promoting and enabling greater and more effective use of standards and standardization. EU regional funding can be used to foster SME competitiveness through boosting SMEs' use of standards and participation in standardization.

Amongst other benefits, standardization:

- Is the gateway to opening up the opportunities of the single market to European enterprises
- Standardization support can be a useful tool in the policy mix used for the implementation of R&I strategies for smart specialization

In this context, European structural funds can be used to finance initiatives that support SMEs in making better use of relevant existing standards, and being more active in the standardization process.

Actions to ensure that SMEs are actively engaged with standards, the standardization process, and that they are reaping the full benefits of this involvement include:

- Raising awareness amongst SMEs of existing standards and the benefits of their implementation and use
- Encouraging SMEs to identify, obtain and implement relevant standards
- Raising awareness of the opportunities available for SMEs in the standardization process and encouraging their participation

The funding can be either directly disbursed to SMEs, e.g. as part of the financing of a research and innovation project grant, or innovation voucher schemes can allow SMEs to access standardization support services from relevant intermediaries (e.g. trade associations, chambers of commerce, innovation centres).

The role of these intermediary organizations is very important since they can be an ongoing communication channel between the world of standards at the national or international level, and the individual SMEs within a region. These organizations have the benefit of both local/sectoral knowledge and links into national and international systems. They can serve as active centralized channels of information on standards, as well as sources of further advice and guidance to individual companies.

Standards and IPR

Efficient licensing of IPRs is crucial for achieving broad and rapid diffusion of innovation. This requires a successful balancing of the incentives to invest in innovation against the benefits for the economy at large of a wide diffusion of knowledge. Standards may include proprietary technologies, especially in innovative domains, and therefore they are a case in point.

The licensing of standards-essential patents (SEPs) is, however, prone to market failures such as negative externalities, information problems, market power and free-riding. The various forms of market failure can result in barriers obstructing the efficient licensing of SEPs and can thus hinder the realization of the economic and societal benefits of the affected standards.

As it currently stands, the system governing patent-based standardization could improve its efficiency in the licensing of IPRs for technologies that are included in standards.

The SEP declaration system and the databases used for this purpose have already been a great achievement, but more could be done regarding transparency, e.g.

- More frequent updating of data or more detailed information on patents
- More bundling using patent pools
- More efficient dispute resolution mechanisms
- Clarifying FRAND (fair, reasonable and non-discriminatory) royalty rates and royalty bases

In such a context, the IPR policies of the ESOs should contain a fair balance between the interests of technology owners and those of technology users, to avoid restrictive effects on competition.

Speech 3.5 How standards guide innovation in mature industries: the diffusion of energy-efficiency technologies in the building sector

Raymond Levitt,
Director of the Global Projects Center and Kumagai Professor of Engineering, Center for Integrated Facility Engineering, Stanford University, USA

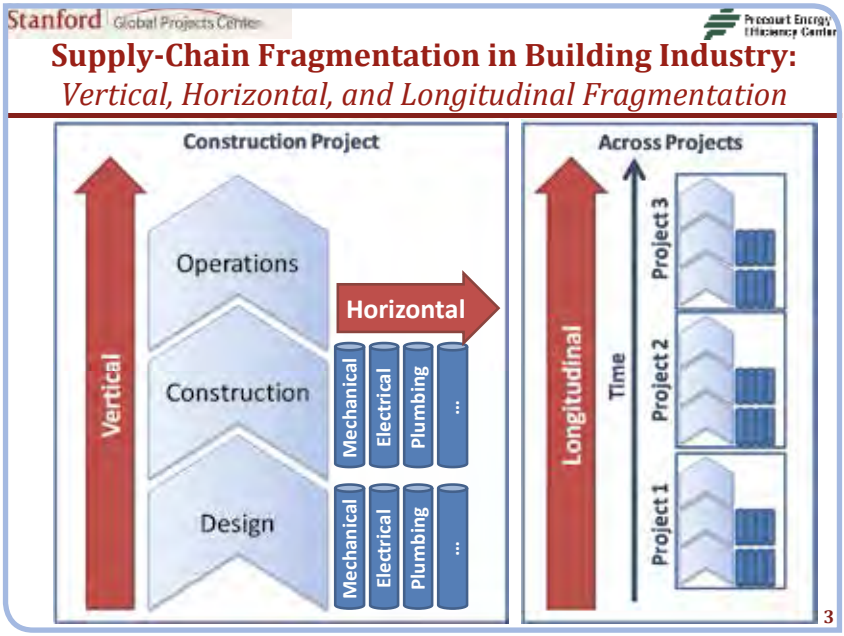
Thank you very much. It's a real pleasure to be with you. I wish I could have been with you in person but unfortunately I had a conference of my own centre both yesterday and today. I'm very pleased to be given the opportunity to share some of the work we have done about innovation in mature industries and I see this as a link between your discussion today on how standards fit into innovation and the discussion tomorrow about green buildings.

As you all know, the building industry is the single largest contributor to greenhouse gas emissions. We have a stock of old buildings which, collectively with some of the better new buildings, consume about 40 % of all the energy in the USA and 70 % of all the electricity. A great deal of this is wasted. We can see how much is wasted when energy service companies come in and take over buildings and can provide the service for 70 % of what the energy consumption was before.

There are significant unrealized energy savings in these buildings, even with existing technologies, but much more with new technologies. An enormous foregone investment, opportunities that are just now beginning to be taken up by various kinds of financial entities that arbitrage this opportunity.

As industries mature, their supply chains tend to fragment. The computer that I'm giving this presentation on is an Apple computer, but it actually fits the IBM PC standard from the early 1980s. What happened was that, as IBM created this system architecture as a standard, the industry fragmented immediately. IBM got out of making microprocessors, they are made by Intel, disk drives are made by Seagate, graphics chips are made by Nvidia, and so on.

The construction industry, being one of the oldest industries we have, certainly the oldest of the large industries, is extremely fragmented. And it's not just fragmented by component the way computers, mobile phones, automobiles or airplanes are, it's also fragmented vertically, by phase of delivery, as shown in Slide 3. Since we tend to deliver buildings one at a time, each one involves a design phase, a construction phase and then a much longer and more costly operation phase.



SLIDE 3

So we have this kind of fragmentation on top of the horizontal fragmentation by component or discipline and they tend to go together. As a result, we have mechanical systems designed by mechanical engineers installed by mechanical contractors ; components purchased from mechanical distributors installed by a particular set of building trades ; ditto electrical systems designed by electrical engineers, purchased from electrical distributors and installed by electricians ; and contractors, especially contractors who employ them.

Then we have a third dimension of fragmentation because we're a project-based industry – that is, we are longitudinally fragmented. From project to project, we have these fragmented structures but the players in the game are different almost every time because we tend to rely, in most market economies, quite heavily on competitive bidding to basically fill out the team, and so things that are learned on one project are often lost to the next project unless they're very carefully preserved, which in most cases they're not. In the case of this extreme fragmentation, there

is a very heavy reliance on standards in order to be able to produce custom buildings that actually go together and most of the time work reasonably well.

The challenge is when we innovate – as I'll explain in a minute. In all these fragmented supply chains, what we see is "production clusters", typically with really strong system integrators like in the airplane industry or the automobile industry, which do a great deal of work to ensure that the components go together. When companies like Boeing try to produce an airplane with less control over the supply chain – as they did for the new 787 green liner where major modules are outsourced with just high-level integration and coordination – they tend not to go together very well.

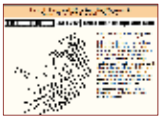
Construction, in contrast, due to the competitive nature of the industry, has evolved to be very loosely coordinated. On a typical building in the US, and I suspect it's not that different in Europe and in Asia, we have a general contractor with a handful of employees on the job. In the US, a typical general contractor might have five or ten employees, of whom five are meant to supervise and coordinate a workforce that might be 500 at the peak and so they are providing very little integration and coordination themselves.

They're relying on what each of the craftsmen know and each special contractor knows about how they do their work. We have highly skilled workers, we have professionally certified architects, engineers of different types but very light coordination of the on-site construction. Instead, we rely on what A.L. Stinchcombe called "craft administration" versus bureaucratic administration.

Craft administration is the knowledge about how to do things and how to integrate them in the heads of the workers. But again, these rely on a variety of different standards (see Slide 5).

"Craft Administration" relies heavily on multiple kinds of "Standards"

- **Architecture/Engineering professional licensing standards**
  - Specify required education (accredited by standards) and experience
- **Craft training standards**
  - Apprenticeship program training and practical experience requirements
- **Building component standards**
  - "System Architecture"
  - e.g., ECOSPEX, MasterFormat, UniFormat in US, Canada
- **Building Codes and other regulations**



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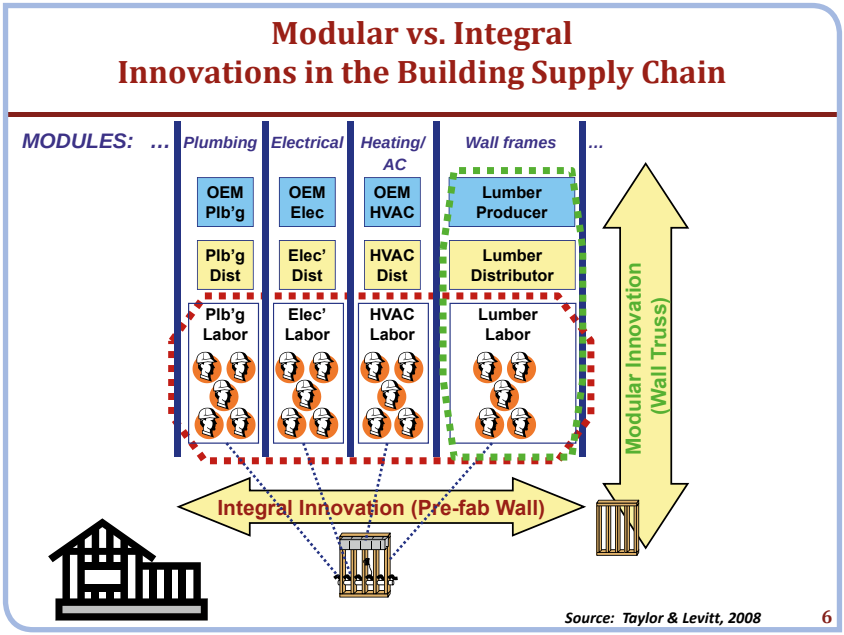
SLIDE 5

We have professional licensing standards, which specify education and experience for the people who do the engineering. On the workers' side, we have craft training standards through apprenticeship programmes, much more extensive in Germany and other countries but also still used in the US. The place where standards are the sort that ISO might be involved in : the building components' standards. We have the system architecture which has evolved and has been formalized through a whole series of different standard documents that define the breakdown of components and their interfaces. We have, for green buildings, ECOSPEX, or for more traditional buildings, MasterFormat and UniFormat that have thousands of categories of components.

A typical complicated building like a hospital building or an airport terminal might have as many as several hundred special contractors, each with different workers installing components that, again, work according to these standards. Finally, we have the regulatory standards initially intended to deal with things like life safety, but now also addressing energy efficiency and other

issues: building codes, building permits, inspection requirements and so on. We're relying heavily on these standards to make sure things get coordinated. All these things work very well when we do relatively standardized or conventional buildings where the components go together in similar ways. The challenge for the green building space is that we're often trying to innovate in ways that challenge this particular way of organizing the industry and this particular use of standards.

I'd like to distinguish between two kinds of innovation. But first, let me talk about this supply chain. What we have in the supply chain of an industry like construction, which is fragmented both vertically and horizontally as I described, is what I call swim lanes.



SLIDE 6

On Slide 6, we have a plumbing swim lane, on the left-hand side, which has the original equipment manufacturers such as Brouwer and other equipment manufacturers of plumbing fixtures. We have plumbing distributors who sell to plumbing

contractors who employ plumbing craftsmen to do the installation, ditto electrical, ditto heating, ditto the framing in the structural steel concrete or wood if its single-family homes.

In the case of single-family homes, it's very easy to innovate within one of these swim lanes. If you want to develop a new way of doing wall trusses, if you'd like to make them out of sheet metal instead of wood or you'd like to prefabricate them instead of building them on site, this is a relatively easy innovation. These kinds of industries with their management by standards can innovate very easily for something within a single swim lane.

On the other hand, if you try to assemble a wall panel, that includes electrical, plumbing, air conditioning and other components within the wall, you are now cutting across multiple swim lanes ; and so now you have to get these previously independent contractors, who are all working according to their own standards and their own sequences and so on, to work together in a new way. This is a real challenge. We find that the first type of wall diffuses quite rapidly within the industry. There have been several attempts in the US to diffuse the second type of prefabricated wall and it diffuses very slowly, if at all. We distinguish the two kinds of innovation. We call our first one " modular ", we call the second one " integral " (see Slide 7) ; other people have called it " systemic innovation " and so we had the hypothesis that one of the ways to make these systemic innovations or integral innovations diffuse more quickly would be to integrate the supply chain. The way we studied it was by looking at which types of energy efficiency innovations were successfully adopted in buildings that were attempting to get LEED certification. This is a voluntary US building energy-efficiency certification that many of you are probably familiar with. What did we find ?

Modular vs. Integral Building Energy-Efficiency Innovations

- **Modular Innovations: Innovate individual module within a single swim lane**
  - More energy-efficient window
  - More efficient boiler/chiller

- **Integral Innovations: Affect the way that multiple modules in two or more swim lanes are integrated**
  - Intelligent BMS that monitors indoor and outdoor temperatures and humidity, uses sophisticated software and firmware to activate the chiller, boilers, fans, window actuators, etc.

7

SLIDE 7

Again, the modular innovation is like a swimmer swimming faster or with a different swimsuit in their own lane. The integral innovation, again multiple modules being integrated, is like doing synchronized swimming but where you change the players in the team every time. And it will be very difficult to get the routine correct if you don't keep the players together.

What we find – I get to the bottom line quickly – it's all about the implications. Modular innovations are adopted about three times as often as the systemic or integral innovation, if you have a little integration of the supply chain. So we looked at mechanical, electrical and plumbing as the three key disciplines for energy efficiency innovations of the sort we were studying, a central control system with windows that vent the building at night in a desert climate in California, which one would think is relatively easy to install. In reality, when you install it, it takes about two years to work after the building is finished because what's going on is that the supply chain is not integrated.

But if you do integrate it, what we find is that instead of 10% of the innovations occurring, when there's no integration of the supply chain, if you have mechanical, electrical or plumbing contractors, or you have integrated engineering firms that do mechanical engineering and plumbing in one shop, or if you have what we call high integration where you have design build companies that do all three – mechanical, electrical and plumbing for both design and installation – you get twice as many or three times as many of these integral innovations successfully adopted.

The implication is that a strategy for adopting these integral innovations in these very modular industries, is to integrate the supply chain either by legal merger acquisition or by creating some sort of alliance contract whereby the parties will agree to play together for multiple contracts. It suggests a sort of strategy for the industry (see Slide 10).

SLIDE 10

To get modular innovations done, you just have to solve the vertical integration problem where, basically, nobody has the

incentive because the building owner doesn't pay the energy cost and the tenant is not able to modify the building. What you have to do is to integrate that supply chain somehow. In the case of residential construction, Solar City basically created a vertical integration of the supply chain to put photovoltaic plates on the roofs of home owners who actually don't stay long enough to see the savings, so they lease the space on the buildings and capture the opportunity that way. With modular innovations, again, standards are not the problem. The problem is with broken incentives or broken agency, and that can only be solved by some vertical integration of the supply chain.

With integral innovations, what you have to do is to integrate the supply chain horizontally and from project to project, so you need to put the required participants in a single organization or a single virtual organization. We see a number of companies emerging in the US now like Zeta Communities, Project Frog and others that have integrated, through alliance contracting, all of their required engineering and construction disciplines to produce zero-net energy modular home products or modular school products at very reasonable cost. They have been very successful in the marketplace.

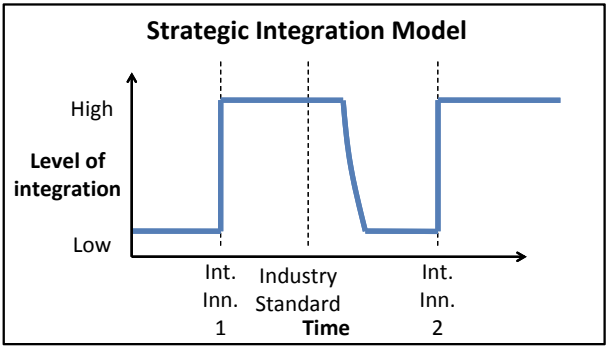
Finally, to do both of these, to get significant building innovations, you need to integrate the supply chain vertically and horizontally and you need to take on the financing of the projects. Companies like Johnson Controls have acquired literally hundreds of companies in the energy efficiency space and now offer an integrated design, construction and operations strategy including financing of the energy innovations. They were so successful that they sustained Johnson Controls through the downturn in the automobile industry, which was another big market for this company after 2008.

What this suggests is that, at any point in time, something will still be considered an innovation when traditional craft industry cannot deal with it. In order to drive these kinds of integration, you need to either legally or virtually integrate the supply chain. As shown on Slide 11, the integration module is one that changes

over time – because something that was an integral innovation at one time becomes an industry standard and then there's a new integral innovation and the sort of industry strategy way to deal with this is to vertically integrate the supply chain until it becomes a standard, then disaggregate it again for efficiency and ability to deal with demand fluctuation, reintegrate the supply chain to be over the next innovation but possibly involving different players and so on.

Dynamic Innovation Strategy in Modular Industries

- **Supply chain integration/disintegration as a deliberate long-term strategy for driving integral innovations into mature markets**



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SLIDE 11

Again, it's not standards that are preventing the innovation, it's the fact that the supply chain has been fragmented, partly facilitated by the standard. But there are industry approaches that can address this.

Many thanks for your attention.

Session 4
Standardization and innovation in the green building sector

Chair's remarks

Chair: Daniele Gerundino,
Director, Research and Education, ISO

Good morning, Ladies and Gentlemen.

When we organized the conference, we thought that we should dedicate the first day to cover the key dimensions of the relationship between standardization and innovation and focus the attention during the second day on a specific sector to investigate the overall theme of the conference within a particular area.

We selected the green building field for the following reasons. On the one hand, it is part of the broader sector of "green technology" to which the Open Session at the ISO General Assembly in San Diego (USA) in 2012 was dedicated with the understanding that further analysis would cover specific sectors. On the other hand, this is a very important sector in which standardization plays a very important role and of which we know that there is a

significant interplay between standardization and research and development activities.

We have with us a number of excellent speakers who will be able to provide the perspective both of researchers and standardizers. We will also have the opportunity to present the results of a pilot research project supported by ISO in cooperation with EURAMET (the European Association of National Metrology Institutes) and NIST (the National Institute of Science and Technology in the USA) which was conducted with the aim to investigate the interactions between standardization and research and development in this sector. The study was conducted by a research associate from Cornell University (USA) and two PhD candidates from Lund University (Sweden). On behalf of ISO, I wish to express our gratitude to all of them.

Speech 4.1 Standardization in the green building field. Overall energy performance of buildings

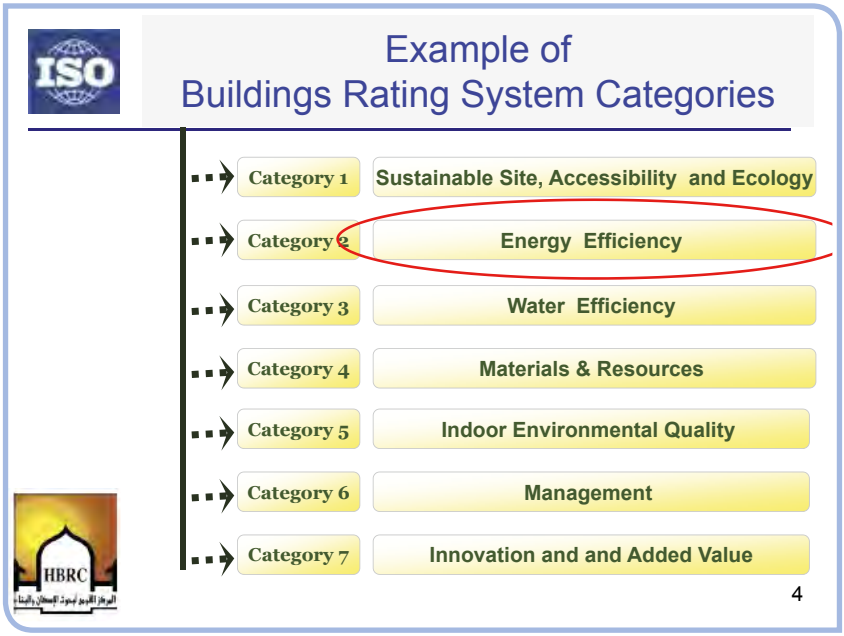
Dick van Dijk,
Senior Scientist, Energy Performance Buildings, TNO – Netherlands Organisation for Applied Scientific Research

My name is Dick van Dijk. I will start my presentation by introducing the concept of green buildings and then concentrate more on the energy performance of buildings.

First, a bit of history of standardization in this field. I will explain the principles of overall energy performance of buildings, then have a discussion on the energy performance standards and innovation, the importance of the systemic approach and the link with product information. Finally, I will say a few words on the current work in progress on the energy performance of buildings in ISO and in CEN.

First of all, what is a green building ? There are several definitions so I took just one. A green building operates energy efficiently, it conserves water, it's comfortable, safe and healthy, it's durable and maintainable with a minimal environmental impact. But I would add one aspect. It is important to take into account the life cycle that comprises the construction phase, the operation phase and the deconstruction phase of a building.

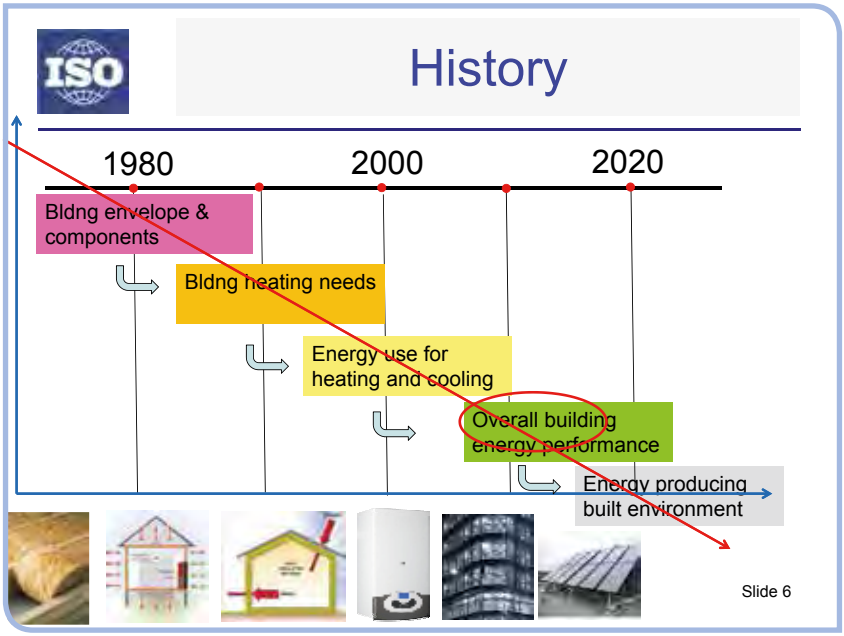
There are also several different rating systems of buildings so, again, I have taken just one which is shown on Slide 4.



SLIDE 4

This is from Egypt and shows a rating schedule where you have different categories. Category 1 is the rating on the sustainability of the site, accessibility and ecology. Then comes energy efficiency, water efficiency, materials and resources, indoor environmental quality, management and, last but not least, innovation and added value. As already mentioned, I will concentrate more on energy efficiency.

Talking of the energy performance of buildings, it is useful to first have a look at the history (see Slide 6).



