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2nd Workshop on digitalisation

Digitalisation in ATM – Joint Human Machine System

The only way forward?

Summary of presentations

Geneva, 1.2.2019

Editor: IFATCA, Marc Baumgartner

Agenda

	When	Who	
Welcome	0830- 0915	Coffee – Marc Baumgartner	
Welcome	0915-0930	Alex Bristol (Keynote)	**Skyguide** - CEO
What is JHMS	0930-1000	Tom Laursen Prof. Toni Waefler	**IFATCA** - EVP Europe University of Applied Sciences and Arts Northwestern Switzerland **(FHNW),** School of Applied Psychology (APS)- Professor
Transformation			
Medical	1000-1030	Prof. Xavier Montet	**University Hospital Geneva** - Head of the General and oncology Unit, Radiology department
Artistic	1030-1100	Simon Senn	**HEAD –** Lecturer
Logistics	1100-1130	Claudia Pletscher	**Swiss Post -** Head Development & Innovation
Research	1130-1200	Fons Rademakers	**CERN openlab** - Chief Research Officer
What is disruption?	1200-1240	Prof. Juan José Montero Pascual	**Florence School of Regulation** /UNED
Lunch	1240-1330		
Discussion	1330-1530	Bachmann, Baumgartner, Laursen, Waefler	Discussion
Wrap –up and closure	1530-1600	Prof. Erik Hollnagel	Senior professor of Patient Safety at **Jönköping University**

This document summarises the content of the presentations delivered during the 2nd Digitalisation Conference organised by IFATCA on the 1st of February 2019 at the press room of @GeneveAeroport.

The following pages offer short summaries of the presentations, captured from various notes and highlighting the main points made by the presenters. The summaries do not necessarily reflect the views of the contributors, as they have been collected by the author of this summary.

The presentations can be downloaded on the following website: www.atcfactory.ch and www.ifatca.org .

Welcome and Introduction

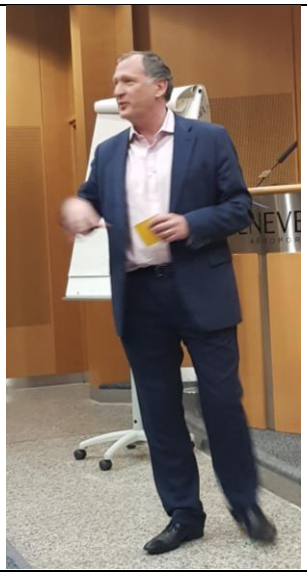
Marc Baumgartner, SESAR and EASA coordinator of IFATCA, Air Traffic Controller and Centre Supervisor at Skyguide Geneva

Motivated by the increased infiltration of new and digitised technology into society, IFATCA decided to organise its second digitalisation conference around the theme of what is the best way for ATM to benefit from new digitalisation technology.

It is difficult to estimate where ATM is heading (with the advent of e.g. virtualisation, cloud based services), with outsourcing of core activities (e.g. like Flight Data processing) and no more physical or geographical limitations with regard to ATM units (just political will and social issues). Increased digitalisation also brings with it Artificial Intelligence/Machine Learning, Big Data and Internet of Things. Integrated human machine systems should not devalue the human to justify the machine, nor should there be a critical attitude towards the machine in order to achieve rationalisation of the human.

It is hoped that the conference outcome will assist the SESAR ATM Masterplan to integrate the planning of effective synergies between the human and technical systems from design to deployment, with a joint human machine system. Further research on automation needs to go beyond the theoretical part and facilitate future deployment, without delays and/or disruption to current ops.

Concluding his presentation Mr. Marc Baumgartner explained the agenda and the objective of the conference.



Key note Speech

Alex Bristol, CEO , skyguide

In opening his keynote speech the CEO of Skyguide, Mr. Alex Bristol mentioned that the human machine system is growing and that the job of ATCO may not be as fun as it used to be. He states that we have a choice: We can either design technology and try to plug the gaps created with humans, or we can design a joint system that looks at what people are good at and what technology is good at, and design them to complement one another.

The role of the human has to change in our industry, irrespective of the technology. It does not matter which techno we look at. Take drones for example: will they only be used for the purpose they are currently designed for? No.

En-route sectors will operate in the future with a single person, where currently there are often two. Two ways to approach this are possible:

- Take the human out of the current system and pretend it is a good way to work, or
- Look forward and consider how to optimize the machine and the human capabilities.