SLIDE 6

In the early 90s, we developed standards on the quality of the building envelope, concerning thermal properties (e.g. thermal insulation) and the air tightness of the components. Then, it was realized that energy could also be gained by the sun, so passive solar techniques were introduced and this required standardization not only looking at the losses but also at the gains, so we developed standards on building heating needs. Then, around the year 2000, it became clear that there was a need to include

not only the efficiency of the heating systems but also the cooling needs and cooling systems, and now we are dealing with the overall energy performance. And we are looking forward, in the years ahead, to having a completely integrated approach for the energy-producing built environment.

We are now at the level of the overall energy performance of buildings. What is that about? It means you have a lot of puzzle pieces and they all have to fit together. The first piece of the puzzle is the building and the building elements: the thermal properties, but also the solar properties of windows, the air flows and ventilation systems, heating systems, cooling systems, daylight and lighting systems, the assessment boundaries – what is the building, what do you include, what do you not include –, building automation and control, the climatic data you need for your assessment, renewable energy sources of course, and the way to express energy performance like a new numerical indicator or rating scale.

But think also about the overall energy balance. There are buildings that do not only *consume* energy. More and more buildings *produce* energy, for example with photovoltaic panels. And what should be done with the energy at the district level and how should it be integrated in the overall energy assessment? And think about the operating conditions: different spaces have different requirements for conditions of use, so these also have to be taken into account. And, of course, the domestic hot water needs and the overall systems.

Since 2009, in ISO we have a joint working group, *Energy performance of buildings using the holistic approach*, involving two ISO committees: ISO/TC 163, *Thermal performance and energy use in the built environment*, and ISO/TC 205, *Building environment design*. "Holistic approach" stands for the overall energy or systemic approach, whatever you want to call it, and I'm lucky to be one of the two co-conveners of this joint working group. Our task is to plan the development of standards in this area and to try to put them into a coherent and complete package. All this work is being done and is greatly inspired by many sources, but especially

by the European Energy Performance of Buildings Directive due to the mandate from the European Commission to CEN. CEN develops a set of standards in this area which has led to a close connection between ISO and CEN. I will come back to that later.

SLIDE 10

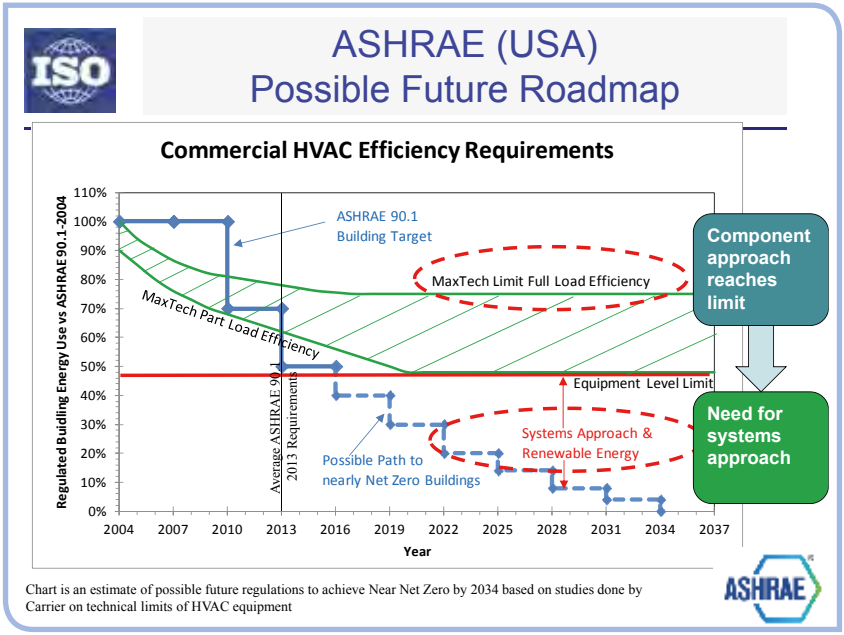
Adopting a systemic approach (see Slide 10) first requires common terms, definitions and symbols because if you use different languages, you're lost. Then you build up your calculation procedures in a systematic way: what are the boundary conditions you need, which component input data do you need in order to calculate the energy needs of the building and the relation with the system losses? The next step is to collect all the energy elements from the lighting, from the ventilation, cooling, heating and so on.

Then you need to look at the classification of spaces. Are we dealing with, for instance, an office space, an assembly hall or a residential building? The aggregation of the energy performance: how do you add up cubic metres of gas and kilowatt hours of

electricity? This is done, for instance, by a primary energy use, and expressed, as already mentioned, using numerical indicators and rating scales, and finally you have the overall energy performance of your building.

Why a systemic approach? Simple, the product performance is not equal to the building performance when a product is installed in the building... I have some examples of that. This is an issue that can expect increased awareness at national and international levels.

One example for instance is shown in Slide 11 from ASHRAE in the USA, the heating ventilation and air conditioning branch.



SLIDE 11

They came up with this graph and it clearly shows that if you stay with the component approach, which is the green part, there is a limit as to what you can reach, whereas the ultimate goal is to reach nearly zero-energy-using buildings. The component approach reaches a limit. You clearly need a systemic approach to reach the level we all want. For most of you, the energy

performance of buildings is not your daily business, so I will just give a few examples.

For instance, the heat recovery unit for ventilation. This is a wonderful device and it's widely used. How does it work ? The cold air which comes into your building uses the heat recovered from the warm exhaust air from the building. For instance, you can have a 95 % efficiency, so you only need to heat up 5 % of this air instead of 100 %. But when applied in a building, you have to take into account possible effects that pull down the actual efficiency. Such as duct heat losses. For example, when using a heating system to heat these (cold) ducts, if they are not insulated or large, you will be dealing with an actual efficiency much lower than 95 %. Depending on the location, you may also have to deal with frost protection. And if the occupants open the windows, you also have much more energy loss than you would otherwise think. In addition, in summer, if you do not bypass this heat recovery, you will recover the unwanted heat that will heat up the building and you will not make use of the beneficial cold air from outside, so you will increase the cooling needs.

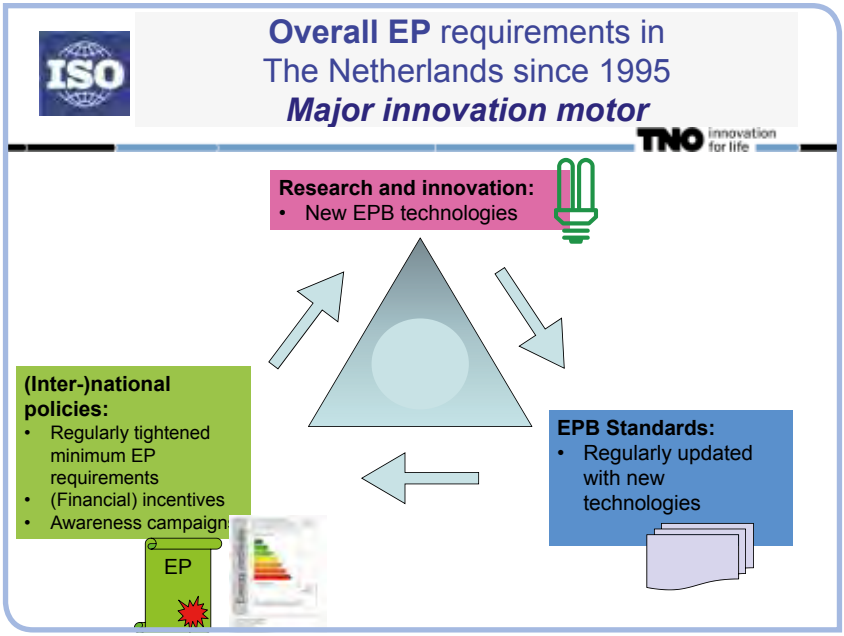
The next example, the heat pump, is also an excellent way to generate heat in a building but if you apply it in a building, you have to take into account that the performance drops drastically when you draw too much power from this equipment. Therefore, only from a system perspective can you see whether there is sufficient capacity. In addition, the heat source temperature may play a role. If the source is depleted, you also have a problem and the performance will not be as good as it seems to be if you look only at the product.

A look at renewable energy. There are complex policy issues involved. For instance, how do you appreciate the use of biomass as a renewable energy source in a building ? How do you appreciate the green electricity produced on site and exported to the grid ? How do you appreciate the use of renewable energy produced at district level and fed into your building ?

The last example is an infrared panel for heating. There are claims that this type of panel produces a significant energy saving.

For instance, you have a better room temperature distribution and a fast response. The radioactive heat is more comfortable and you have decreased ventilation heat losses. But in order to evaluate these claims, you really need a detailed model that includes all the effects. What are the extra heat losses from the panel to the outside, what is the actual temperature distribution and, most importantly, what are actually the standard assumptions with which you compare different systems, normal radiator or floor heating with such a panel ? You need to create a level playing field and that's not trivial.

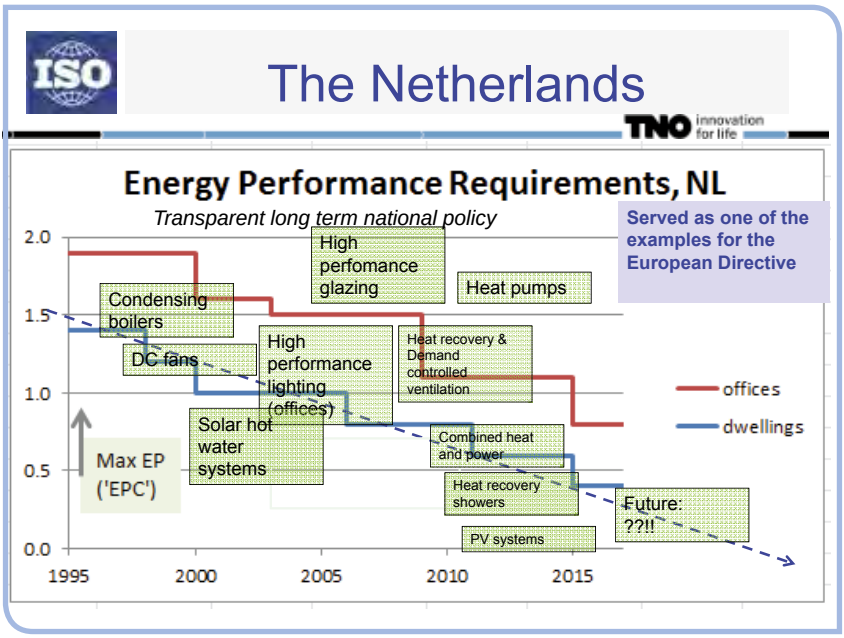
In my country, the Netherlands, we have established overall energy performance requirements since 1995 adopting this systemic approach and it has been a major innovation motor in the Netherlands (see Slide 16).



SLIDE 16

From research and innovation, new energy performance of building technologies emerged. These were introduced in the energy performance of building standards which are regularly

updated with these new technologies. This gave the government the opportunity to tighten the energy performance requirements for buildings as of 1995 and to update public awareness schemes and financial incentives. In turn, this was a stimulus for further research and innovation (see Slide 17).



SLIDE 17

In this slide, you have the graph highlighting the Dutch policy over the long term and it's important to notice that this was quite a transparent national long-term policy. People involved in research and innovation knew in advance what would be the next steps, so they could foresee the tightened energy performance requirements. Indeed, this led to a number of innovations, which were widely implemented in the country as soon as they were introduced in the energy performance calculation procedures. For instance: condensing boilers, direct current fans, solar hot water systems, high-performance lighting, high-performance glazing, heat recovery and demand-controlled ventilation, heat pumps, combined heat and power systems, even heat recovery showers,

photovoltaic (PV) systems and, of course, it remains a question mark as to what the future will bring in this area.

These overall energy performance requirements in the Netherlands were taken as a useful source by the European Commission when they drafted the European Directive for the Energy Performance of Buildings.

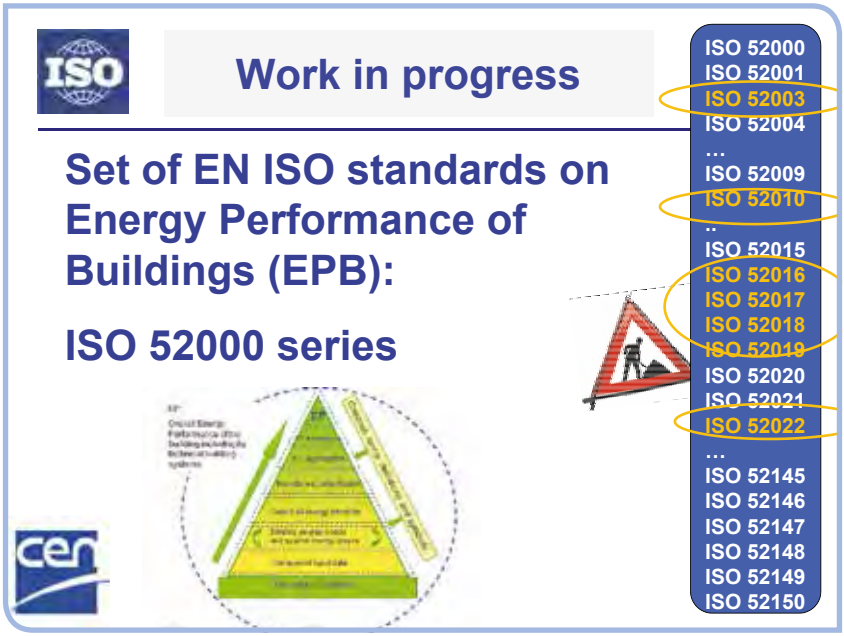
Coming back to the international arena, in ISO and CEN we have a unique international cooperation.

I already mentioned the historical development pattern, starting with standardization of the building components, covered mainly in ISO/TC 163, *Thermal performance and energy use of the built environment*, more recently complemented by the work of ISO/TC 205, *Building environment design*.

ISO/TC 163 closely collaborates, since the early days, with CEN/TC 89, *Thermal performance of buildings and building components*, and Navid Gohardani, the next speaker, is the living example of a secretary to these two committees. On the other hand, ISO/TC 205 collaborates closely with ASHRAE from North America.

Since 2009, we have established a joint working group of ISO/TC 163 and ISO/TC 205 to deal with all the aspects of the energy performance of buildings and, in turn, this ISO joint working group closely collaborates with CEN/TC 371, which is responsible for the energy performance of buildings at the European level.

This brings me to the last subject and that's the work in progress. We are currently working at full speed to develop a set of EN/ISO standards on the energy performance of buildings and in ISO we have been able to reserve a series of numbers for these standards. The ISO 52000 series is what we are heading for and, at this moment, the first set of Draft International Standards are in the pipeline to be published soon for enquiry... the orange ones highlighted on Slide 19.



SLIDE 19

This brings me to the conclusion that International Standards on the overall energy performance of buildings are a major innovation motor for which you need a systemic approach. But there are also challenges and the challenges are, for instance, that the calculation procedures are regarded as complicated, particularly by policy makers.

They have difficulty in following all the details and they ask all the time "Can you not make simpler calculation methods?" The input data from the product performance assessments are not always in line with what you need to assess the energy performance of your building and you also need to cover a wide range of technologies, climates, building types, occupant patterns and policy issues. I think that's what we manage in this set of standards by making all the standards unambiguous while, at the same time, building in flexibility for countries or other stakeholders to make their own choices. That concludes my presentation, thank you very much.

Speech 4.2 Standardization in the green building field

Navid Gohardani,
Secretary of ISO/TC 163, Thermal performance and energy use in the built environment, *and of CEN/TC 89,* Thermal performance of buildings and building components

Good morning, Ladies and Gentlemen. I am delighted to be here. First of all, I want to thank the organizers and my fellow speakers. It is a great opportunity to share experiences and expertise and this is a great example of international cooperation.

I am going to briefly talk about standardization and innovation in the green building sector. As previously mentioned, I am managing on behalf of the Swedish Standards Institute the two secretariats of ISO/TC 163 and CEN/TC 89 as well as the Swedish national mirror committees to the two ISO and CEN technical committees. My talk will be about innovations in conjunction with standardization within the green building sector, so I will start off by presenting the concept of a green building and define its meaning. Then, I will talk about standardization and innovation, the benefits of standardization, especially at the early stages, for innovation purposes, and also about some successful standardization projects. As always, you have to look at both sides of the matter, so I will talk about some unwanted effects or disadvantages of early standardization and also of the role we have in terms of innovation and where we are headed in terms of energy efficiency.

Green building: the concept – one could say: "green building", "sustainable" or "high-performance building" – is described as the practice of increasing the efficiency in which buildings and

their sites use and harvest energy, water and materials. It is quite a vast area. One has also to protect and restore human health and the environment throughout the whole life cycle of the building, which encompasses the siting – where the building is going to be located –, design, construction – architectural values –, the operation of the building, maintenance, renovation, refurbishment and, finally, deconstruction.

A misconception or a traditional view is that there is a contradiction between standardization and innovation, that standardization hinders innovation and innovative thinking. But, in fact, standards can support innovation and promote the adoption of new technologies in several ways. Standards can codify and spread state-of-the-art developments in various areas as well as bridge the gap between research and the products and services that are provided. In addition, the standardization process can facilitate the introduction of novel and innovative products for interoperability between new and existing products, services and processes. It is usually easier to penetrate a new market if standardization has been carried out or standards exist covering your product.

Some benefits of standards for innovation : as I mentioned, innovation can be promoted as a facilitator of access to new markets. It furthers the creation of new markets so one can actually diversify and differentiate from other market players or competitors by ensuring quality of products and supporting research (R&D – in terms of innovation, the standardization process can support ongoing and future research and development and enhance visibility). Of course, if you have a new product that you want to market, it is beneficial that you also mention a specific standard related to your product. This facilitates trade and ensures compliance with regulatory requirements in terms of free trade and thereby strengthens regulation. Many countries refer to standards in their legislation regarding how to operate buildings. Obviously, we have increased safety and environmental protection. Many of you are aware of the "CE" mark in Europe which is a conformity marking and does not necessarily

represent quality. The marking represents the manufacturer's claim that the requirements of all relevant European Directives have been satisfied. It says that you have a product of a specific quality in terms of health and safety and so on. Often standards are globally recognized and it is easier to access a new market if a standard exists or you are proceeding towards a standard through ongoing standardization. One example of successful standardization in terms of innovative products is within the European Framework project SMT, which stands for "Standards, Measurement and Testing". SMT was a starting point for standardization of the scratch adhesion evaluation test for ceramic coatings, following the European standard EN 1071-3 and ISO 20502. Actually, this ceramic coating was used as an exterior paint solution for buildings and was developed through standardization. Another example, also within this SMT framework, called HAMMER, which concerned grain size measurements for hard metal tool materials served as a baseline for the development of ISO 4499, Parts 1 and 2.

As you may know already, there are many environmental certification programmes for buildings. One of them is LEED (there are obviously others) which stands for "Leadership in Energy & Environmental Design" and is a green building certification programme. It recognizes "best in class" building strategies and practices. To receive any LEED certification, the building project and the building itself must satisfy some requirements and earn enough points for the required certification. The prerequisites and credits differ for each rating system and the architectural engineering teams choose the best fit for their products. This means you can just be "certified" or achieve "silver", "gold" or "platinum" certification. Something that a building owner would be very pleased to show, for instance, is "platinum certified". In the context of sustainable buildings, the LEED certification programme provides owners and architects with incentives to build green and, as a result, energy-efficient buildings have evolved into the mainstream of building construction.

However, some experts in the R&D department, or those who develop novel and innovative products, have a natural tendency to refrain from disclosing information and from joining the standardization process for reasons such as protecting intellectual property. The general notion is that standardization can suppress innovation, but the reality is that standardization can also contribute to network effects, making it possible for experts to exchange ideas with others in similar positions, resulting in a more efficient and rapid implementation in new markets. In terms of the environment, I mentioned the LEED certification of buildings but there are many other schemes which may confuse building owners as to which one to use. In many instances, countries would use the national certification programme if such a programme exists. In other cases, they could use the BREEAM (Building Research Establishment Environmental Assessment Method), GreenBuilding or other programmes.

The benefits of standardization in early stages are that you have experts who participate in technical committees discussing standards, products and systems. This brings something new to their R&D area. Early discussions among experts also enable faster development of applicable standards and help to prepare the green building sector for newly developed products. Early-stage standardization enables a well-established introduction of these new products. If the market is prepared for these products, it is easy to back it up with a standard through a standardization process.

Some words about the energy efficiency goals for the European Union. The European Union has ambitious goals when it comes to energy and climate. By the year 2020, Europe should achieve a 20 % reduction in greenhouse gas emissions, a 20 % share in renewables in the energy mix and a 20 % decrease in energy consumption, compared to 2007. As of January 2014, the European Commission proposed new targets for the year 2030 in greenhouse gas reductions and renewable energy in its 2030 Framework on Climate and Energy. For greenhouse gas reductions, the requirement is 40 % and for renewable energy

27 % respectively. There is also a strategic initiative called Energy Efficiency Communication, proposing mid- and long-term objectives for the energy efficiency policy of the EU, by assessing progress towards the 2020 energy efficiency targets and further proposing a new 30 % target for 2030.

My fellow speaker, Mr. Dick van Dijk, mentioned the Energy Performance of Buildings Directive (EPBD). This is the main legislative instrument affecting energy use and efficiency in the building sector within the EU. It deals with both new builds as well as existing housing.

In May of 2010, a recast of this directive was adopted by the European Parliament and the Council of the EU, in order to strengthen the energy performance requirements and also to clarify and streamline some of the provisions of the 2002 Directive, which this one replaces. There are a number of requirements within this recast but one specific requisite is that, as of the end of 2020, all new buildings will have to consume nearly zero energy. In addition, to a large extent, the energy consumed will have to originate from renewable energy sources. Net-zero energy buildings will have to produce the amount of energy they are going to consume. The total amount of energy used by the buildings on an annual basis will roughly equal the amount of renewable energy created on site.

When it comes to the global perspective and the energy performance of building standards, as mentioned earlier, there is a cooperation between CEN/TC 89, ISO/TC 163 and ISO/TC 205, *Building environment design* – which has a US secretariat – in developing these standards. This enables us to reach a global consensus from meaningful comparisons of actual energy use, the potential of energy saving and renewable energy technologies at a global level. This is obviously essential for international cooperation to address the environmental and climate change problems that we face.

The road ahead : these are just my personal predictions and my suggestions on how to proceed in order to bridge the gap to the set of energy efficiency targets. One is strengthening the local

and regional verification of national building codes and accurately informing consumers of the energy performance of buildings for sale or for rent because the way local government and legislators act has a tremendous effect on how the buildings will perform in the long run. It is also very influential in fully involving utilities in working with customers to obtain energy savings. Finally, strengthening market surveillance of the energy efficiency of products. We need to have better surveillance equipment in order to be able to aid end users. In order to implement innovation in the green building sector in a more efficient manner, my take is that we have to redefine the role of local government in a low-carbon economy so that it does not always end with national legislation. We need to incorporate and implement strategies at the local level, invest in energy-efficient and low-carbon infrastructure and set favorable planning conditions. This has to be something that is available to everyone, so we have to prevent social exclusion, depending on demographics and other societal factors. We also need to make the technology available for everyone when it comes to net-zero energy and low-carbon buildings.

So, what I want you to take away from this presentation is that innovation and standardization can be a catalyst for growth in a free market and also that innovation is usually a safe approach towards differentiation of products or services, which typically precedes standardization. The standardization process promotes both innovation and diversification and innovations today will shape future standards. Thank you very much.

Speech 4.3 Standardization and innovation in the green building field: insights from North America

Vaishali Kushan,
Research Associate at the Samuel Curtis Johnson Graduate School of Management and Cornell University, Ithaca, NY (USA)

Good morning, everyone. ISO and the National Institute for Standards and Technology (NIST) commissioned to Cornell a study to understand how standardization and R&D activities affect innovation in the green building field in North America. Today, I'm providing an overview of the findings of this study.

The study was conducted by interviewing 33 professionals associated with 24 organizations and companies working in the green building field.

Oversimplifying, let me first observe that in Canada, voluntary standards (or at least some of them) are often incorporated into regulations so we can say that the Canadian system is more "centralized" than the US system. In the USA, standards are primarily used as a foundation for green building rating programmes such as LEED and Energy Star. Both programmes are adapted by each Federal State based on their needs and specificities, for example with regard to climate. Based on my conversations with these 33 interviewees, there are various aspects included in green buildings. Many of them were covered by Mr. van Dijk in his presentation but, most importantly, to be qualified as "green", a building has to be environmentally friendly and energy-efficient.

The study focused on thermal insulation and HVAC (heating, ventilating, and air conditioning), therefore I will briefly touch on the building design materials used, and the overall performance of buildings with regard to HVAC.

The building design concerns notably the overall envelope of the building, i.e. the physical separation between the inside of the building and the external environment – it includes the weather barrier, air barrier, and thermal barrier.

Insulation materials form the thermal envelope of the building and are used to protect the building from the weather. The overall performance of the building (energy performance and quality of the internal environment) is measured through specific monitoring systems, and HVAC is directly connected to that.

The most commonly used insulation material is fibre glass, both in Canada and the US. Fibre-glass insulating material dominates the market. While standards provide us with many answers (regarding the characteristics and properties of the material), there are some issues to be addressed.

The first challenge I will discuss is when conflicts between standards and codes occur, i.e. when these two collide. For example, in the US, the American Disability Act requires building accessibility for all citizens. This means that persons with disabilities should have adequate access to buildings. When a building is designed following the LEED rating programme, it usually means that the building has to be comparatively small.

The American Disability Act requires big bathrooms to allow easy entrance by a wheelchair. But the LEED rating programme requires for the building to be small, triggering a negotiation between architects and regulators.

As shown in this example, when two codes collide, it is very difficult for them to design a building that can accommodate both sets of requirements to the maximum extent.

Another challenge is when standards are used ineffectively. In 2005, New Orleans, in the state of Louisiana, was struck by hurricane Katrina. While the hurricane hit the city, it did not create damage until the flood wall broke, which made the city go under

water for a long period of time, resulting in a massive generation of mildew and mould.

The city documents showed that all standards and codes had been applied. However, it was found that the LEED programme in New Orleans was actually using the ASHRAE 189.1 standard that neglects moisture flows into a building. The complementary standard, ASHRAE 160, which accounts for the moisture flow, was not part of the programme. Therefore, moisture was out of control, which shows that, when standards are only partially used, problems like mildew and health-hazardous mould could arise. To resolve similar issues, a software called Wufu was developed – it is based on the ASHRAE 160 standard that provides solutions to deal with moisture in the building.

While there are some issues associated with the use of standards, standards provide many benefits. Improved efficiency and support to innovation are among them.

An example of this dynamic was given by an interviewee, in relation to insulating materials tested using the "guarded hot plate" method specified in an ASTM standard. The standard required for the plate to be heated in "single mode" and it did not allow data transfer and connection to the building's monitoring system.

Based on this experience, a new standard has been developed that allows more flexibility on how plates can be heated (in particular in "double mode", which is faster and uses less energy) and supports direct connection to the building's monitoring system, providing immediate feedback on how the building performs.

Many interviewees complained about how much time it takes for a product to enter the market. For thermal roofing insulation, a new product has to be exposed in the field for a period of three years, before it can be tested for ageing. A new standard, ASTM E1908, is being developed, which reduces the waiting period for testing the material's ageing from three years to two weeks.

Green technology is also concerned with health issues. *Urea formaldehyde foam insulation,* which I will refer to as UFFI, was

used from 1930 to the late seventies to bind fibreglass insulation materials. Many of the manufacturing companies producing fibreglass insulation, the most common material in North America, found that they were health hazardous.

Manufacturing companies using UFFI to bind the product, relying on the findings of medical research, were able to develop new products, which are more environmentally friendly and energy-efficient. The new technologies are called ECOSE and Eco Touch, and are based on standards UL 723 and ASTM C553.

ECOSE uses renewable ingredients and Eco Touch uses plant-based ingredients to bind the insulating material.

To test the products, we need tools, and one of them is the "green" software "EDGE": a software used to determine how a building can improve its environmental performance and energy efficiency. It uses country-specific climate and local construction techniques to calculate how to reduce the environmental impact and energy consumption, allowing to achieve a 20% increase in efficiency. "BACnet" is another software used to communicate directly with the building's control systems. WUFI, which I have already mentioned, deals with moisture flow into the building.

The interviewees' opinion on the relationship between standardization and R&D was assessed by asking them to respond to a number of questions, giving a score from 1 to 5 – 1 being the poorest and 5 being the best.

All participants said that there was a direct relation between R&D and standardization activities. However, they rated the level of exchange of information between the different stakeholders as mediocre. The application of recent R&D into standards was felt to be poor. The main reason given was that the researcher's language is often too complex for manufacturing companies and practitioners to follow. Another issue raised was that, as a result of the financial crisis, training amongst construction workers has substantially declined. There is one supervisor for 20 day-to-day workers and, therefore, many of the standards they are supposed to apply are either not properly implemented or ignored.

The key benefits from participating in standards development indicated by most interviewees are the ability to influence the standards' content and the possibility of acquiring knowledge of changing markets. By having this knowledge beforehand, companies can modify their product and gain competitive advantage.

The main problems related to standards development, concerned the perceived dominance of a relatively small number of powerful companies, resulting in ignoring issues that should be taken into account.

Lack of resources doesn't allow many NGOs or smaller companies to participate, so their voices are not heard whilst large companies are able to commit time and resources, which results in a possible overrepresentation of their interests.

Based on the research findings, I would like to give a few recommendations. Yesterday, many speakers mentioned the important role of public-private partnerships (PPP) and I fully subscribe to that. More PPPs could help to speed up the development of new green technologies and accelerate market take-up.

Greater attention to ensure balanced representation of interests in standards development is highly recommended. I would add a personal opinion – that perhaps increased government intervention is needed for standards to be used most effectively.

In conclusion, I found that research is continuously helping us to improve existing products and to develop new and better ones. Standards and research need to be optimally synchronized to reach the goal to build green. Thank you for your attention.

Speech 4.4 Standardization and innovation in the green building field: insights from Europe – Part 1

Philip Hedestad,
PhD candidate at the Institute of Economic Research, Lund University School of Economics and Management, Sweden

Ladies and Gentlemen,

I am Philip Hedestad and this is my colleague Markus Arnez Wegelius. We are here today to talk to you about the perceptions of research institutes and standardization bodies, and what it means to work with each other in the field of green buildings. We will try to see how these actors can establish a closer connection at an earlier stage in order to develop more and better standards.

For the first section of this presentation, I will run through the basics on how the research was conducted, and Markus will then describe the research findings. Finally, we will run through a joint explanation of the recommendations on how to strengthen the relationship between research and standardization.

Markus and I are PhD students from Lund University, and we come from SRC, the Standardisation Research Centre. Our day-to-day research includes standardization in supply chain management and strategy. For that reason, we were – and are – very happy to have taken part in this project, supported by Mr. Daniele Gerundino from ISO.

We conducted interviews with 25 experts from all over Europe, focusing on insulation materials and HVAC (heat, ventilation and air-conditioning) systems. We wanted to learn more about R&D

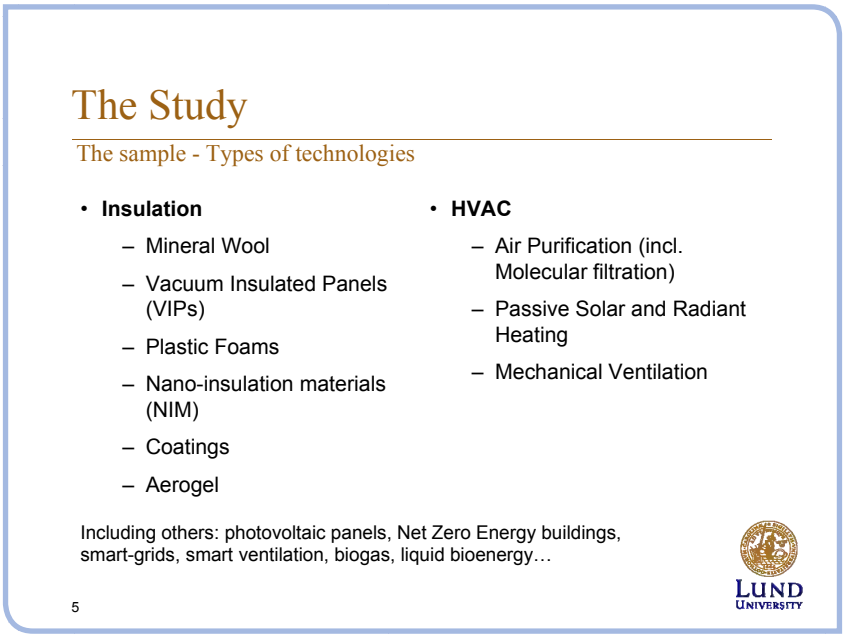
and standardization to understand the attitudes, dynamics, and perceptions of the concerned parties, as well as learning from success stories and failures, with a view to provide recommendations for the future.

On Slide 4, you can see an overview of our sample, showing some of the organizations interviewed.

SLIDE 4

And it is worth noting that 92 % of our interviewees have an active role in standards development.

On Slide 5, we have listed some product innovations that the interviewees were involved in.



SLIDE 5

The prevalent ones concern mineral wool, which is an old and reliable technology. The second one is VIPs (vacuum-insulated panels) which are exactly what they sound like, small gas-filled panels that provide high thermal inertia, even in thin walls, as opposed to mineral wool that you find in thick concrete walls. Then you have all the others.

We asked our interviewees fairly open questions, to let them speak freely about issues related to standards and standards development. Questions concerned the main benefits and challenges linked to the use of standards, the overall relation between standardization and R&D activities, existing barriers to the achievement of optimal results and recommendations on how to make progress. Many technical committees, International (ISO) and European (CEN), are active in the areas covered by our project – the most important ones covered by the interviewees belonging to our

sample were ISO/TC 163, *Thermal performance and energy use in the built environment*, ISO/TC 205, *Building environment design*, CEN/TC 88, *Thermal insulating materials and products*, and CEN/TC 350, *Sustainability of construction works*.

I also have to outline a few definitions that we have used in the context of our research. *Standardization*, which is essentially an agreement between several parties aiming to achieve an optimum degree of order in a given context. *Product innovation*, i.e. a product that is either new or has been significantly modified. *Research and development*, i.e. the undertaking of product innovation to benefit culture and society. This means that R&D leads to innovation. For the sake of simplicity, we will use these terms interchangeably.

On Slide 10, you find some facts about buildings in Europe.

The Building Sector in Europe

- Buildings in Europe **consume around 40% to 50% of all end-use energy** as heating and electricity (Palmer & Cooper, 2011; Bourdic & Salat, 2012; Troy, 2012).
- Buildings in the EU have the **greatest energy saving and energy efficiency potential**, approx. 27% for residential houses (Ardente et al., 2011).
- Buildings have had a **50% growth rate** over the last 50 years in the UK (CPA, 2010).
- 72 % of the 150 million dwellings in Europe were **built before the year 1972** (Gaterell and McEvoy, 2005).

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SLIDE 10

In Europe, buildings are the largest energy-consuming sector, accounting for 40 % to 50 % of all end-use energy, and several

studies have shown that the building sector has the greatest energy efficiency potential.

Most of the existing buildings in Europe were built after World War II and almost three-quarters of them are at least 40 years old. Retrofitting existing buildings to improve their energy performance is a priority today, followed by the construction of new energy-efficient buildings. Standardization plays a hugely important role in both areas.

After innovation comes standardization, and then certification. But why do these need each other? Well, from the literature that we have been studying in the first phase of the project, the construction sector has become increasingly complex, which means that there are many new actors, and they need to communicate well in their value chain. It is important to align scope of work and accountability, as well as to ensure compatibility and interoperability of building components and systems.

We can say that standards provide the basis for all that.

From a broader perspective, we can say that standards, in general, support economic growth and welfare. Swann and Lambert have given an important contribution to scholarly thinking in this area by showing that standards do not constrain companies in their pursuit of innovation, but it is actually the other way around, standardization does promote innovation.

And with that, I leave the floor to my colleague Markus Wegelius.

Speech 4.5 Standardization and innovation in the green building field: insights from Europe – Part 2

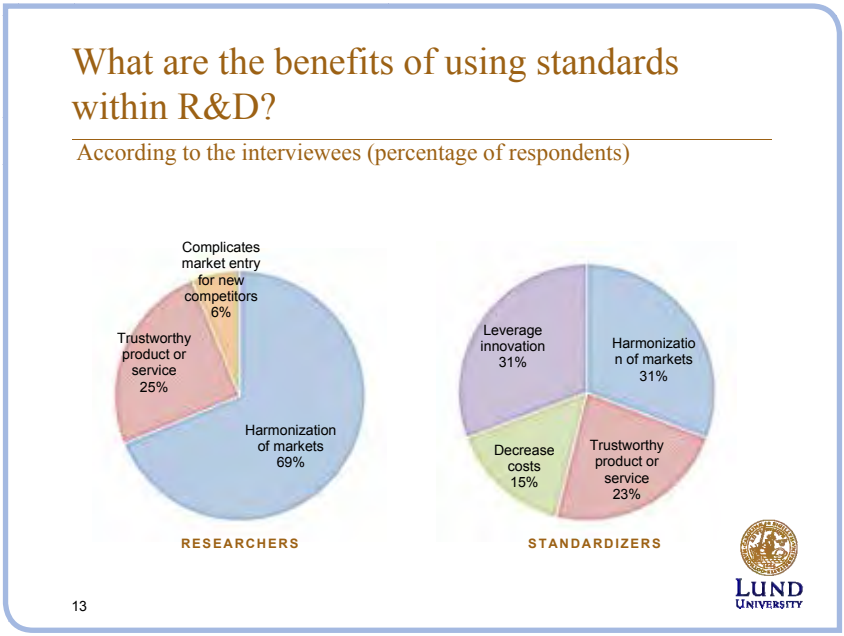
Markus Arnez Wegelius,
PhD candidate at the Institute of Economic Research, Lund University School of Economics and Management, Sweden

Good morning, I'm very happy to be here. I'm sure we're all very excited to explore the findings of our study. Before I start, I thought I could share a quite interesting anecdote, at least for me personally.

SLIDE 13

The gentleman on Slide 13 on the left of the slide is my great-grandfather, Dr. Edvard Wegelius, who served as ISO President in the late 1950s (1959-1961), in the early days of ISO. The good-looking fellow on the right is my uncle and he is currently working at CERN, and has done so for the past 14 years. And so I thought that this is the perfect conference for me to attend, as it is hosted both by ISO and by CERN. So I am very much the gap in between my family members. Excuse me for that little personal parenthesis.

The first findings concern the question of the main benefits of using standards in R&D.



SLIDE 14

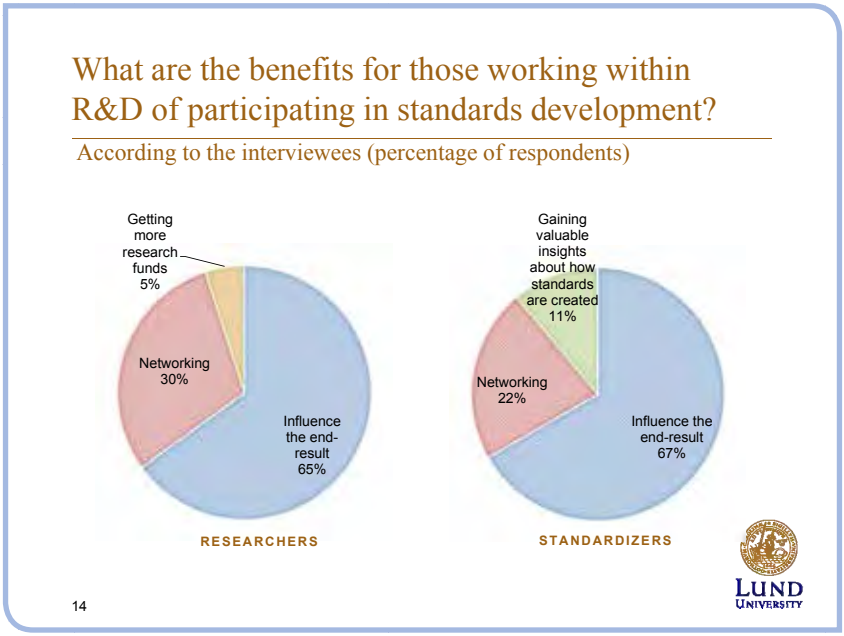
The pie chart segments on Slide 14 represent the percentage of answers that we received from the respondents. Researchers on the left are composed of those within private enterprises, independent, third-party actors as well as academic researchers. Standardizers are those working within national standard bodies.

The main takeaway is that, for the researchers, benefits are very much connected to their business interests, the competitive edge

of their company (if they are working for a private enterprise) and to market concerns: "harmonization of markets" (hence facilitating market access) is considered the main benefit, followed by "providing a trustworthy product or service", and complicating market entry for new competitors.

On the standardizers' side, it's a little more varied. We have the same market elements, with additional motives, such as "leveraging innovation" and "decreasing cost". I think the interesting point here, which I believe Navid Gohardani and others might have already touched on in their presentations, is that there is perhaps still a traditionally held view among researchers that standards do not leverage innovation.

The next question for which we sought an answer is: What are the benefits of participating in standardization for those working in research and development?



SLIDE 15

On Slide 15, we see rather aligned results: both groups believe that "influencing the end result" is the key benefit, followed by

networking, i.e. meeting fellow colleagues in the industry. On the researchers' side, there are also a small amount of interviewees who believe that participating in standardization was a means of obtaining more research funds, possibly from their own company or from external sources. Standardizers assume that it would be important for researchers to gain valuable insights into how standards are created, but we do not see this on the researchers' side, which suggests that there is a lack or a mismatch of communication.

The third finding regards the drawbacks (or perhaps a better word "challenges") of using standards for those working in research and development. Here we see, on both sides, the usual suspects: time and money[6]. Furthermore, on the researchers' side, and we think it is quite interesting, we see that a number of them believe that standards can be unclear, vague or too complicated. Due to that, a lot of companies felt that they were obliged to hire external consultants, specialists hired to assist in the implementation of those standards within their companies. We also see that some research takes the traditionally held view (which we do hope to contradict through this conference) that standards do not support innovation. On the standardizers' side, some respondents think that benefits may not materialize until many years later and many of them (almost one-third) see the difficulty of pleasing all stakeholders participating in the technical committees.

Moving on to the barriers of achieving optimal results through the interaction of research and development and standardization, we can see similar findings: lack of time and funding on both sides. However, about 11 % of the researchers consider the conflicting agendas of stakeholders as an important obstacle (within technical committees, this can lead to potential conflicts and arguments which can bring the standardization process to a standstill – requiring a long time to resolve conflicts).

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6 Note of the editor: "money", as described in the research report, makes reference to the cost associated with developing and implementing standards – not to the cost of purchasing the standards documents.

Confidentiality concerns, as well as the threat of free riders, complete the picture. Confidentiality concerns means that many private enterprises are reluctant to divulge proprietary information due to the fear that their competitors might exploit it. The threat of free riders concerns the fear that certain private companies could still reap the benefit of standards without sustaining the development costs, gaining unfair advantage over competitors engaged in standards development. On the standardizers' side, almost one-third mentioned the difficulty for researchers to secure time for standards development amid their regular work, whilst another 18 % considered the slow process a significant barrier.

At this point, let me briefly highlight four case studies: the first one concerns the complexity of standards. Here, we are dealing with two standards addressing methods of calculating moisture risks in buildings. The first standard, EN 13788, was devised to measure moisture risk, but was apparently too simple. This was considered an advantage in the beginning, but it led to misleading results that could be easily manipulated. As a result, industry stopped using this standard due to the unpredictable results of its application. The second standard, EN 15026, was devised to improve the first one, but unfortunately the calculation method applied became too complicated. As a result, the application of this standards was slow and painful and, even worse, could be used only for a few materials. The takeaway from this case is that the "right" standard seems to lie somewhere in between the two.

The second case study is an example of mixed interests within standardization. The context was that of a technical committee dealing with roof insulation. There was disagreement in the committee as certain independent consultants submitted poorly supported evidence for the proposed solutions. It was later discovered that these "independents" had actually connections to private enterprises that were looking to defend their interests within the technical committee. In this particular case, they claimed that if the technology of a certain company was used, there was no need to use roof insulation. However, the insufficient evidence provided

was put down by the committee. This led to a conflict in which, eventually, legal action was threatened.

The third case study seems to be a direct confirmation of the benefit of standards for society. Here, we are concerned with a standard that ensured quality in the market of mineral wool. There are new players in this market that provide non-standardized products, cheaper and of lower quality, which do not meet customers' demands. In this case, standards enabled the provision of better and clearer information regarding product quality, helping to meet customer demands.

The fourth case study shows a standard that gave a direction. It concerns a very innovative, venture-capital-funded Swedish SME that focused entirely on researching and developing different applications of aerogel. Until recently, aerogel was only used in the aviation, space and military industries, i.e. high-level industries. But this company was looking to extend it to everyday applications. As they were new in the business of applying aerogel into insulation, they were able to find standards referring to insulation, and these standards greatly aided their initial research and development, providing guidance.

The conclusions from the responses received from the interviewees indicate that the relation between standardization and innovation is, on the whole, positive. Standardizers and researchers are mostly in agreement about the benefits of standards. They also agree that the key challenges are insufficient time and money. This leads us to the very interesting question of how can we maximize the investment of the actors involved in standardization.

From our findings, we have identified four different recommendations for improving the collaboration between innovation and standardization.

SLIDE 24

The first is to improve the management of expectations, creating a well understood and common agenda. This includes a clear identification of the goals of different stakeholders. Many of our interviewees felt as if their opinions were not regarded, with dominant stakeholders always in the driving seat. We think it is important to look properly at everybody's interests in the beginning, to avoid bottlenecks in the end (see Slide 24).

Standardizers and researchers should work more as active advisers to each other, perhaps even creating joint R&D centres where standards could be connected with product innovation at an earlier stage.

Technical committees should also develop a strategy aiming at prioritizing work in order to get the product or service out on the market as soon as possible. We are strong believers that this will benefit both parties.

The second recommendation addresses the time and money problem. Surely, this is not unique to standards development but something that all organizations or individuals struggle with. To

mitigate this problem, we believe in measures helping to increase the efficiency of standards development, such as clearer guidelines, tools and templates, on- and off-site assistance and regular follow-ups, smart use of communication technologies – basically anything that would contribute to minimizing stakeholders' use of time and money.

SLIDE 25

Our third recommendation (see Slide 25) concerns the proactive management of the standardization process by standardization bodies and, eventually, other organizations. This should ensure the participation of neutral third parties and other stakeholders to counteract possible overrepresentation of one type of stakeholder (especially private companies or even just a few of them).

A healthy balance of stakeholders within a technical committee is important to ensure a more holistic approach, supporting the interests of the whole of society – as opposed to the narrower interests of some private companies. Funding provided by national standards bodies or public authorities to support third-party

participation could be a good investment, possibly resulting in higher-quality standards.

In addition, standardization bodies should develop clear conflict mitigation strategies. We noticed, in at least one case, that whilst conflicts may arise, it seems that standardization bodies don't have a standardized procedure to deal with them. So we would advise for strategies to be put in place, as well as, if needed, for the training of chairmen and convenors in terms of conflict resolution skills.

The appointment of active and engaged chairmen and convenors is also very important : we noticed that, in certain technical committees, there were relatively passive chairmen. This, in turn, led to participants losing motivation, dropping out of the process completely, reluctant to continue.