It's not just the ATM world that struggles with it as everybody has the same fundamental challenges. It would be wrong to use safety criticality as a reason not to move forward. Automation is happening so let us design this in the future and that it is best done with humans.

Skyguide is in the process of digitalisation and Alex is proud of what skyguide is doing. Skyguide does it with the humans. The industry is in the process of virtualisation. Drones are going to disrupt ATM. How do we prepare for that? Create the capability, without the future happening to us. It is good to have people outside the industry, and not become insular. We need to design the Human Machine System.

However we predict the future, we will be wrong; our challenge is to make sure it will be better.

What is Joint Human Machine System

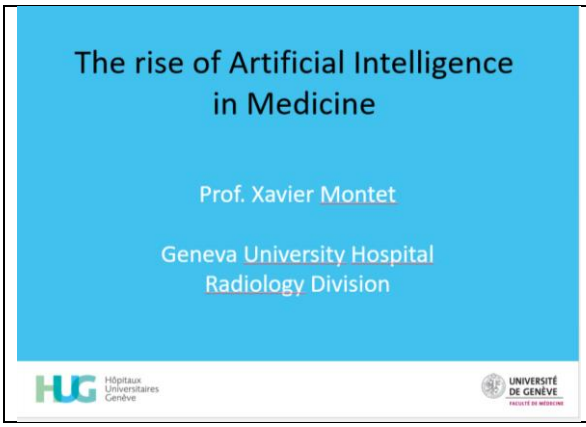
Tom Laursen, IFATCA Executive Vice-President Europe, ATCO Naviair

Prof. Toni Waefler, University of Applied Sciences and Arts Northwestern Switzerland (FHNW), School of Applied Psychology (APS)

Nothing has been more prolific over the past century than human/machine interaction. Automobiles, telephones, computers, manufacturing machines, robots, office equipment, machines large and small; all affect the very essence of our daily lives. However, this interaction has not always been efficient or easy and has at times turned fairly hazardous. Cognitive Systems Engineering (CSE) seeks to improve this situation by the careful design of human/machine interaction as the purposeful behaviour of a joint human-machine system.

The presenters offered a principled approach for understanding and designing the interaction of human work and complex technology. The presenters used a top-down, functional approach and emphasize a proactive (coping) perspective on work that overcomes the limitations of a simplified structural view on human information processing. They describe a conceptual framework for modelling joint human-machine systems that can be applied to single human/machine systems as well as to widespread sociotechnical systems focusing the complex interplay of humans, technology and organization.

Understanding the complexity of human/machine interaction is critical for exploiting technical potentials in order to design human-machine systems that are safe, highly functional, and efficient. This is a critical reference for researchers, designers, and engineers in a wide variety of disciplines.



The rise of Artificial Intelligence in Medicine

Prof. Xavier Montet
Geneva University Hospital
Radiology Division

Professor Xavier Montet started his presentation by introducing some headlines which have created expectations that AI could replace doctors in the near future. He explained the difference between a neural network and a deep neural network. The human brain is capable of extrapolation and generalisation. AI is not able to do this. If we don't label images to build a neural network, the data is unstructured and requires a huge amount of work to make the data usable. In the US currently there are about 150 Exabyte of data available. The learning is quite slow on how to create a neural network. AlexNet[1] has 60 million of parameters and 650000 neuron (to detect cats on an image).

In order to use some of the AI, the high-resolution pictures have to be downsized and the quality of the data input is lower. Prof. Montet shows examples of downsizing pictures of the human body.

A convolutional neural network (CNN) learns faster if the data is labelled. "Deep learning for chest radiograph diagnosis: A retrospective comparison of the CheXNeXt algorithm to practicing radiologists" shows that in certain categories the algorithm is better than the human. Most of the time however there is no difference, except that the AI is much faster.

CNN can also be fooled. It could just take a simple rotation and translation and for unknown reasons the result is not explainable. Simple changes of a few pixels could give a completely different result. As this is a frightening prospect, human needs to check and control this.

A GAN (Generative adversial network) is shown as a possible future usage in Radiology. Professor Montet shows an example of how to "morph" a horse to zebra, or a young adult to an older one. A GAN could be used to reconstruct data from a blurry and bad radio and AI would be used to augment intelligence.

Prof. Montet went on to provide an outlook how medicine (Radiology) could work in 10 years from now. He gave an example of lung nodules detection.