Finally, the last recommendation is to promote standardization and its benefits. Promoting the benefits of standardization will have long-lasting positive results for both industry and standards bodies. As we mentioned before, our findings show that communication between researchers and standardizers should be improved. If more people in the industry could clearly identify the benefits of standards, they would increase their participation in standards development.

The " practicalities " of standards development are sometimes not known in the industry, for example the way to contact their national standards body, CEN or ISO can be confusing for some of them. Standards bodies should help make all this as clear and simple as possible.

Last but not least, facilitating the participation of highly innovative SMEs is also very important.

Thank you for your attention.

Session 5

The role of standardization in CERN's innovation and technology transfer process

Chair's remarks

Chair: Enrico Chesta,
Head of CERN Technology Transfer and Intellectual Property Management Section

Good morning and welcome to this session dedicated to the role of standardization in CERN's innovation and technology transfer process. Like yesterday, we are going to talk about CERN again. At the beginning of the conference, there were some overview talks by some of the directors on the activities of CERN, mainly in the field of science.

If you go to the main Web page of CERN, you will see there is a nice article about how "standard" the Higgs boson is. Now, it's clear that we're not talking about the same standards that ISO is dealing with because nobody is willing to make international

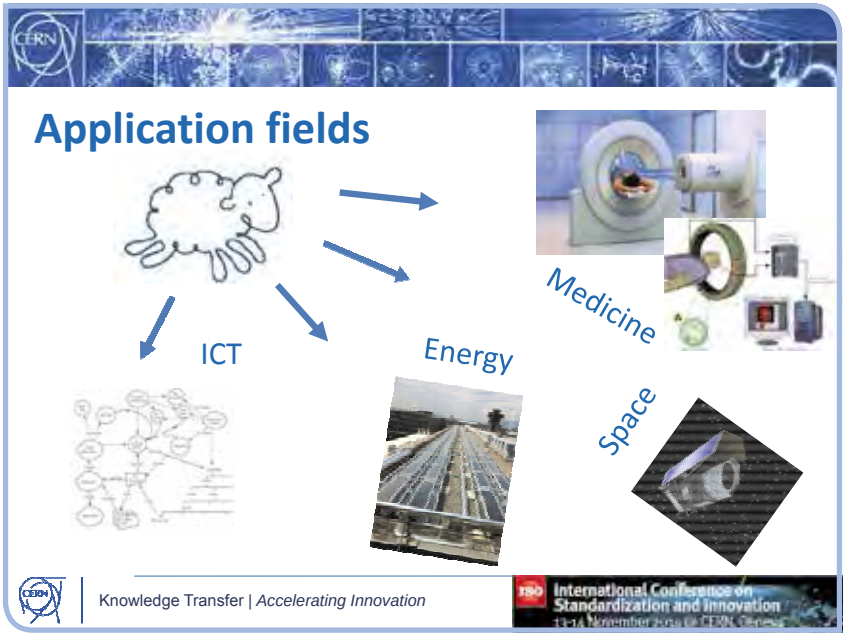
trade with Higgs bosons. But there are technologies that CERN develops and for which standardization can be useful, and this is part of the session today.

Just a little introduction about myself. I am Enrico Chesta. I am in charge of the intellectual property management and technology transfer section here at CERN. I am also involved in the EIROforum Working Group on Innovation Management. The EIROforum is an international network of scientific organizations and we do believe that standardization can play a critical role.

Now, just a few slides to introduce this session. Technology transfer at CERN has to do with identifying and promoting technologies developed for our scientific programme that can find applications and can have an impact on society at large.

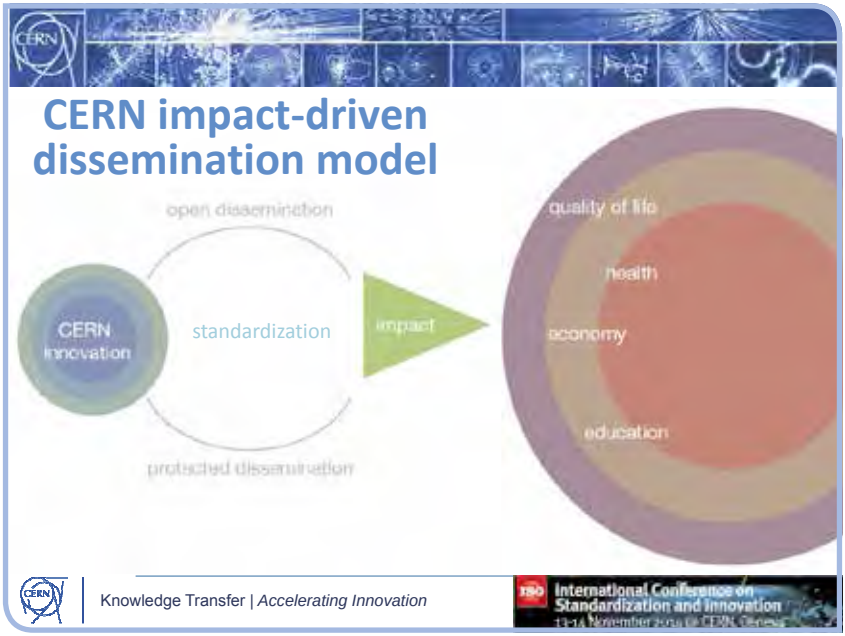
The technologies we are dealing with come mainly from three big domains, which are accelerators, detectors and IT. We can go into more detail about different technology fields in which we have strong expertise, ranging from superconductivity, vacuum cryogenics, high-performance detectors and, of course, the processing of huge amounts of data.

All these technology fields can have an impact on society, mainly through the support of external partners, and, in most cases, what we are dealing with is what the French would call a "mouton à cinq pattes", i.e. technologies which are everything but standard. Probably, it's also what our suppliers think about our requirements in most of the cases.



SLIDE 3

Still, our ambition is to find applications for technologies in fields like medicine (both therapy and diagnosis), energy, space or telecommunications (see Slide 3). We have been quite successful in the past and we are using a model that looks something like this.



SLIDE 4

As you can see on Slide 4, this is what we call the impact-driven dissemination model of our innovation. When we start our innovation, we try to share the impact on society at large using different channels like open dissemination or protected dissemination. We believe that standardization can be placed right in the middle because it is really a highway for achieving impact, either through open or protected dissemination. In both cases, standardization can play a role and the objective of this session is to provide examples.

We have examples that show how, for us, standardization is a real enabling tool for knowledge and technology dissemination. The paradigm shift, mentioned yesterday in the panel discussion, i.e. that standards can open new global markets, is something we are very interested in, and we are trying to leverage on it for our dissemination processes. We have the feeling that there is a potential which is not fully exploited yet, and so we are interested in exploring more opportunities.

Standardization can certainly play a role in innovation management. We heard yesterday about ISO/TC 279 on innovation management and we are very much interested in collaborating and contributing to the discussions.

We also have good examples related to the procurement of technologies. We don't want to avoid or overrun specifications. Standards are very helpful for that and we will have a nice talk about safety, how standards can facilitate the safety approval process in our international environment and, finally, a very nice example of how standardization can drive new and challenging innovation and it will be given by our colleague from the METAS Institute who is collaborating with CERN on a project concerning the (new) definition of the kilogramme as a standard unit of measurement.

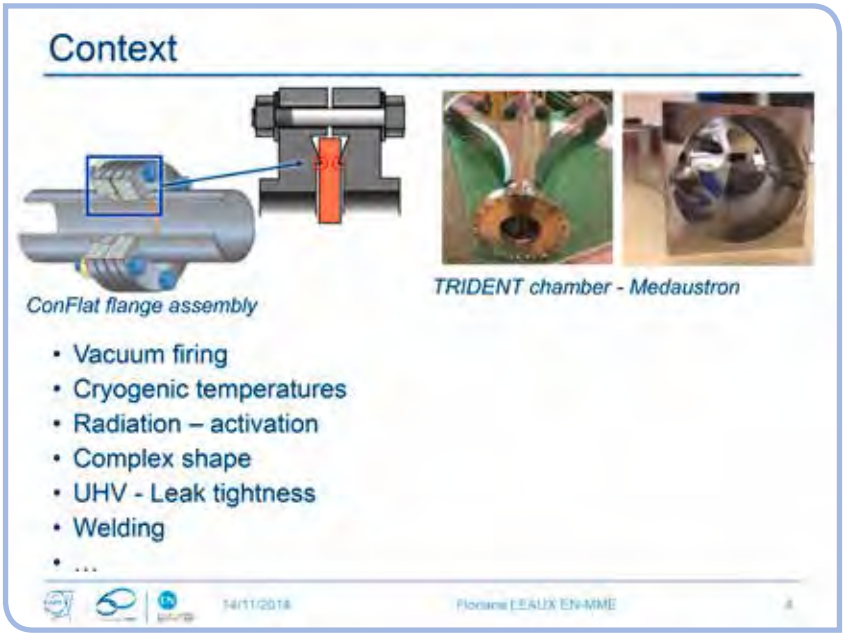
I am going to introduce every speaker separately and I suggest we try to find a few minutes for questions for every talk because they are very different from each other. The first talk will be given by my colleague Floriane Leaux. Floriane is a materials engineer at CERN in the engineering department, Mechanical and Materials Group, in particular in the materials laboratory where she is responsible for the electron microscopy activity. She is actively involved in technical support for the procurement of raw materials and she is especially in charge of leading a group on metal raw materials and the writing of technical specifications for the procurement of non-standard materials that are adapted to the specific needs of CERN.

Speech 5.1 How to procure non-standard materials for demanding high-energy physics applications within a standard framework

Floriane Leaux,
Material Engineer, Material, Metrology and Non-Destructive Testing Unit, CERN

Good morning. Today I will talk about how, for its specific needs in terms of high-energy physics, CERN manages to procure non-standard materials within a standard framework. Quickly, some context. To find the X boson and to manage the accelerator complex, all the components of our machines are subjected to very particular environments.

They could be : high vacuum, ultra-high vacuum, the material may need to do vacuum firing at 950 °C, materials are subjected to radiation, and so on.

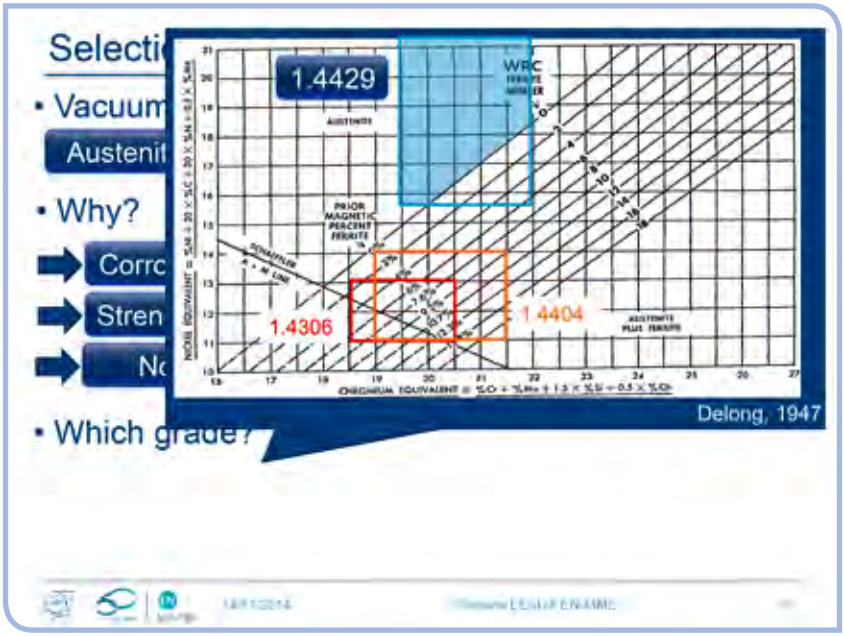


SLIDE 4

As you can see on Slide 4, CERN can deal with complex shapes. This shape is directly machined in a block and has to be leak-tight, even if at some point the components are very thin. I will not go through all the requirements, but they are quite substantial and can also be combined together. I will present a very practical example of specific requirements in terms of metallurgy for CERN and how we adapt the procurement process in order to get this material.

First, I take as an example the need to find material for ultra-high vacuum. Stainless steels are the reference material because they are non-corrosive. Moreover, austenitic[7] stainless steels also maintain good strength and ductility at room temperature, but also at cryogenic temperature due to their austenitic structure and the fact that they are non-magnetic. We will aim to choose austenitic stainless steel – but which grade ?

7 Austenitic : « composed of austenite », a nonmagnetic solid solution of iron and other alloying elements used in making corrosion-resistant steel.



SLIDE 15

On Slide 15, you have a nice graph. Again, I won't go into much detail but it relates the composition of the steel to the tendency to form ferrite, when the material is welded or deformed. The ferrite will degrade the properties of the steel. We want that after any treatment – welding, deformation, or cryogenic temperature – the steel remains in the required range.

[Editor's note : In what follows, different types of stainless steel are described, based on their steel grade according to the EN 10088 series (a numerical range from 1.4000 to 1.4578) or the SAE classification (in particular 200 and 300 series, including alphanumeric characters). Steel grades are defined in relation to the percentage of other metals present in the alloy, e.g. chromium, nickel, molybdenum, ...]

If you look at the (red rectangle in the slide) grade 1.4306, which is more or less equivalent to 304L stainless steel, it can be seen that it can create up to 10 % of ferrite so this is not the steel we would choose.

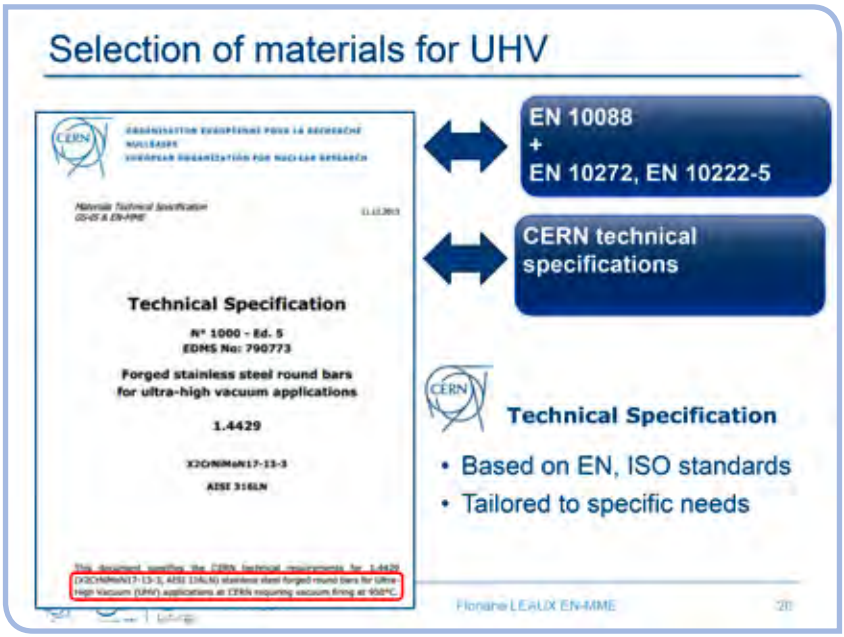
If we look at this one (orange rectangle in the slide), steel grade 1.4404, which is more or less equivalent to the 316L, it is similar to the previous one. Therefore, for specific cases such as cryogenic applications, when non-magnetic properties are required, this grade cannot be chosen.

If we look at this (blue rectangle in the slide) steel grade 1.4429, which is commonly related to 316LN, it can be seen that, in some domains and for some ranges of composition, it can also lead to ferrite formation, but it is most likely that we will remain in the range excluding ferrite formation, so we will go for a 1.4429 for some of CERN's specific applications.

Why does 1.4429 behave like that ? It is because molybdenum and nitrogen increase the stability of austenite and also its strength, which is particularly important when vacuum firing at 950 °C is required, which tends to degrade the mechanical properties. 1.4429 is covered by standards like EN 10088 for corrosion-resisting steel, and other standards for pressure applications.

These grades (1.4306, 1.4404, 1.4429) are commonly used at CERN for pressure applications, not only for vacuum applications but also for other specific technical requirements. Some applications are not fully covered by existing standards. In these cases, CERN builds ad hoc technical specifications, as you will see, which finally allow to purchase the right material for the right application.

On Slide 20, you can see an example of what a CERN specification looks like.

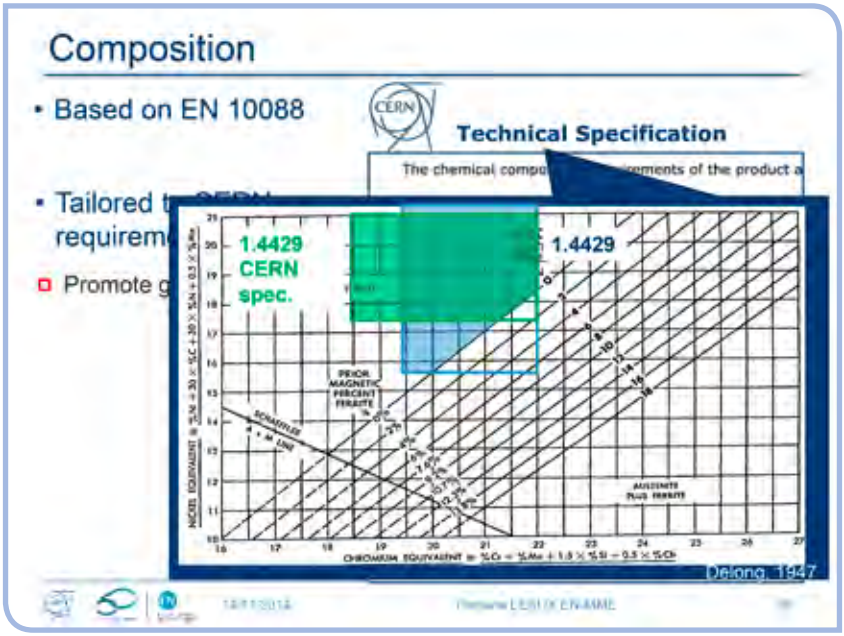


SLIDE 20

It is based on EN and ISO standards, sometimes ASTM, but it also contains specifications tailored to our specific needs.

To understand CERN's specific requirements, we need to do a bit of metallurgy now, but I will try to be as clear as possible.

Of course, the main composition of metals is based on standards but CERN's applications need specific requirements concerning, for example, the gamma stability, so minimizing the austenite-ferrite phase transition is really important to keep it stable. For this reason, we ask for a specific content of chromium and nitrogen. I go back to the diagram on Slide 26.

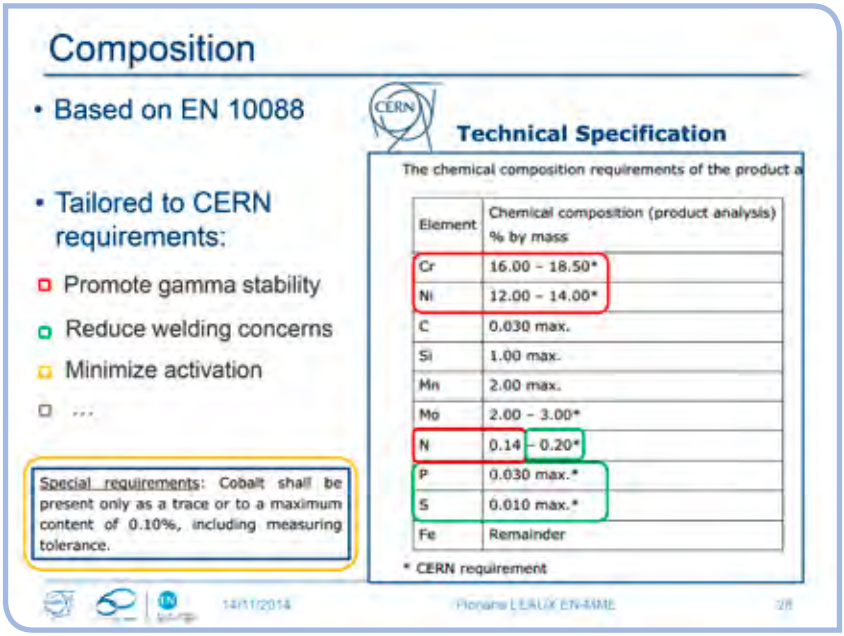


SLIDE 26

You can see the blue rectangle corresponding to a normal 1.4429, but when the CERN-specific requirements are added (green rectangle in the slide), the risk of forming ferrite is extremely limited. With this "CERN extreme" composition, we are almost 100 % sure that the material will stay in the austenitic domain and, in some cases, this is really important.

We want to reduce as much as possible the concerns due to welding because with a 27 km long LCH, we need to do at least 10 000 welds. It is really important and, for that, we have special requirements of very low concentrations of phosphorus and sulfur.

We also need to minimize activation : cobalt is an element which can normally be present in a proportion of 0.15/0.20 % or even more, but we really want to reduce it to 0.10 % to minimize the activation.

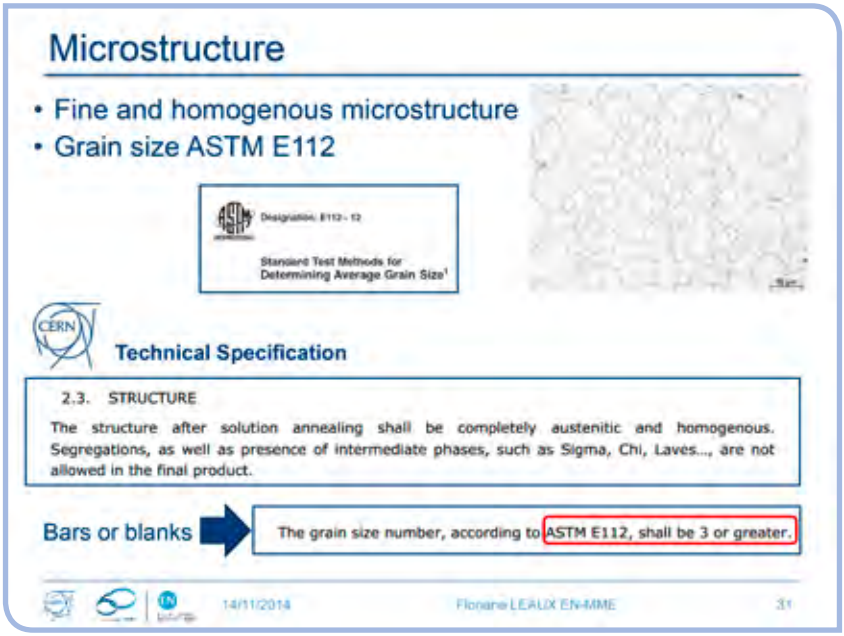


SLIDE 28

So what you see on Slide 28 is an extract of one CERN specification : with the supplier, a dialogue is established in order to explain CERN's applications and corresponding extra requirements, which deviate from the standards.

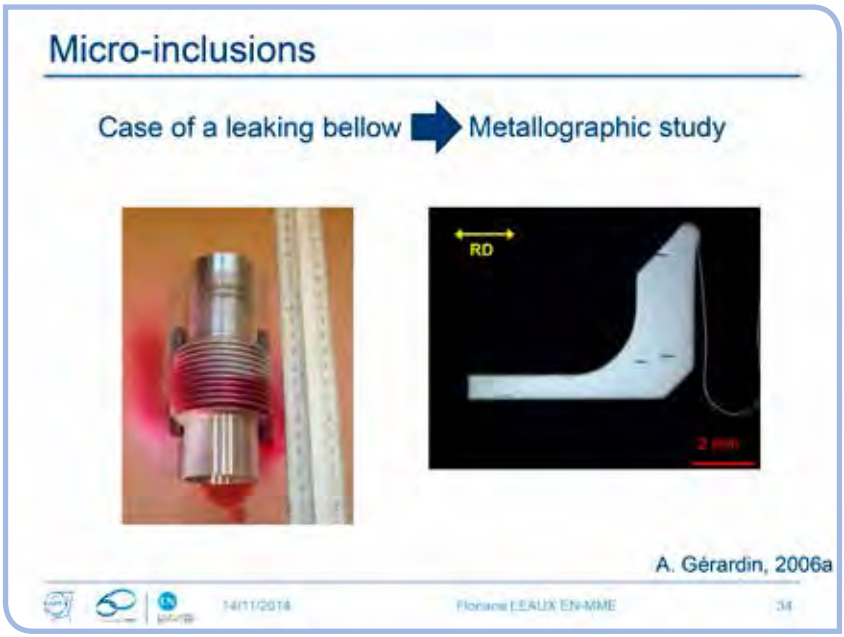
We are also concerned with the metal's microstructure, especially because, in some cases, our components have to be as thin as possible and leak-tight. For this, we need to have a homogeneous and very fine microstructure. In the standards, especially for plates or bars, no limitation for the grain size is given. In addition, ASTM E112 is commonly used by industry to determine the grain size. So CERN is using the ASTM E112 standard in its specifications.