[1] A convolutional neural network

Before concluding his presentation Prof. Montet showed possible future evolution of the use of AI/ML in the medical world:

Steganography, information in images that humans cannot see

From imaging to **radiomics[2]:** Every picture is made of small boxes. A Gray Level co-occurrence matrix (GLCM) from the image to its numerical representation. This is using same information but the way to look at it is different.

Radiomics would be used as a new way to extract values which are applying filters to nodules and identify benign to malign nodules. The ideas for the further evolution of the new technology comes from the people applying the current processes and technology.

The question is what kind of Business Model will be needed in the future to keep up with the speed of technological development?

Professor Montet concluded by two take home messages:

- AI will transform medicine
- AI is not yet replacing human doctor…

[2] Extraction of quantitative sub-visual features from medical images, Allowing // data mining //classification

	Simon Senn, Artist and lecturer at Geneva University of Art and Design (HEAD)

Mr. Simon Senn www.simonsenn.com started his presentation presenting two of his recent works.

L'hotel des sapiens: Three women and three men are naked and masked. They each have a number assigned. The action takes place in an abandoned building. Each protagonist holds a camera in his hands. Each one of them must film the other persons without being seen by the other moving cameras. Four extra static cameras are filming the whole scene.

The ten resulting videos are precisely synchronized. The installation of the work is an interactive video in which the spectator can navigate between the different viewpoints with a remote control and he(r) is being filmed while doing this.

Meadowlands 1 Soweto, South Africa: A black guy is standing in an impoverished ghetto environment, surrounded by trash and dirt with barracks visible in the background. Pointing at his surroundings, he talks loudly and strong-willed into the camera in Zulu. Charged with emotions, he complains about the corruption and distress in his country. Very convincingly and impressively, he expresses his anger about the unfairness in South Africa that is still omnipresent in the townships. Being furious about no changes at all, he is demonstrating and communicating his feelings to the world.

The persons were picked from the street and the best "actor" would be rewarded with 200 rands for the most convincing message.

Mister Simon Senn then went on to introduce his latest work which started with him buying a computerized 3 D https://www.3dscanstore.com/ skin of a woman in a black Friday sale. When he got the "model", he had first to find a skeleton to articulate the "body" like a real human being. He found a 3-d skeleton for free but as a by-product he had to leave part of his idea or work with Adobe, who was providing the skeleton. Then he managed, with the video

installation and a virtual reality camera, to introduce himself into the naked body of a woman. According to him, it was very special to move himself in woman's body that gave him a new sensation as he felt like a woman.

In a second stage Simon decided to go and find out who the model was. As there were about 150 cameras taking pictures, to produce such a skin he assumed the model left some traces on social media from the event. http://ten24.info/3d-scanning/ The skin revealed no real trace of identification, except the company who produce it. After some research he found the girl who served as a model for the skin, as she posted the photo session on Instagram. He contacted her and is trying to continue his artistic journey to find answers to questions, such as: to whom does this body belong, what is my real identity. He may yet meet the model.

The use of 3D scanned bodies is widely spread in the cinema industry and in some of the new production of films the use of such scans of actors are used for different purposes reducing the cost of production. www.mixamo.com

Innovation Insight @Swiss Post Chances and challenges of the digital transformation

Ms Claudia Pletscher, Executive Vice-President Development and innovation Swiss Post

Ms Claudia Pletscher started her presentation by giving an overview of Swiss Post and how it had moved from the times of post carriages to automated autonomous delivery robots.

Swiss Post is the 3rd largest company in Switzerland, with over 7000 electric vehicles and is number one in logistics, public transport and e-banking with 1.8. Mio ebanking clients. Its' fleet drives the equivalent of 8 times around the globe every day in distance and is an important player in e-health.

Competition comes from surprising areas - Amazon, Uber, Ebay, Apple, Google etc. are challenging Swiss Post that had to adapt to the clients becoming more mobile, digital and individualistic. Swiss Post is adapting to new trends and technology by using and testing robotics, smart and internet of things, data analytics, drones and connected economies (such as blockchain and digital trust), virtual and augmented reality – just to name a few which have been implemented.

In order to become faster and adapt to the new client needs and the new trends, Swiss Post is working extensively with start-ups and they have developed a professional screening process in order to secure the most capable start-ups for the different solutions. Ms Claudia Pletscher showed three world wide "premiers" – parcel delivery by drones, autonomous bus service and automated delivery robots. E.g. the drones deliver blood samples and have reduced commuting time from 45 minutes to 3 minutes. After a drone initiated an emergency landing as programmed, all the drones were grounded until the reason for the emergency is known.