For example and as shown on Slide 31, for plates or bars, we ask for a grain size number equal to or greater than 3.



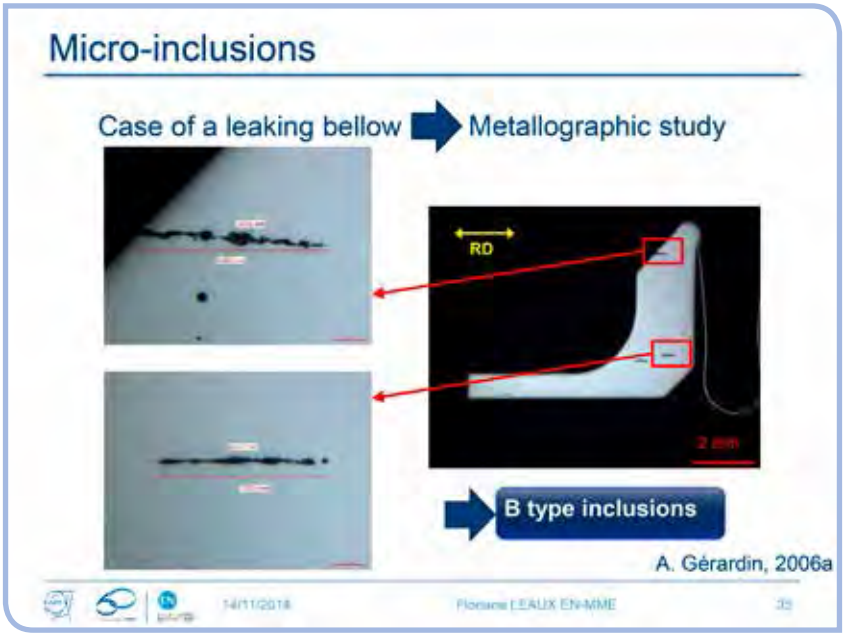
SLIDE 31

Now, I will talk about the cleanliness of the steel. In 2006, we had some leak problems on a component. You can see on Slide 34 the result of deep penetration testing.



SLIDE 34

Something I didn't mention before, vacuum of 10^{-11} mbar is often requested. So absolutely no leak can be accepted.



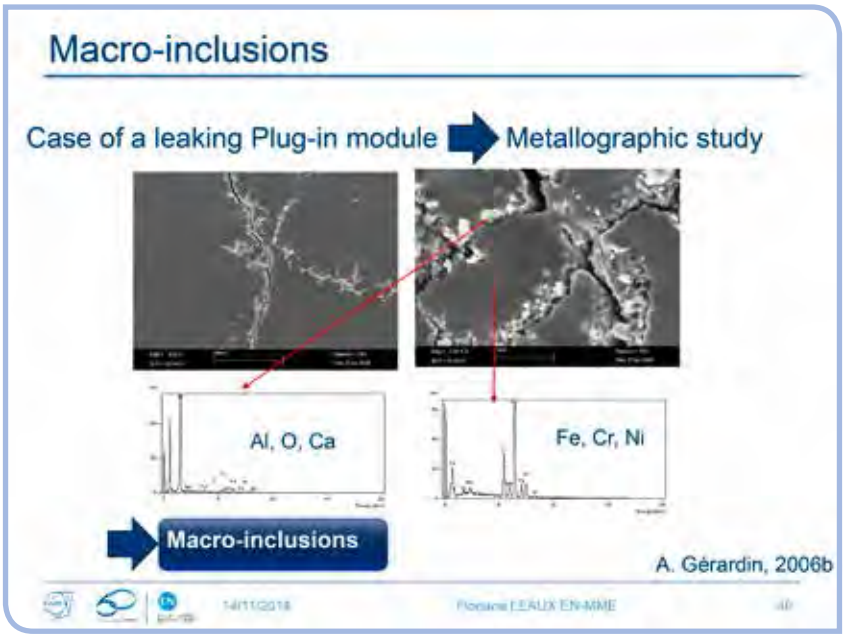
SLIDE 35

On Slide 35, you see that, after a metallographic study, some inclusions, which are B-type inclusions, were observed. These inclusions are not mentioned in any standards for normal applications, but they are evaluated by the standard ASTM E45. So CERN added some specific information about the minimal level of inclusion.

CERN also encountered another leak problem but, as you can see on Slide 38, it's not related to the same kind of inclusion.

SLIDE 38

On Slide 40, you have the base material which is austenitic stainless steel – no problem, but you can see really big particles which are made of aluminum, calcium, etc.

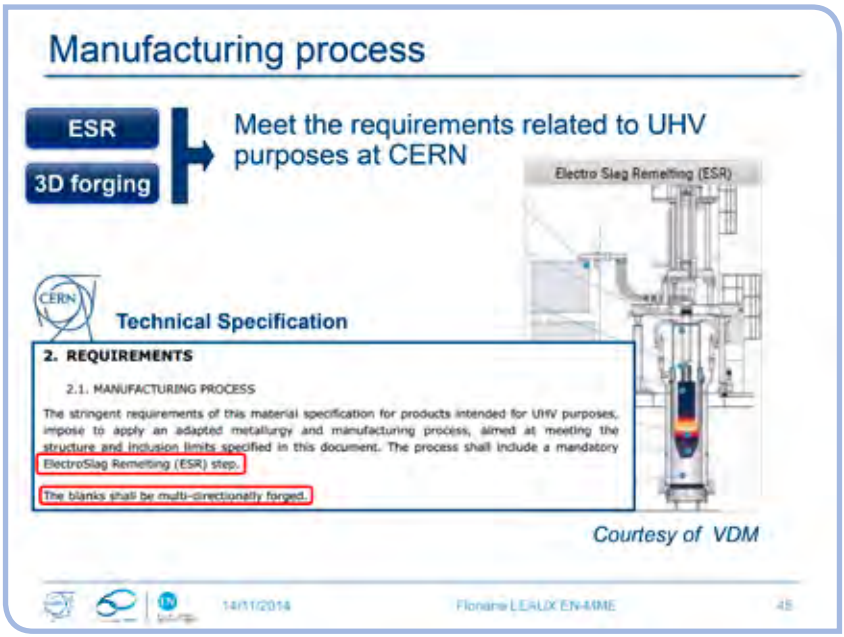


SLIDE 40

These are macro inclusions, which are in fact related to the presence of residual slag in the material. These macro inclusions are not covered by any standards, not even ASTM E45. So to procure the desired material, CERN mentions explicitly that such inclusions will be a case for rejection if found in the steel. And for this, the process needs to be adapted : the steel should not be only cast but remelted, in order to purify it as much as possible. This is a rather unusual process, especially for stainless steel, even with grade 316LN.

I come now to the manufacturing process. As I just said, a remelting process, called ESR (Electro Slag Remelting) is needed to meet CERN's requirements. We know what we want, but we also have to discuss with the supplier how to meet these requirements. For example, during the manufacturing process, to obtain the

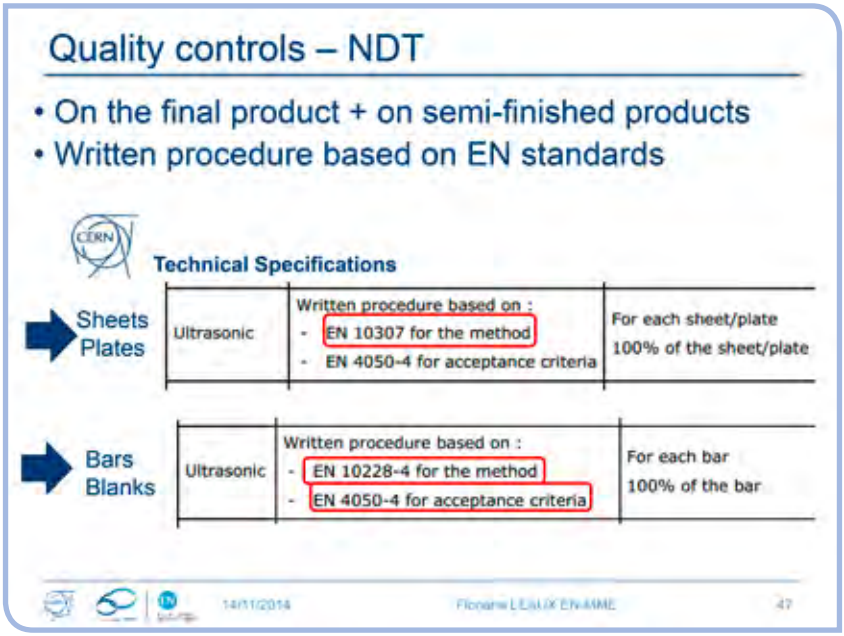
homogeneity of properties, a 3D forging is necessary. This means that the big blanks will be forged in three directions to achieve a fine and homogeneous structure.



SLIDE 45

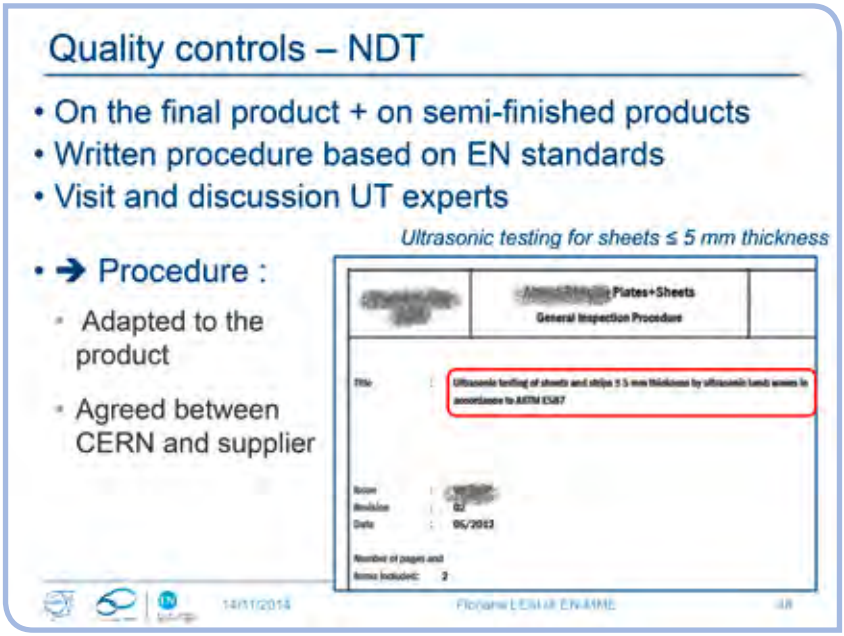
All these steps create a very unusual stainless steel. Finally, we need to control the final product and this is also not done in a fully standardized way (see Slide 45).

Then I come to the ultrasonic testing. It is a non-destructive testing and each bar, sheet or blank delivered to CERN is tested to check, as much as possible, its homogeneity. In CERN's specification, the specific standards for the ultrasonic method and for the acceptance criteria are defined.



SLIDE 47

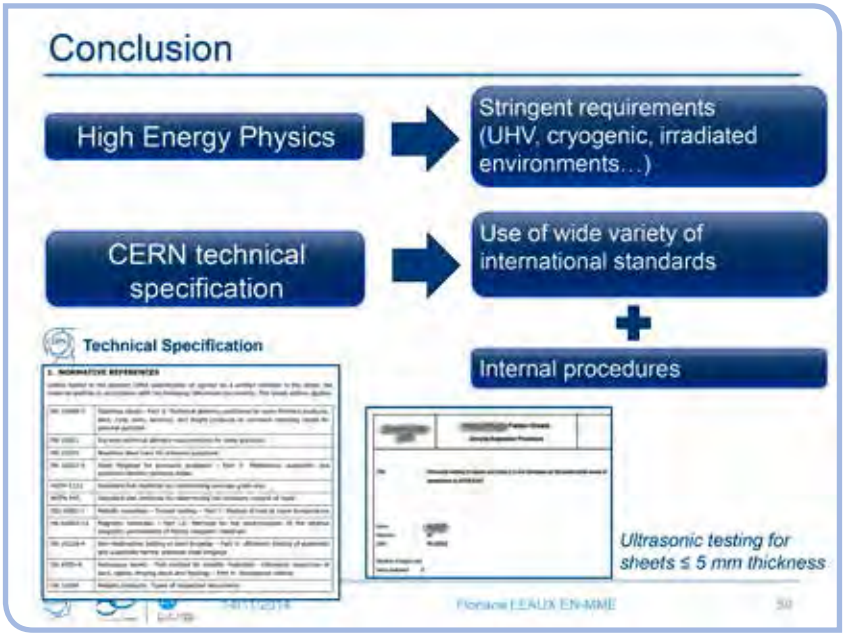
As shown on Slide 47, EN 10307 is a commonly used method, although CERN's requirements are higher with regard to the acceptance criteria, the size or indication that will be accepted or not. Then the specification is accompanied by a written procedure giving details of the testing and acceptance criteria. The following example is based on an aerospace standard. This is really a tailor-made procedure and it is usually the basis for discussion with suppliers. In some cases, no standards cover our needs. For example, for thin sheets below 6 mm, there is no standard but we still need them to be leak-tight, with no inclusion, no discontinuities or anything ; so with the supplier, we agreed to build some procedures to check the properties (see Slide 48).



SLIDE 48

This example concerns an austenitic testing using a specific method which is covered by an ASTM standard for the delivery of such sheets.

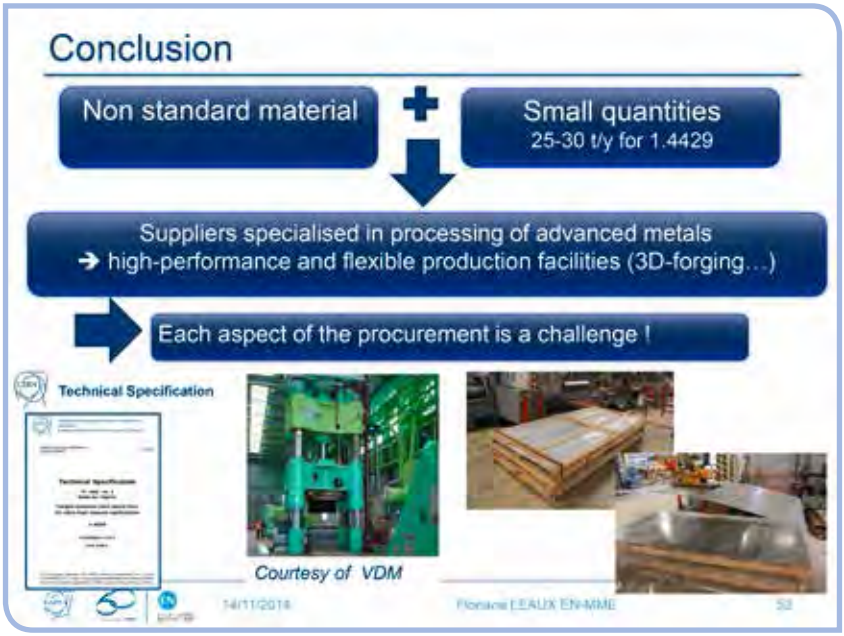
Let me now arrive at the conclusion. In the domain of high-energy physics, but it's also the case for other demanding fields like aerospace and medical applications, we have very specific and stringent requirements. So the aim of the specifications CERN is building is to use as much as possible standards that are available and used by manufacturers and, if needed, add an internal procedure to build a consistent guidance document for the procurement of the material. An example is shown on Slide 50.



SLIDE 50

Of course, as explained, these materials are not conventional standard materials that we can take directly "off the shelf". Sometimes, a dedicated casting and remelting process is needed. At the same time, the quantity is small. CERN purchases around 20 tonnes of metal per year, which is really a low quantity. However, it is changing because there are more companies and institutions using the same level of requirements, like ESRF (the European Synchrotron Radiation Facility) in Grenoble, France, which also has a particle accelerator, and the ITER project (International Thermonuclear Experimental Reactor) in Cadarache, France. So the quantity is increasing.

The challenge is to find suppliers specialized in processing materials of very high level, that can perform flexible production in terms of casting for forging and so on. Actually, each step of the process is really a challenge.



SLIDE 52

On Slide 52, you see, for example, a big forging machine that allows to forge large blocks of stainless steel, and here is an example of stainless steel sheets according to all the CERN requirements described so far.

That's all, thanks for your attention.

Speech 5.2 Safety at CERN in the context of worldwide collaborations

Ralf Trant,
Group Leader, HSE (Health, Safety, Environment) Unit, CERN

Good morning. I think I can continue with what my colleague Floriane Leaux said, covering the issue of the relation between standardization and innovation from a different perspective.

I have to say the presentation and most of the detailed knowledge of what I am going to present has been prepared with my colleague Adrian Henriques. He is on vacation so he can't be here, but he prepared most of the slides.

Just a few words on safety. When we talk about safety at CERN, what we have to keep in mind is the specific technical, operational and legal binding conditions we have here at CERN as an intergovernmental organization.

We just had the best demonstration of the meaning "cutting edge", "unusual", "non-state-of-the-art" technologies, which we are using in many domains, and Floriane Leaux just gave a very good example in her presentation coming from the material vacuum site.

On the one hand, as you may have seen yesterday during the guided tour, CERN is a major industrial site because we have a lot of infrastructure to maintain. We have thousands of people on the site every day. And there are particularly sensitive aspects we have to deal with, i.e. the radiation areas. We have 45 km of tunnels for our machines, which are classified radiation areas.

On the other hand, as you heard already yesterday morning, we are known for our research laboratories. Our installations are very dynamic. They are changing according to the needs of our researchers and the research today, not only in our domain, is always a worldwide collaboration. We are a European laboratory but, in reality, we are a world laboratory so we are a very open organization. We have thousands of people from all over the world coming here as physicists or as trainees. You know that education is part of our mission and, of course, people do not only come with a pen or, today, with a lector, they also bring along their equipment as part of the detectors which are being operated here.

We are an intergovernmental organization with the right to establish its own legal framework as necessary for the proper functioning of the organization, according to the host state agreements signed at the beginning of CERN, about 60 years ago. Why ? Because we are the only laboratory that is on two territories at the same time. We are in France and we are in Switzerland. But, of course, we have to operate our facilities with a single set of rules. Nevertheless, it's obvious that we have a strong interest in collaborating with our host states : France and Switzerland.

In the beginning, say five decades ago, the collaboration was separate to each host whereas, today, we use a tripartite approach to go into all relevant domains. So it's France, Switzerland and CERN sitting around the table to discuss what we need to address together.

Just one additional word on the CERN safety rules. We are establishing and updating the safety rules. It's part of the mandate of my unit and we do this in order to have a common set of rules that apply to the whole site of CERN, both on the French and on the Swiss site. However, of course, we do not reinvent the wheel. We base ourselves on the host state rules, on the European regulations or directives, and also on International Standards, which is your topic. Of course, we do this only where it's needed and when we don't have rules, then the French and the Swiss rules apply depending on the part of the territory of the organization, whether it's on the French or the Swiss side.

Finally, of course, the organization takes all necessary measures to ensure compliance with our safety rules and, from the monitoring point of view, my unit has a particular responsibility.

Coming back to the challenges of the organization, whatever we do today at CERN is in a very international collaboration.

SLIDE 5

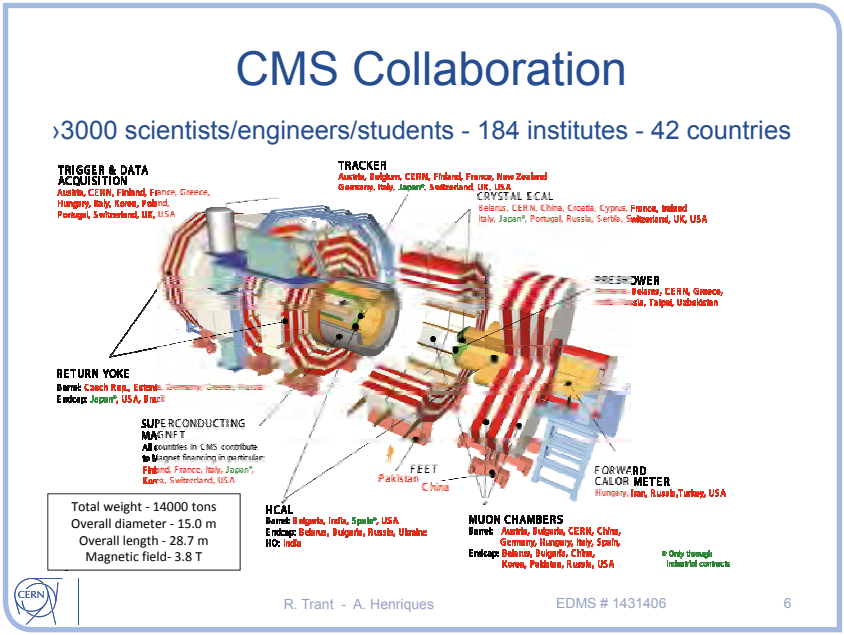
On Slide 5, you see a picture of a part of the machine for the upgrade project which is running currently at CERN. It's the High Luminosity Large Halon Collider (HL-LHC) and this is for the interaction regions.

You should imagine this as representing, on the right-hand side, either components of Atlas or of the CMS (Compact Muon Solenoid) experiments, or, on the left side, a series of magnets which, as it was originally for the LHC itself, populate the tunnel.

You see that we get this equipment from many countries and not only from European ones. We get it also from colleagues in Japan or in the USA, or somewhere else in the world. The superconducting magnets are the results of leading research and

development, and I think CERN is really at the cutting edge in this area. However, in order to operate them, you have to cool them down to very low temperatures. This means you have to build them in a cryostat, which is a pressure vessel, and we get pressure vessels here from all over the world so we have to think about compliance.

Another example, not from the machine but from the experiment point of view, is the CMS collaboration – one of the very large experiments which I've just mentioned. It involves the collaboration of around 3000 people from around the world : 42 countries, 184 institutes including, as you see here, countries such as Japan, the USA, Brazil, Korea, Russia, China, Pakistan, whatever you want around the world.



SLIDE 6

That's why I'm saying we're not talking of a European laboratory anymore (that's what CERN formally is), but of worldwide collaboration happening here on a daily basis (see Slide 6).

This is a challenge not only for the colleagues who are doing science and engineering, but also from the safety point of view. They go hand in hand.

We have our CERN safety rules. They are in the examples which I will show you and they are in line with the European safety regulations. It means that we base ourselves on the binding European directives and then we use standards to the maximum extent we can. Sometimes we refer to them explicitly in our rules, which makes them not only highly recommended but mandatory.

I can take as an example the welding of pressure vessels shown on Slide 7.

SLIDE 7

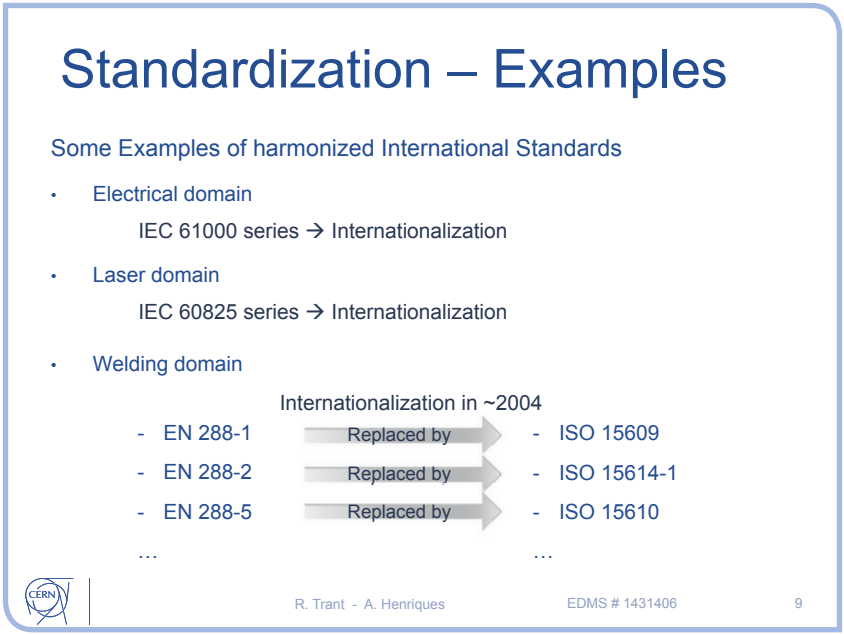
We have the CERN safety rules, in line with the European safety regulations. There are surrounding directives and harmonized standards from ISO and CEN. "PED" stands for European "Pressure Equipment Directive".

Why are standards so important and highly relevant for us? If a standard is classified as a harmonized standard with a certain

directive, here I mean a European directive, it provides presumption of conformity to the essential safety requirements of the directive. For us, it means we can apply it because we know that the safety requirements are met.

We consider this as a unique approach applicable within the design office, whether it's here at CERN or somewhere else, in the manufacturing companies, again whether at CERN or outside, and, of course, this is not only true for our organization but also for our collaborations in the experiments here at CERN. We can use them, of course, in the same way as engineering guidelines for implementing safety in the projects.

In addition, we have another few examples in the electrical domain shown on Slide 9.



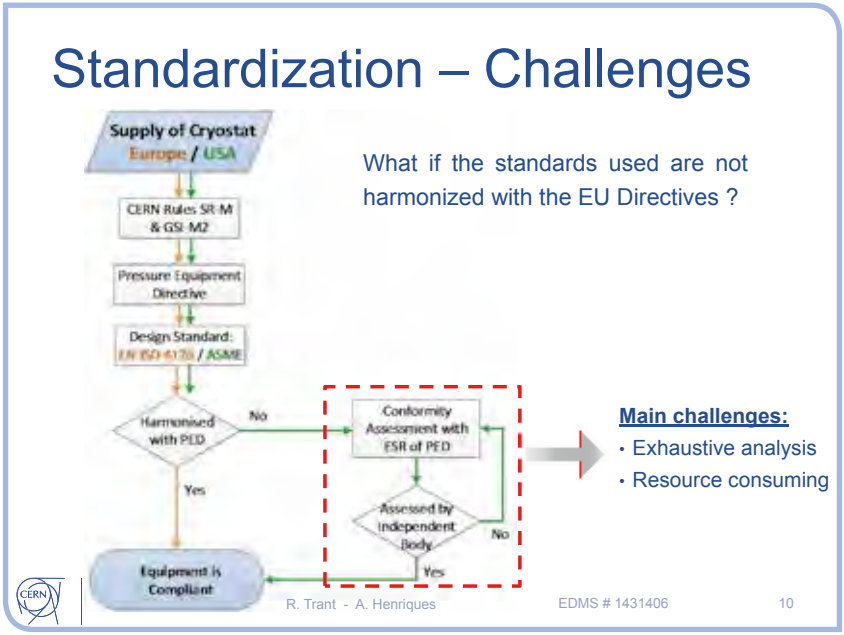
SLIDE 9

The IEC 61000 series on electromagnetic compatibility is very international so we can apply this. In the laser domain, there is the IEC 60825 series on the safety of laser products. Again, it's very international so we can apply it. For the welding domain,

we had originally the European references which, about 10 years ago, were replaced by the ISO ones.

This means that, if you have a welder somewhere in the world who is qualified according to ISO International Standards, he will be recognized by CERN because we are using the same standards. We might have additional requirements, as we have heard before from my colleague, but that is a question of the peculiarities of our organization and of our specific needs.

But let me say something about the standards that are not harmonized with the European directives. How do we deal with them?



SLIDE 10

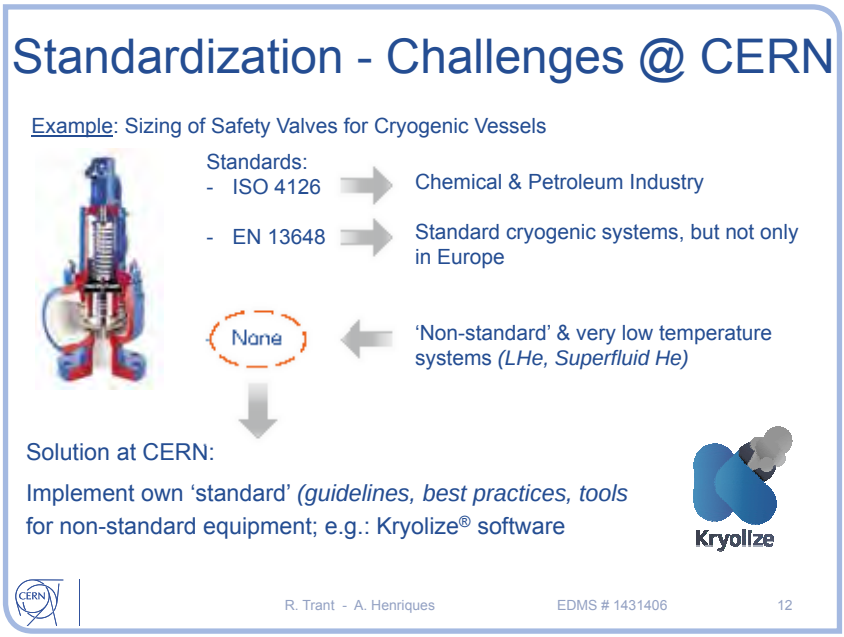
This is the way it goes (see Slide 10): We get a cryostat supplied for a superconducting magnet for the High Luminosity LHC. Part of it is manufactured in Europe, another part is manufactured in the USA. Everything that comes from the CERN side has to comply with our rules, based on the pressure equipment directive in Europe.

The design standard for the European component is not a problem, but for the US part, we have an ASME standard, which is not a European harmonized standard. So, whereas for the European qualification we can go straight ahead (provided that the equipment is compliant with the harmonized standard), for the US colleagues, we have to check that the ASME standard meets the essential safety requirements of the relevant European directive.

It's not that we doubt that it is safe, but it's a question of assessing it and this can be a resource-intensive undertaking. The product is assessed by us, as an independent body within CERN, and, finally, we can prove that the equipment is compliant but it is an extra loop that costs time, money and resources on both sides. It would be nice if we could avoid this because it is not a straightforward task and it's also not at all specific to CERN. Again, the standardization challenges are similar in our sister research organizations and I can give the example of ITER.

Having intensively discussed this point with our colleagues from ITER, we know that for each ASME standard, ITER has developed a document of about 100 pages that explains how to make exactly this assessment to ensure that the essential safety requirements of the European directive are met. This can be an essential saving.

Another example concerns the safety valves for cryogenic vessels (see Slide 12).



SLIDE 12

If you look at what international standards are available, you find an ISO standard, but this is clearly driven by the chemical and petroleum industry. There is also a European standard which is, let me say, a standard for cryogenic systems, which can be used in the food industry or in other sectors making use of cryogenic temperatures, i.e. down to liquid nitrogen temperature of -200 °C.

This is still quite warm for us because we are operating most of our installations at temperatures, which, as already mentioned, are very challenging, at 4 K or 2 K. There is no standard on how to dimension safety valves for these temperatures, so, as we do in such cases where no standard exists, we have developed our own approach. We have guidelines, best practices and tools.

We have a dimensioning software that we call "Kryolize", which was developed in-house by some of my collaborators from

our cryogenic group and they are also performing testing together with the Karlsruhe Institute of Technology in Germany. Of course, whatever we develop here for our own purposes, we are willing to share with colleagues from other research institutes and we do this with the help of our Knowledge Transfer Group. They are specialized in making this available to the outside world. At CERN, we are pushing the boundaries of science and technology. I think we are well known for this, in our domain of course. We are developing and building a lot of prototypes and non-standard equipment and what we should not forget, as was very visible in the slides of the previous talks, is that sometimes we have quite an unusual set of requirements or an unusual combination of risks.

When we talk of the LHC machine tunnel, we have radiation protection issues; we have oxygen deficiency hazard issues due to a large quantity of cryogenics and, of course, fire hazard is present all over so we might have very special requirements.

For example, for the ventilation systems of our accelerator facilities, an ISO standard (ISO 17873, *Ventilation systems for nuclear installations*) exists but we are not a power plant. We are looking for ventilation systems that serve the needs of our accelerator tunnels in the context of a special combination of risks, which may not apply to a nuclear power plant. Some of them will, others not, so what we do in such a case is to sit together with all the concerned experts in the organization. We try to look into all the details and come up with solutions that respect our set of specific requirements and environmental conditions.

International standards can really facilitate research and development and innovation because we are a worldwide undertaking. So if you have one international, global, or, if this is not possible, at least a European harmonized standard, from our perspective, we could see a lot of gain from CERN going exactly in this direction – and I don't think we would have to convince you!

Let me close my presentation with some remarks about possible forms of collaboration.

Coming back to the question raised beforehand about participation of expert colleagues in some of the standardization

committees, I know of some individuals who already participate, but I don't think it's really a "standard" approach yet.

However, we are an experienced R&D laboratory and, of course, we share our knowledge with industry and other research laboratories via our specialized Knowledge Transfer Group. Perhaps it's also a starting point here today to see that, when talking to each other, we could, either as an expert or as a very challenging customer, contribute with our experience and knowledge to what you are doing.

Thanks a lot for your attention.

Speech 5.3 Standardization and innovation using open hardware

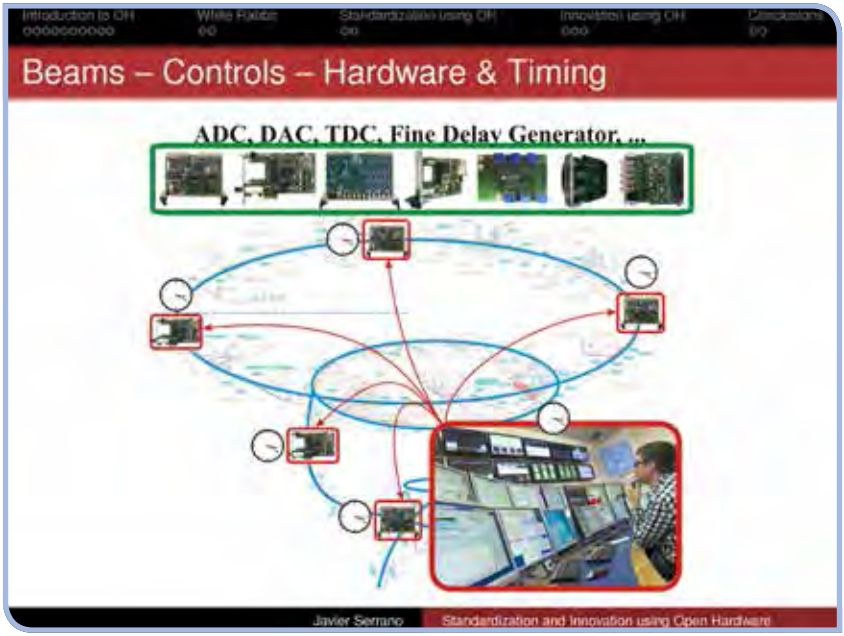
Javier Serrano,
Hardware and Timing Section Leader, Controls Group, Beams Department, CERN

Thank you for inviting me and for the talks yesterday and today. They were interesting and I learned a lot. I didn't hear much about free and open source design, so I hope you can learn something from this talk as well.

I will start with an introduction to open hardware, followed by the description of a particular project called "White Rabbit", which I will use to illustrate our involvement in standardization, and I will finish with some words on innovation in the context of open hardware.

Let me start with a description of the overall context. We work in a group whose mission is to deliver control and data acquisition

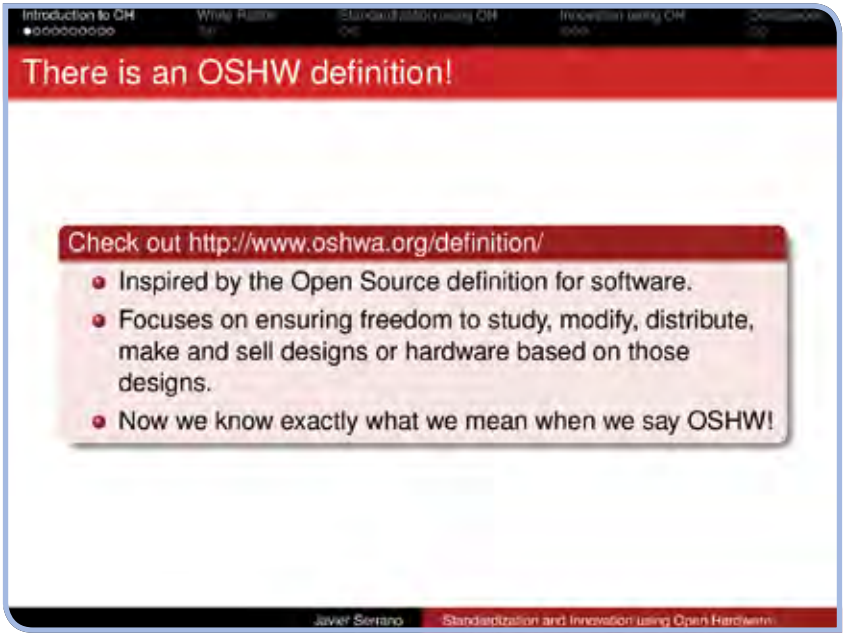
solutions for particle accelerators. It's a highly distributed real-time system (see Slide 4).



SLIDE 4

The LHC accelerator is 27 km long and all these control boards need to act coherently on the particle beams so we need something called a "Timing system", which distributes a common notion of time everywhere from the control room so that these pieces of hardware can act coherently.

Now, some words about open hardware. First of all, there is a definition. As you probably know, the word "open" is very often abused so it's good to have a definition (see Slide 6).



SLIDE 6

I think the "official" and most widely recognized definition is the one coming from the Open Source Hardware Association. It focuses on granting freedom to study, modify, distribute, make and sell the design or hardware based on that design.

Now, why do we use open hardware? First of all, because of peer review – please note the analogies with standardization. Some of the reasons why we deal with open hardware are actually the same reasons why people develop and use standards. We get designs reviewed by many people, some expected, some unexpected, some free of charge, some for a fee. It doesn't always happen, but it happens very often.

We also have a healthier relationship with companies, which is not based on vendor lock-in: an artificial dependency deriving from having bought a lot of hardware of this or that type in the past, forcing us to keep buying the same equipment. The relationships we have today with suppliers are based on excellence, good support and a good price/quality ratio. These are the important factors for us and we are working with many more companies

than before. Before we had this fear of lock-in, which kept us developing a lot in-house instead of collaborating with companies.

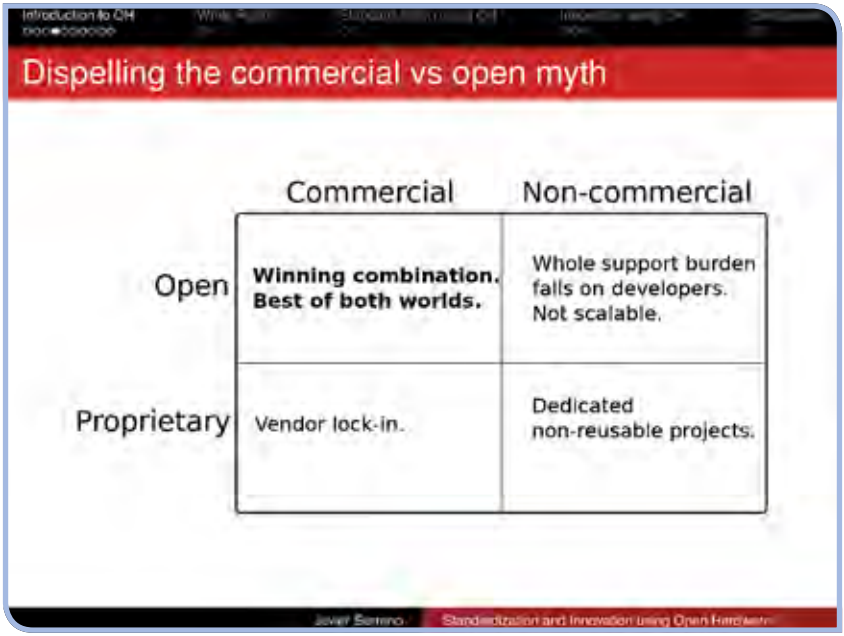
Another very important aspect for CERN, as well as for other public institutions, is to be able to spend your money where the funding agencies want it spent, and we're aiming at a degree of freedom which is very important for us. Before, when we had to procure a piece of hardware, we had to rely on companies that already had that product in their catalogue. Now, we can significantly expand the number of potential suppliers by asking companies to manufacture open designs that are available to everybody. This also opens the door to small companies – a very important factor in our context.

Design reuse is another advantage : again, something in common with standards. When the design is open, people are less afraid of lock-in and they tend to use it much more. This generates significant advantages, such as more peer review, bigger markets, lower prices, better support, etc.

Finally, we are very lucky to work in an institution where dissemination of knowledge is part of the mandate. We have to find efficient ways of doing this and open hardware, putting your stuff on the Web, not only the design, but all the supporting documents, is a very efficient way of doing this.

Now I would like to dispel a myth. I don't know if it's necessary to dispel it in this community but it happens very often in the designers' community that people tend to counterpose commercial versus open. The problem, however, is slightly more complex.

It's a two-dimensional problem (see Slide 12).



SLIDE 12

On one axis you have "open" and the contrary of open is not commercial, it's proprietary, and the contrary of commercial is not-commercial. You have four possible combinations. When some people speak of open, they sometimes mean "open, non-commercial". The problem there is that if your project is very popular and useful, you end up being swamped by questions and giving a lot of support, leaving you no time to design anymore – so this is not scalable. When people talk about "commercial", sometimes they mean "commercial-proprietary" and, in this case, as I said, the big problem is "vendor lock-in".

We're experimenting this combination ("open" and "commercial"), which we believe is a winning combination. It allows you to avoid vendor lock-in, but, at the same, it comprises commercial support, which is very important to make things scalable.

One thing we identified very early on was the need for a repository, so we created this open hardware repository to host all our designs. It's a collaborative Web page which has the usual suspects: Wiki, a way of managing a file repository, a way of managing a mailing list and tracking issues.

Here, you can see a piece of hardware (see Slide 14).

SLIDE 14

I just wanted to illustrate that this is manufactured by companies in Spain, in the Netherlands and in Poland. The very same design files are used to produce and sell this product by many companies and, if a new company came about, they wouldn't even need to ask us for permission. The design is available on the repository and the licensing terms, which I will explain later, make that possible.

SLIDE 15

On Slide 15, you can see a time-to-digital converter manufactured in Spain and Germany; and on Slide 16, an ADC board, a mezzanine board manufactured in the Netherlands and Poland.

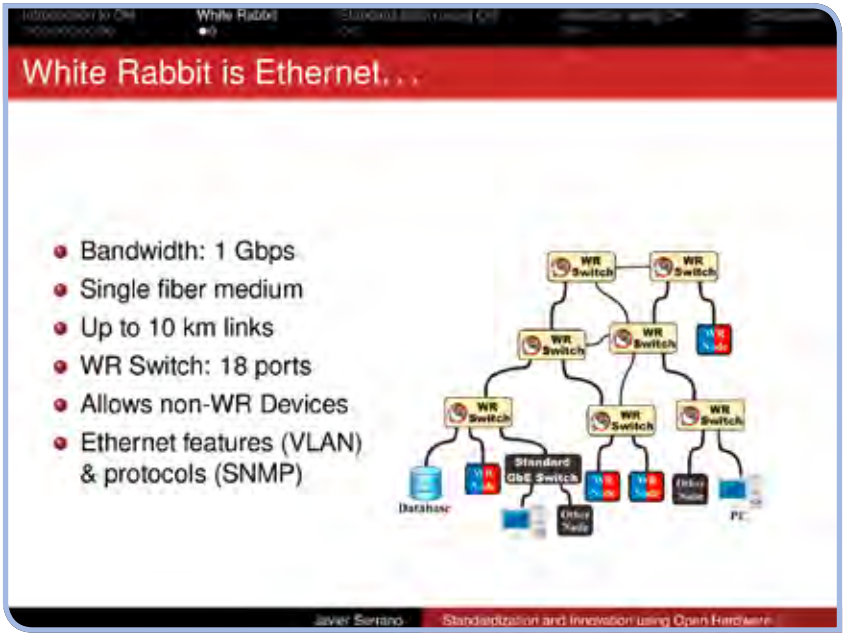
SLIDE 16

One other ingredient that we found very early on was the need for a licence so that the legal aspects of open hardware were well covered and companies and individuals understood precisely the conditions. The goal was clarity. It was developed in collaboration with the Knowledge Transfer Group at CERN and it is better suited to our needs than the non-hardware licences such as the GNU General Public Licenses and the family of Creative Commons, because it takes into account that the designer documents will ultimately become hardware. It defines the conditions for using and modifying licensed material, which is the design files.

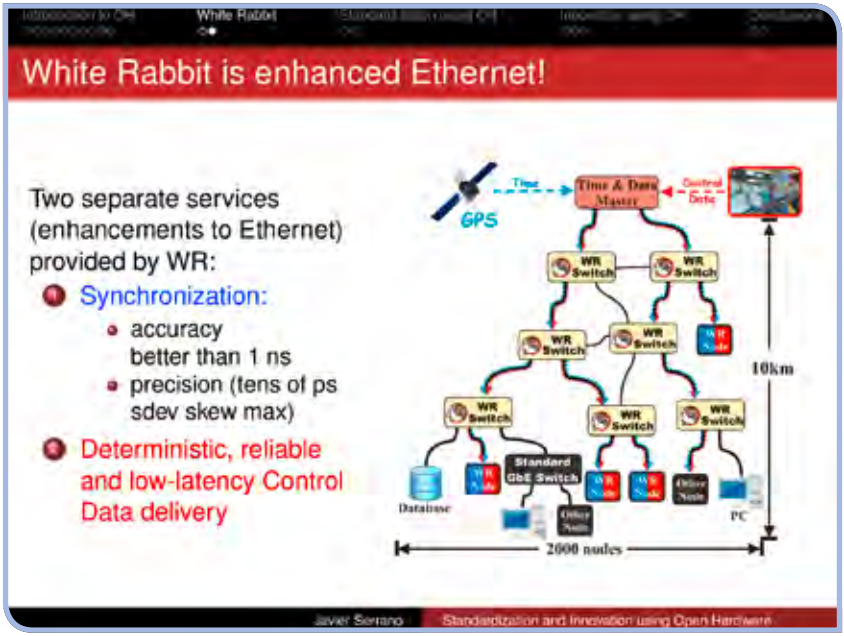
This licence defines a clear legal environment. That was the goal. It is just a two-page document very easy to understand and quick to read, so people can understand easily if it is suitable for them. It was inspired by the free and open source software licences. In particular, the persistence mechanism was inspired by the "copyleft" mechanism in software. Anyone is free to study, modify, manufacture and share and any modifications must be distributed using the same licence so that all downstream

modifications and improvements profit everybody. As I said, it takes into account hardware production so, when producing and distributing, manufacturers are cordially invited to inform the licensor. This is just a "cordial invitation" because anything else would not be non-free, and the distributed hardware must come with documentation.

Let me now say some words on the "White Rabbit" project. I'm going quickly on this (see Slides 22 and 23).



SLIDE 22



SLIDE 23

"White Rabbit" is a synchronization system. It is an evolution of Ethernet. We designed switches, Ethernet switches, which are being commercialized as open hardware and there's software inside, which is free software. They are an extension of Ethernet, which means that you can hook any piece of standard Ethernet gear, like laptop computers or other switches, and it interoperates perfectly. In addition, it has two extra services that Ethernet does not provide : synchronization and determinism.

Synchronization : any White Rabbit node hooked to this network gets, just by virtue of connecting in a seamless way, a common notion of time to within one nanosecond, one billionth of a second, even if these nodes are very distant like tens of kilometres away.

Determinism : an upper bound for the latency of any message going from point A to point B in the network by design, so people can do control and data acquisition systems, real-time systems, applying worst-case design techniques.

Now, some words about standardization. Of course, as all people in our domain, we use many standards, such as computer bus standards, VME, PCI express. The mezzanines I showed are FMC mezzanine cards standardized by VITA as VITA 57. When we design field-programmable gate arrays, inside there are blocks and these blocks are interconnected by a bus called "Wishbone" and we also use Linux drivers.

Note that I'm being a bit sloppy and somehow relaxed about what I call a "standard". It is just whatever people agree on and fulfils this role of reducing risks and encouraging reusability. And we contribute to standards too. I don't know how many people at CERN are doing this, but we decided some time ago that it was worth it. It is an investment and we would probably need more encouragement from management, because it takes time and it takes resources. But it is important and useful.

It does take time, so we figured that it would make sense to start contributing to standards when we felt that our needs were not being completely covered by an existing standard. For example, White Rabbit is represented in the High Accuracy subcommittee of IEEE P 1588. We contributed to the Wishbone bus with a new pipelined transfer mode and we contributed with code to the Linux official kernel.

Regarding our experience with IEEE, with the precision time protocol, i.e. IEEE P 1588, I believe that, through this effort, White Rabbit will be significantly adopted by industry. Industry is very reluctant to adopt things that are not standardized and for very good reasons. For example, for us, in the case of White Rabbit, we could change our minds and change the specifications from one week to the next, so investing is a much safer proposition when a technology is standardized.

We get from standardization similar things to what we get from being open. Many competent people are looking at our work – the very same reason for which we have chosen to be open. These very competent people look at our stuff and say, "Here's something that you did for CERN which is very specific; you could do it in a more generic way". And it actually evolves into a better design.

I think White Rabbit gives the standard something important that any open implementation can give. It helps communication because one can always revert to the sources if there is a misunderstanding. It will help adoption when the standard is approved because there is already an open implementation that people can immediately use, giving a sense of confidence because, even if the final version of the standard is probably not what White Rabbit is today, White Rabbit has shown that it works. So there are good chances that what we are trying to standardize will also work in an easy way.

If during the standardization process, there are new ideas, it's easy for people to try them out on a common open platform – and it's the same at the end of the standardization process.

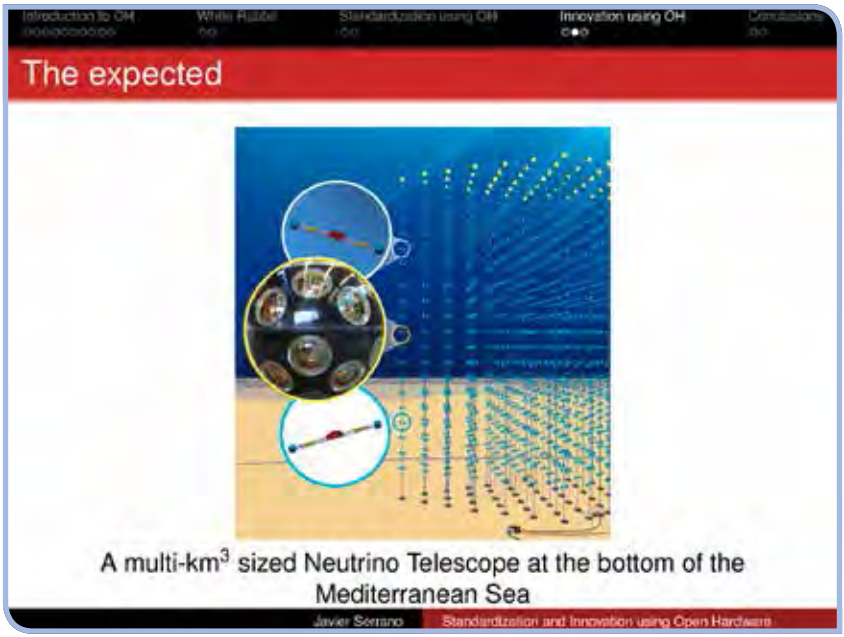
In addition, you know, small companies do not usually have the means to participate in a standardization effort and this might create a gap in their ability to implement the standard. An open implementation like White Rabbit, however, contributes to a more level playing field with the bigger companies that participated in the standardization effort.

Now, some words on innovation. You know, in physics labs, we are quite used to collaborating with other labs that do similar things, so it's expected that when you have an open project like White Rabbit, some other people, somewhere, will use it like our friends in Tibet. They're building a cosmic ray detector, so they have many small telescopes and if they synchronize them together, they can behave as one big telescope. It's important for them to embrace this project, which is open. I think this is a common theme in open designs and open projects because the users are going to give you something which is very valuable for them : their time. And I think the only way to do this is really to put them on the same level as you in terms of ownership. These projects belong to them as much as they belong to us. This is a very important point in my opinion. Once you have these communities that grow because of the openness, there are going to be people who have VERY creative ideas and there are also going to be people who have different needs (see Slide 30).

SLIDE 30

For example, in this case, they have extreme variations in temperature that we don't have at CERN, so they investigated what was the effect of delays in optical fibres and delays in electronic components, which are very critical to the operation of White Rabbit in extreme conditions – big variations from day to night, from summer to winter.

A similar thing is happening with our friends in the Neutrino Telescope under the Mediterranean Sea Project (see Slide 31).



SLIDE 31

This is a big project which is going to be installed 100 km into the sea and there will be a string of detectors to detect neutrinos. So, here, the challenge is how to make it very robust because every time something breaks, you're not going to take a boat and go 100 km into the sea to fix it, and also to make it very low-power and resistant to all the conditions in the sea.

Then there are the unexpected things. So, for example, somebody figured that there is a problem locating people who call 112, the emergency phone number.

SLIDE 33

This is somebody we did not know at all. Out of the blue, somebody from Finland came (see Slide 33) and said, "If you synchronize the mobile base stations with White Rabbit to within a nanosecond, you can time-stamp the packets coming from a mobile phone of somebody calling this emergency number and locate it very precisely by triangulating, if you have three or more mobile base stations." Also, other people we didn't know about are working on smart power grids and it turns out that the precise knowledge of the voltage phase in different power stations is critical to deciding how to distribute power in an efficient way. So, again, there is work underway in some universities and institutes to apply this White Rabbit synchronization to the power stations.

Let me come to my conclusion. I think open hardware benefits from standardization as everybody else for the same reasons: industrial adoption through risk reduction.

In addition, there are standardization benefits that are more specific to open projects, i.e. standardization helps to get focus. When you have these large distributed communities, you have

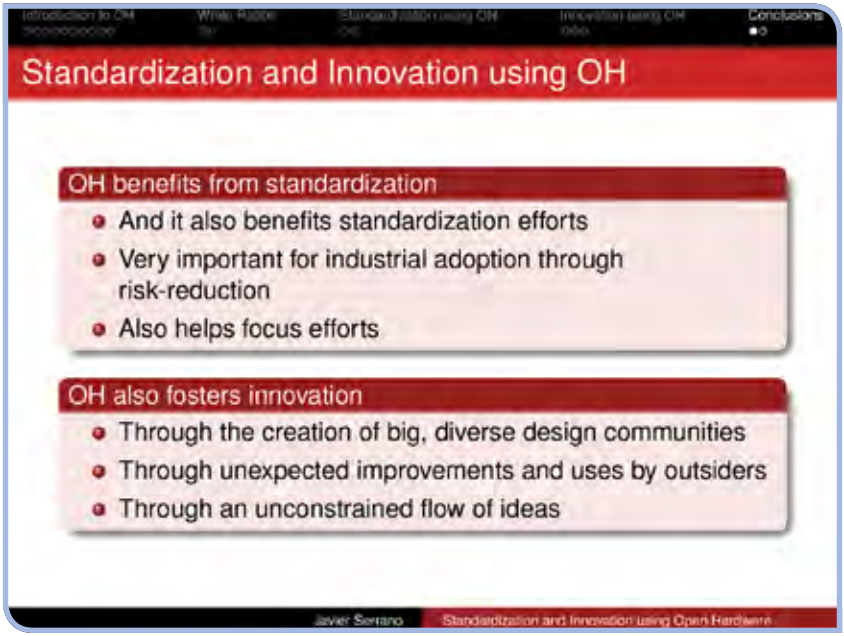
people going in all directions, so it is very good if somebody says what is the real problem to be solved to help focus a bit.

In the reverse, open hardware contributes to standardization efforts, as we have seen in the case of White Rabbit.

Open hardware also fosters innovation by helping the development of very large and diverse design communities. There are many different people in the projects that I have described and they have many different backgrounds, so it's a very fertile ground for creativity. You also have the unexpected ; very nice things happen from time to time which, importantly, favour the unconstrained flow of ideas.

All the time you spend trying to think whether you can say something in public or not, is time that you don't spend designing. We had yesterday a quote from Machiavelli about the importance of not confusing imaginary worlds with reality.

What I am showing on Slide 36 was in our imagination five years ago.



SLIDE 36

It was the possibility to go to commercial Websites of hardware vendors, click on a product and buy it without being locked in, because all these designs are freely available for everybody to do whatever they want with them. Five years ago, we had some open questions about incentives – are companies willing to work this way and so on. We had a lot of doubts, but today I think it is proven that this is a workable solution for a large family of problems at CERN and elsewhere. Thank you.

Speech 5.4 The various aspects of innovation in the METAS watt balance

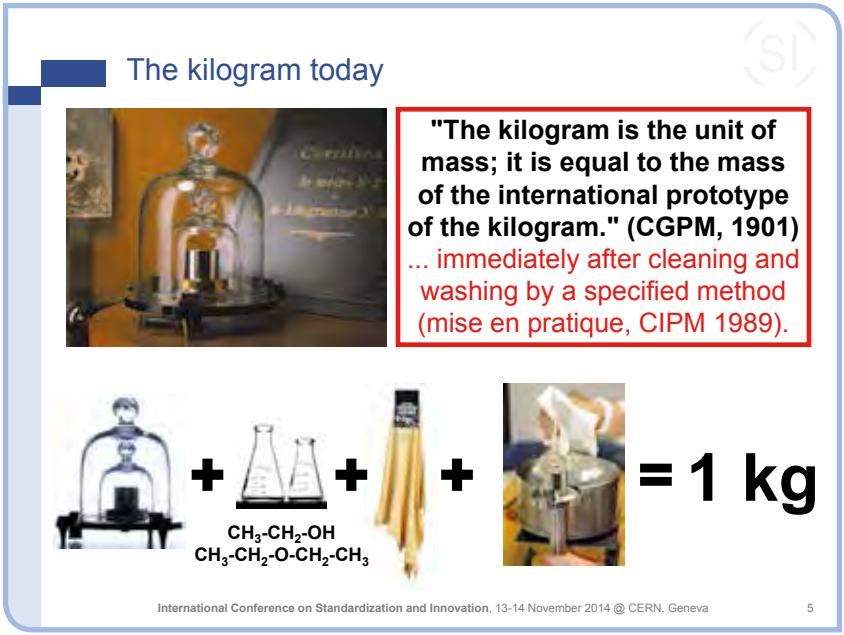
Ali Eichenberger,
Project leader, Watt balance project, National Metrology Institute of Switzerland (METAS)

Good morning, everyone. It's a great pleasure to be here and to have the opportunity to present our project. I will start with an introduction and then talk about the watt balance principle – I think it's something that you need to know. And then I will present our project, Mark II, and finish with some conclusions.

Metrology, standardization and innovation are strongly linked. I think the International System of Units (SI) is a great example of a standard. The national metrology institutes are responsible for its development and dissemination, and for the traceability of measurement which is the base of standardization. But also, innovation needs to recognize standards. New standards drive

innovation by pushing beyond the state of the art and this is a continuous process.

Do you know how the kilogramme is defined today? The kilogramme is still a piece of metal that is kept in a safe in Paris and, on Slide 5, there is a picture of the kilogramme, but I can tell you that it's not the kilogramme kept in Paris because it has only two glass covers.



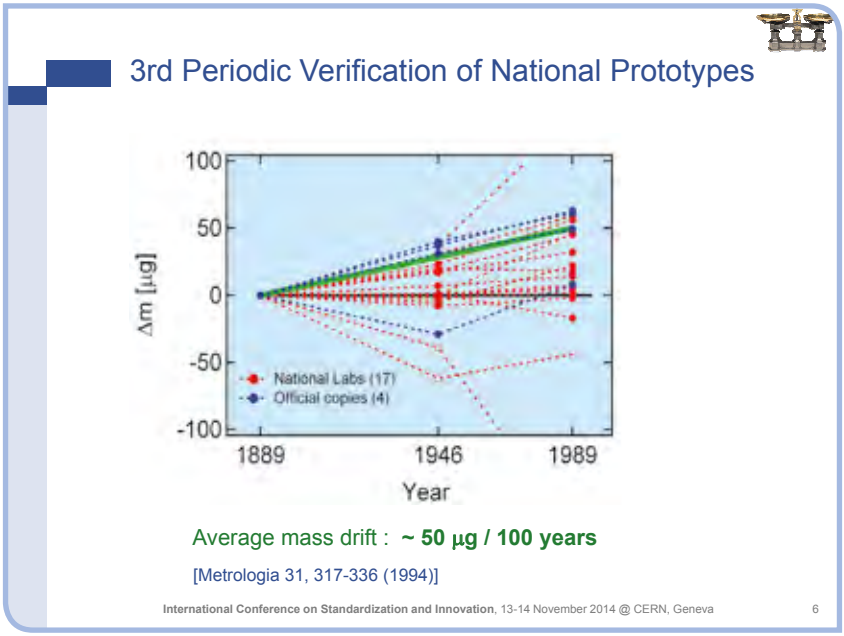
SLIDE 5

The real one has three. This is in fact a picture of the Swiss national prototype which is a copy and if you read the definition of the kilogramme, which is the unit of mass, "it is equal to the mass of the international prototype of the kilogramme" (**Conférence Générale des Poids et Mesures**, CGPM, 1901).

However, 1901 is when this was accepted by the international community, but about a 100 years later, they added a sentence to the definition that says "immediately after cleaning and washing using a specified method". So you have to take your kilogramme,

chamois leather and some solvent, then you rinse it with steam and only at the end do you have a "kilogramme".

This is still the definition today, in 2014. So, the real kilogramme, the one in Paris, was used three times in its life, so it's not so busy. It was used in 1889 for the definition, when they calibrated all the copies that were sent all over the world to the different countries. Then in 1946, just after the Second World War, they called all these copies back to Paris, to make a comparison to see how things were behaving.

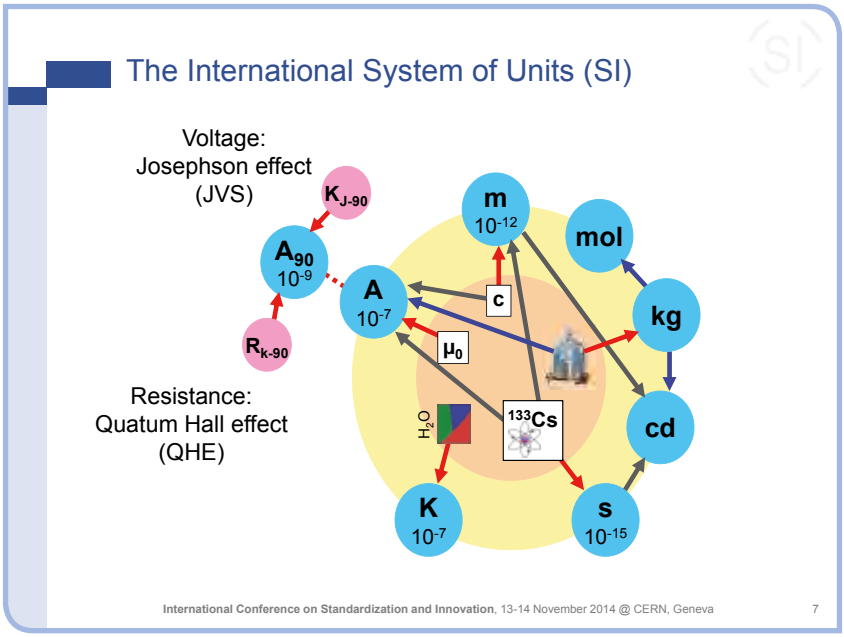


SLIDE 6

They did the experiment again 100 years after the definition and, as you see, the original and the copies have a tendency to gain weight over time, just as we do, right? (see Slide 6)

Of course, it is only 50 μg over a 100 years, which is not a lot, but it is still easily measurable in a mass laboratory. However, due to the definition, you cannot tell whether the graph should be like this or like that because this black line is just a definition. You take the prototype out of the safe and it is one kilogramme.

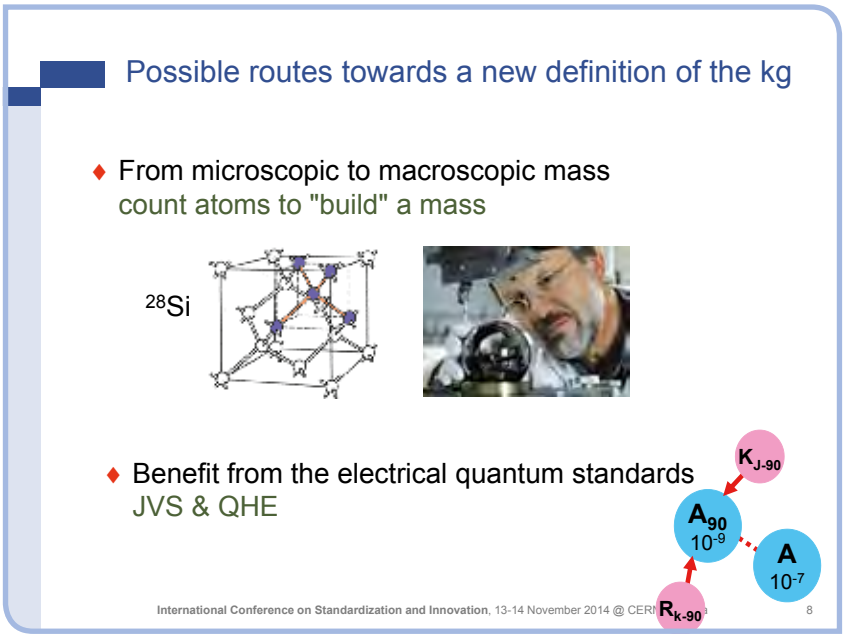
When you buy a kilogramme of bananas in a supermarket, of course, these 50 µg don't really bother you. But if you look at how the international system of units is constructed, you can see that the kilogramme is used for the unit of mass but also for the ampere, so if the kilogramme is not stable, it means the ampere is not stable, which is quite another problem.



SLIDE 7

And that's also why people working in electricity have developed their own system of units based on quantum physics : the Josephson Effect for the voltage and the Quantum Hall Effect for resistance and they can work in this system 100 times better than working in the SI (see Slide 7).

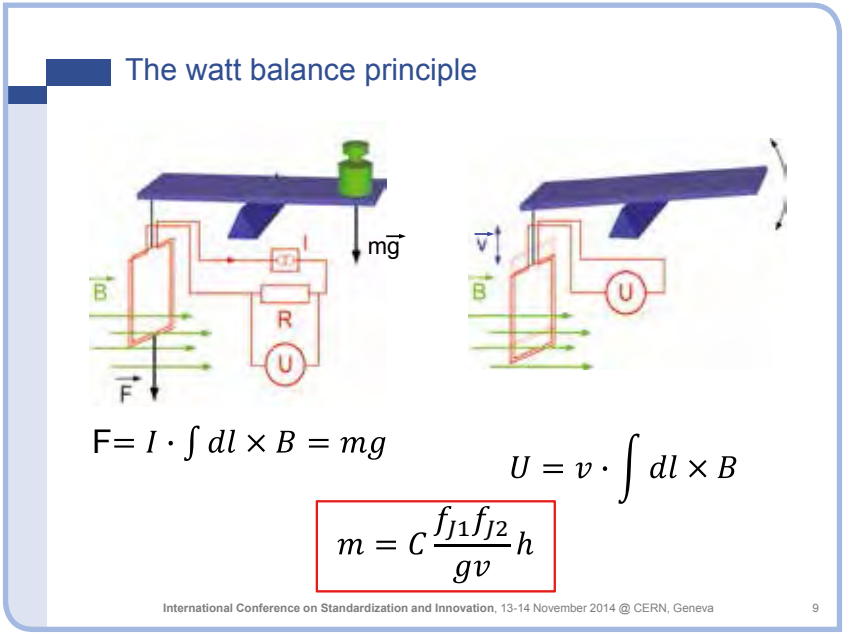
So now we are trying to find another way to define the kilogramme and there are two different approaches which are shown on Slide 8.



SLIDE 8

One would be to take microscopic entities like atoms and build a macroscopic object. This is called the Avogadro project or the silicone crystal project. You take a silicone crystal, you make a sphere out of it, you measure the diameter, you measure how close the atoms are together and then you can count how many atoms you have and relate that to the kilogramme.

The other way would be to take advantage of these quantum standards used in the electrical field and then try to define the kilogramme from them. This is the approach we decided to follow at METAS (see Slide 9).



SLIDE 9

This slide shows the principle of the watt balance. You take a balance, you put your test mass on one side, you have its weight here and, on the other side, you put an electrical coil into which you inject a current to produce a force. The force you can produce is proportional to the current you inject in your coil and the coefficient here is a description of the geometry of your magnetic field and your coil.

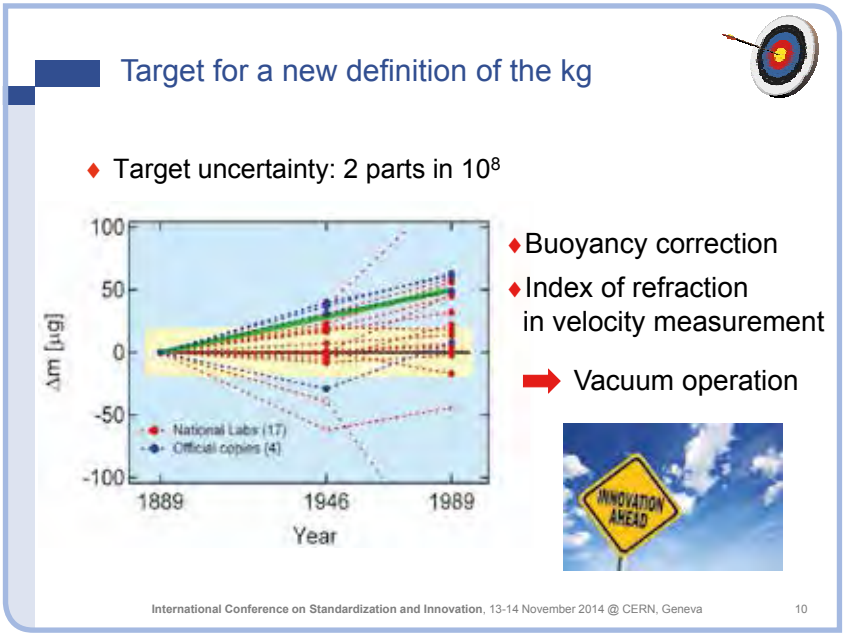
On the other side, you have your weight. The problem is that you cannot really attain a required accuracy but you can measure it in another way. You can take your coil and move it up and down along the vertical axis in the magnetic field and induce a voltage across it. If you measure the voltage, you can see that it is proportional to the velocity and, in fact, the coefficient is exactly the same as the previous one, if you did things correctly. Now, you combine these two expressions and you end up with this one, which is simple (the formula in the red rectangle).

You have on one side the electrical power, on the other side the mechanical power, and that's why we call it a "watt balance", because the power is measured in watt. Now, you can go one step further and show that the kilogramme can be linked to the Planck constant.

[Editor's note : In order to do that, you need to take into account the Quantum Hall Effect and the Josephson Effect. The first links the "Hall conductance" to the charge of the electron and the Planck constant, and the second, the current generated by the Josephson Effect at a "Josephson junction", with the difference in the phases of the two superconducting wave functions. These quantities can be related to the current in the circuit of the "watt balance" and therefore to the mass.]

In fact, with such a system, we are now measuring the Planck constant and as soon as we, the different metrology labs in the world, all agree on the value of the Planck constant, then we can fix it and derive the measure of the kilogramme.

This experiment would be used to "realize" the kilogramme. This is something that we like in metrology: to relate a unit to a constant of nature. The target uncertainty we are shooting for is about 2 parts in 10^8, which is symbolized by this yellow rectangle on Slide 10.

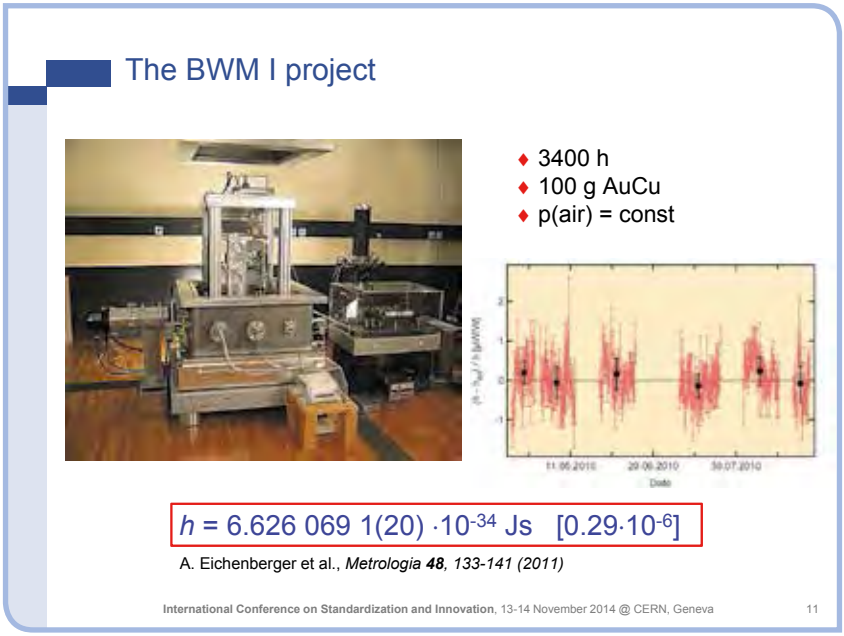


SLIDE 10

If you measure that in the air, you have to take into account the buoyancy effect and the index of refraction. So, to avoid this, it's better to work in vacuum. This is where radical innovation starts, because if you find something on the market, it will either be magnetic, which you cannot really use, or it will be non-vacuum-compatible.

This means that you have to develop everything you want to use.

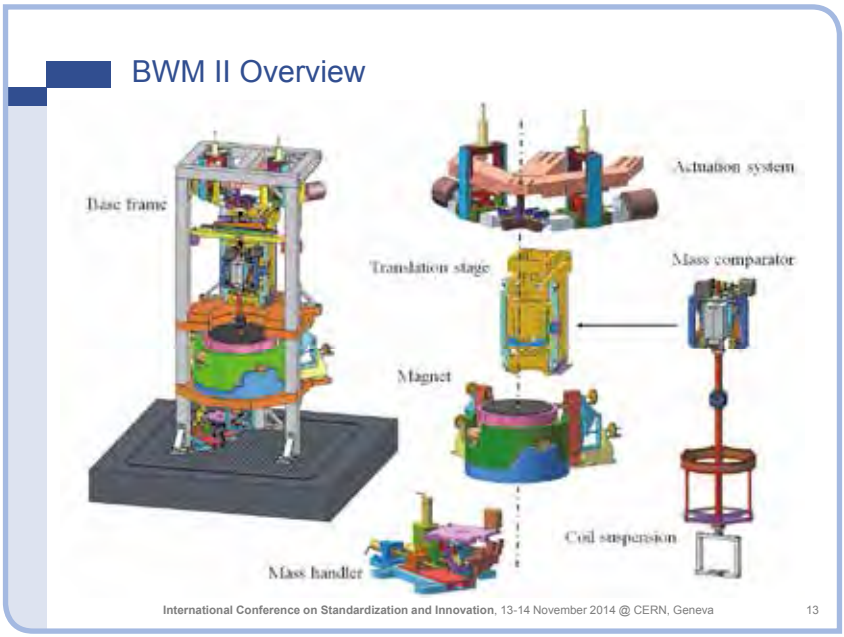
Slide 11 shows the first watt balance that we built in 1997.



SLIDE 11

In 2010, we published a result based on 3 400 hours of measurement and this was about ten times higher in uncertainty than we wanted. We were shooting for 2 parts in 10^8 and this was 3 parts in 10^7.

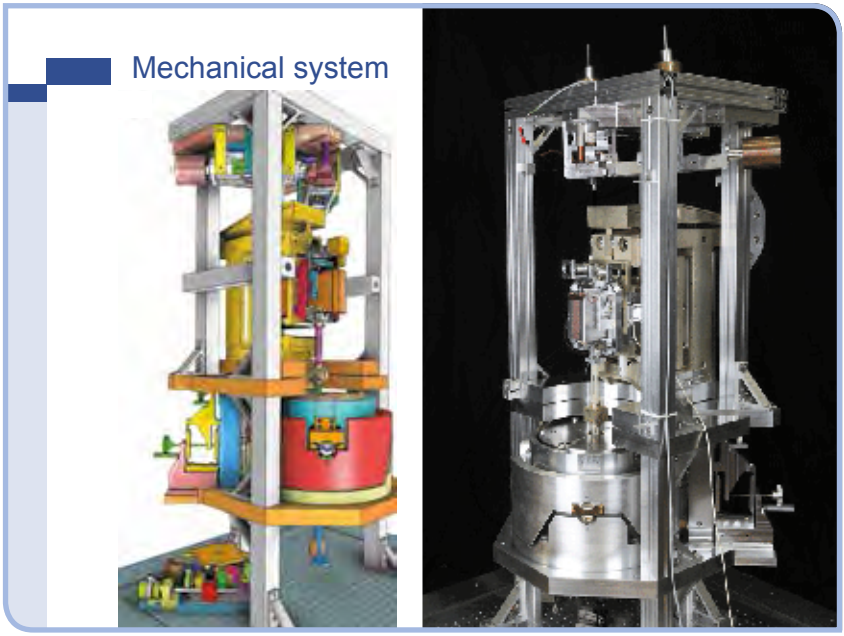
At that time, we decided to start a new project but one condition was to make this project in collaboration with external partners, either research institutes or commercial partners, and we came to CERN and found people very interested in helping us to develop a magnetic circuit. The EPFL (École Polytechnique Fédérale de Lausanne) was responsible for designing the guiding mechanism to move this coil up and down and Mettler Toledo, which is a famous company for mass comparators, designed a prototype for our application. We also have Maxon Motor for the mass exchanger actuation.



SLIDE 13

On Slide 13, you see an overview of our system and of its constitutive elements. We have the actuation system ; we have the guiding stage ; we have the magnet here and the mass handler, and these are coupled in series with the suspension and the coil that we put in the magnetic field. The coil has a diameter of about 20 cm. This is 1.2 km of wounded wire.

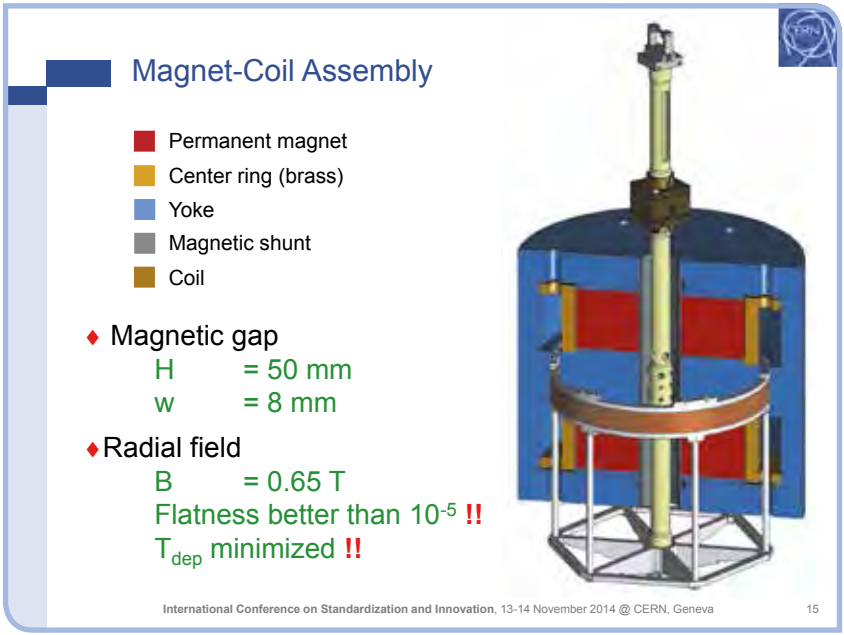
Slide 14 allows you to compare the sketch and the reality.



SLIDE 14

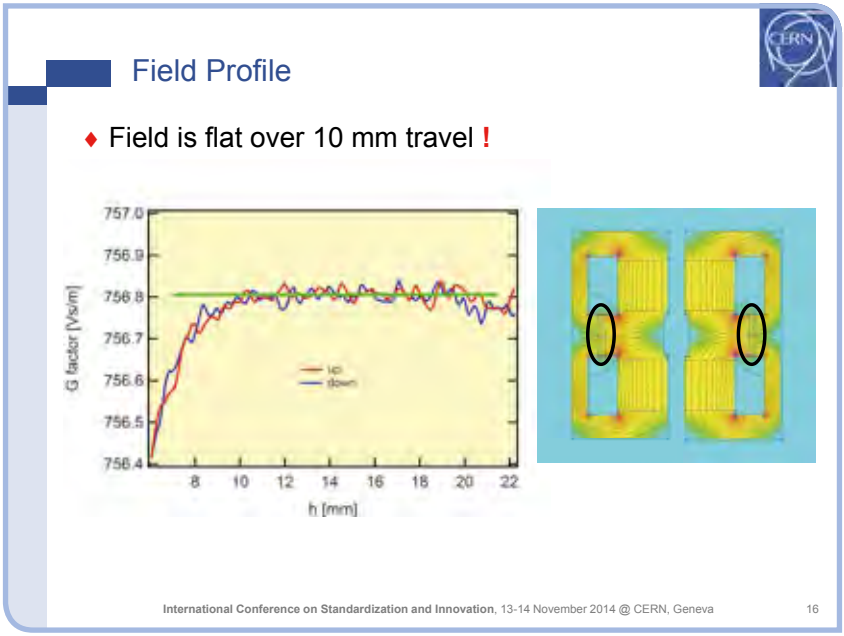
You can see how this yellow block is guiding the coil that you cannot see because it's immersed in this magnetic field here. So we will now have a look at the different components (see Slide 15).

This is the magnetic circuit we designed with the people at CERN.



SLIDE 15

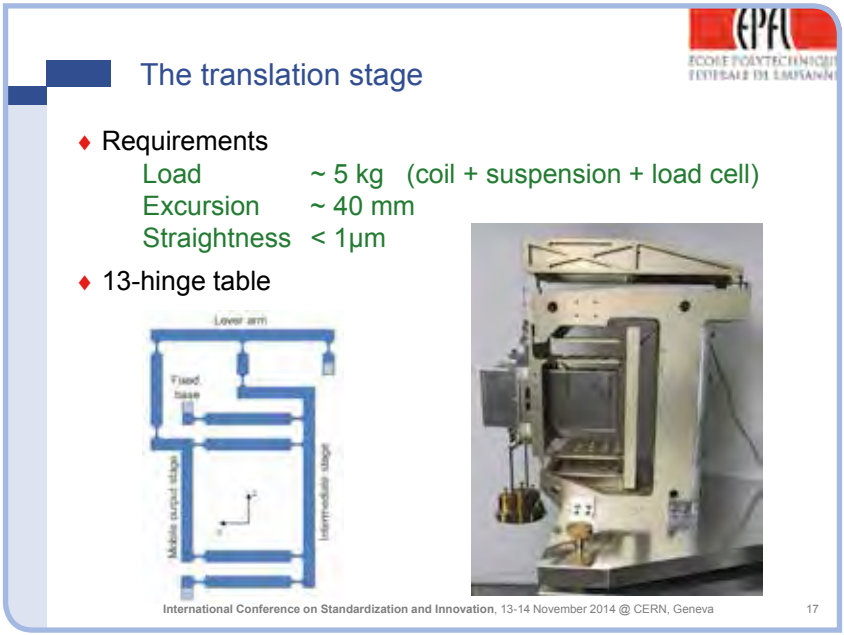
It is based on two permanent magnets here. When we did this project, they said they'd never seen such a big magnet. They are building huge magnets but one piece of permanent magnet is the largest one they have seen. The magnetic gap is here, so we have a radial field and the height of the gap is 50 mm and the width 8 mm. We can produce a field which is 0.65 T and something that we wanted was to have a very smooth and very flat field because we don't need to know where the coil is when we do the weighing in this case; also, these kinds of components have a strong temperature dependence so we wanted to develop something to get rid of this dependence or to minimize it.



SLIDE 16

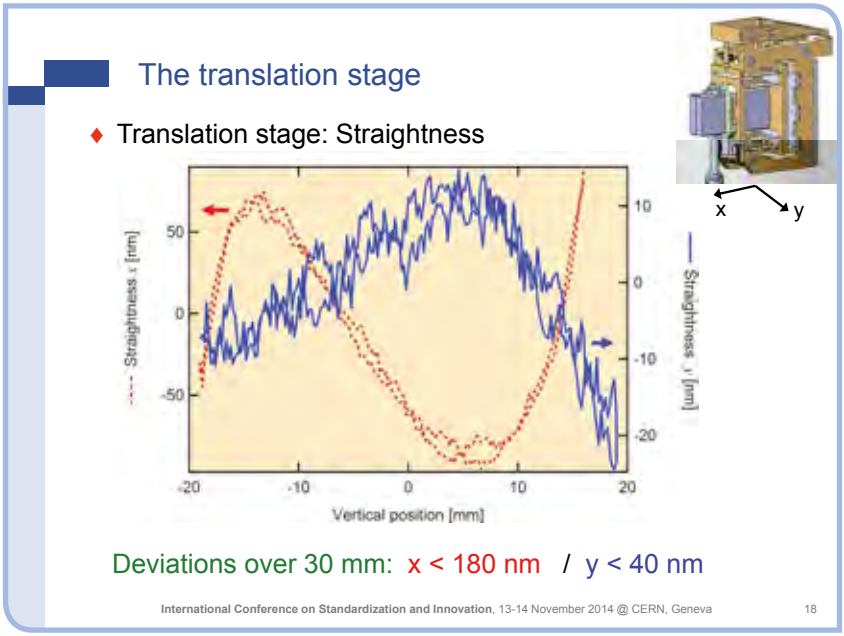
This year we measured the field and we're really happy to see that it was flat, as shown on Slide 16. It is not so straightforward because you have to assemble this magnet, which is about 100 km with a precision of 5 µm or better, and you can imagine the forces you have when you assemble these different pieces. Now, we need to move this coil up and down and for that we need to move about 5 kg of material and we wanted to have an excursion of about 40 mm and a straightness better than 1 µm.

Slide 17 shows the solution we chose, which is a bit complicated for me to explain.



SLIDE 17

Here, you can see the block that you saw moving in the previous picture. We have sort of "small hinges" where only a small piece of material is left and this allows the thing to bend and this cross is this pivot here and, in fact, here is the mass comparator which is moving up and down. There is no coil at the moment, it's just a counterweight. The performance of this translation stage is shown on Slide 18.



SLIDE 18

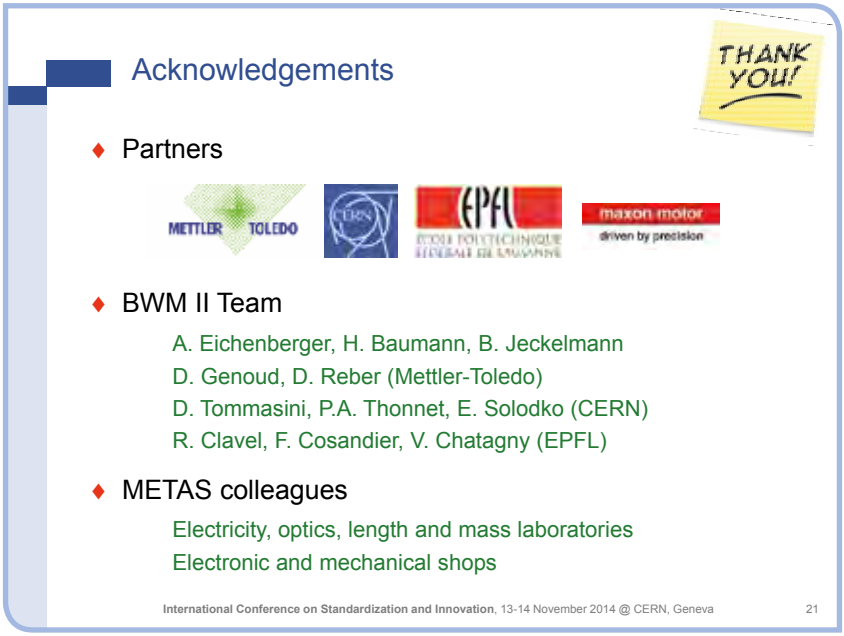
We have a travel of about 40 mm and a deviation from the linear motion which is only 180 µm in the worst case and 40 µm in the other direction, which is far better than we expected.

Finally, we have the components from Mettler Toledo, the leader in balances for mass comparators. They designed this mass comparator with monobloc technology and it measures a load of 1.8 kg with a resolution of 1 µg, so this is in the 10 to -10 range. The measurement window is 4 g. We wanted to have something very light because we have to move this with the coil. It is only 1.3 kg and, of course, is vacuum-compatible because we need to operate this in vacuum. This is a view of the system and the box you see here is the latest version of the mass comparator.

In conclusion, I would say that the new project "BWM II" brought together scientists that we didn't expect to have with us and there was a very high motivation among the collaborators.

For example, at Mettler Toledo, I think everyone in the company wanted to work on the project. At one point, they had to say, "Stop, stop, not everybody can work on this project!"

The results are beyond expectations, not only the measurements that we did, but also the products. For example, at the beginning Mettler Toledo said, "OK, we'll do a prototype for you but just be aware it will never be a product for us." But now, they think they might be able to make a product out of this mass comparator technology. Our system is almost ready for measurement. We still have to do a little bit of work, but we will start the measurement either at the end of this year or the beginning of next year.



SLIDE 21

Finally, I need to thank all the partners, listed on Slide 21, my colleagues here, and also the European Metrology Research Programme that is strongly supporting us. Thank you for your attention.

NOTE of the editor

We were not able to include in the publication the important contributions given by the speakers who participated in the panel discussions. The panel sessions, however, have been recorded and are available on the conference Website – www.iso.org/sites/standardsinnovationconference/presentations.html

We want to thank all of them for their valuable insights.

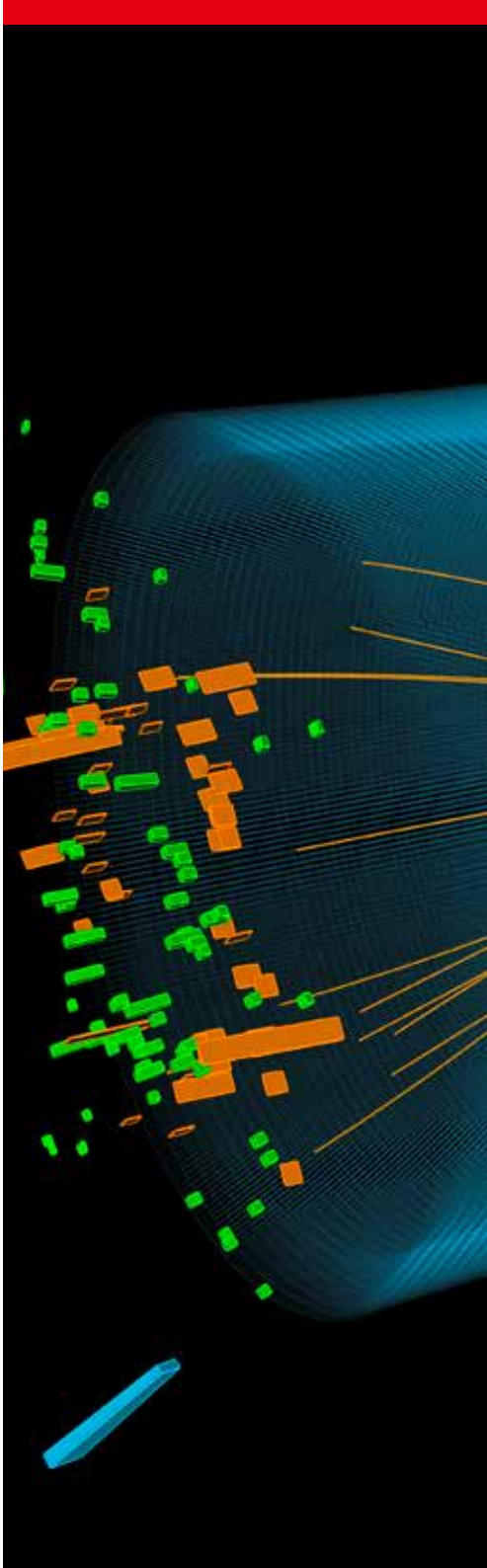
Panel Chairs

- **Chair of panel 1: Knut Blind**, Professor of Innovation Economics at the Faculty of Economics and Management at the Berlin University of Technology, and Director of the research group "Public Innovation" at the Fraunhofer Institute of Open Communication Systems in Berlin, Germany
- **Chair of panel 2: Stephen K. Kwan**, Lucas Professor of Service Science in the Lucas College and Graduate School of Business, and Associate Dean of Graduate Business Programs at San José State University, USA

Panellists (in addition to the conference speakers):

- **Ashok Ganesh**, Director Innovation at CEN/CENELEC
- **Martin Golebiewski**, Project Leader and expert for data management and standardization in systems biology at the Heidelberg Institute for Theoretical Studies (HITS GmbH), a private non-profit research institute in Heidelberg, Germany
- **Duncan Jarvis**, Programme Manager for EURAMET, Europe's Regional Metrology Organisation
- **Bertrand Nicquevert**, Chairman of the Specification Committee for Accelerator and Technology, Engineering Department, in the Quality and Organizational Processes section at CERN
- **Erik Puskar**, Manager for Global Standards & Information within the Standards Coordination Office at the National Institute of Standards & Technology (NIST)

- **Jörn Stenger**, Member of the Presidential Board of PTB, at the National Metrology Institute of Germany. He represents Germany as delegate in EURAMET and is the Chairperson of the programme committee for the European metrology research programmes EMRP and EMPIR
- **Susan Tatiner**, Director, Standards & Technology Policy Education at the IEEE Standards Association



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