An example where the human has been involved in the design and conception of the use of new technology is the sorting of letters in the morning at the post office. Thanks to augmented reality, the sorting process is more efficient and allows a better-informed overall service, less dependent on the skills and knowledge of an individual post (wo)man. The use of virtual reality during training is augmenting safety in the logistics and design processes.

A further example of Swiss Post having anchored themselves in one of the new business fields, is the internet of things in the smart city with applications such as smart buttons. As one of the biggest real estate managers in Switzerland, the new smart button were first tested in house before being deployed as a seamless logistics tool in the health domain.

To conclude her presentation, the EVP Innovation and Business development of Swiss Post showed the innovation process at Swiss Post and the use of the ecosystem.

Knowledge Sharing Opportunities

Fons Rademarkers
Chief Research Officer
CERN
Openlab

Mr. Fons Rademarkers started with his presentation with a quick overview of the set-up, mission and objectives of CERN. The Openlab exists since 2001 and has the aim to provide knowledge-sharing opportunities. They are entering their sixth three-year phase. They evaluate and test state-of-the-art technologies in a challenging environment and improve them in collaboration with industry. They also communicate the results, demonstrate the impact, reach new audiences, train the next generation of engineers/researchers, promote education and cultural exchanges and collaborate and exchange ideas with other communities to create knowledge and innovation.

The three main areas of R&D are computing challenges. This includes increased data centre performance with hardware accelerators (FPGAs, GPUs), scaled, out capacity with public clouds, HPC and new architecture and changed, computing paradigms with new technologies like Machine learning, deep Learning, advanced data analytics and quantum computing.

The joint R&D projects are conducted with all the big global companies involved in new technology and work in particular on topics such as data quality monitoring, anomaly detection, physics data reduction, benchmarking/scalability, systems biology and large-scale multi- disciplinary platforms, further predictive/proactive maintenance, high bandwidth fabrics, accelerated platforms for data acquisition, code modernisation, data storage and cloud infrastructure and networks.

This is all framed with the basic principles that the intellectual property is open and that there is knowledge-sharing. This allows the communities to work beyond high-energy physics, thus benefitting e.g. medical applications.

CERN has a long history of proven results in the art of collaborative research and it is a unique place where ideas and people can "collide" to generate innovation. The unique technologies can and have to be made universally available to other research and to industry and society at large, allowing to address common challenges that can benefit from broader discussion and solutions. He further showed how a Monte Carlo method could be replaced with a Deep Neural Network for fast simulation or to have to generative adversarial networks trained to compete each other, or to use a detector output as a 3D image.

A 3-D convolutional GAN was shown with 1M parameters and examples of physics simulation with GAN were shown. In conclusion Mr. Fons Rademakers showed work CERN Openlab has developed with UNOSAT to count shelters in refugee camps, based on satellite photos for disaster relief.

	**What is disruption** Professor Juan José Montero Pascual

Professor Juan Montero opened his speech by telling the audience that when he received the invitation to participate in the conference, he wondered if he might be in the wrong place. However after having listened to a doctor, an artist, Cern and Swiss Post, he believed he might fit into the conference program after all.

Oxford dictionary describes disruption as *disturbance or problems which interrupt an event, activity or process*. Both the 1995 paper published by Prof. Clayton Christensens from Havard Business school on "disruptive technologies" and the 1997 book *"The innovator's Dilemma, when new technologies cause great firms to fail*" become the paradigm in consulting for incumbents affected by digitalization.

A distinction between sustaining innovation versus disruptive innovation shows differing trends. While in the case of sustaining innovation incumbents nearly always win, in the case of disruptive innovation, new entrants nearly always wins. Email and Uber were used to illustrate disruptive innovation.

Differences between the traditional approach and the disruptor in relation with regulation:

Disruptive	Traditional
Move fast and break things	Avoid all risk
Little or no regulatory analysis in the product development	In depth legal analysis in product development
Fix regulatory issues as they pop-up	Identify all regulatory obstacles
	Lobby authorities to improve regulatory landscape
	In case of doubt: STOP

Prof. Juan Montero proposes possible responses where the incumbent should keep sustaining innovation in the traditional structure (which might be viable for years). Then a subsidiary should be created for disruptive innovation projects. The subsidiary should be kept separate, but highly protected, by a leadership team. Over time, the subsidiary could overgrow the traditional arm.

What about ATM ?

It is a very complex institutional system that has difficulties to evolve and where safety is of paramount importance and there is little room for experiments at the core activity but there is certainly room for sustaining innovation.

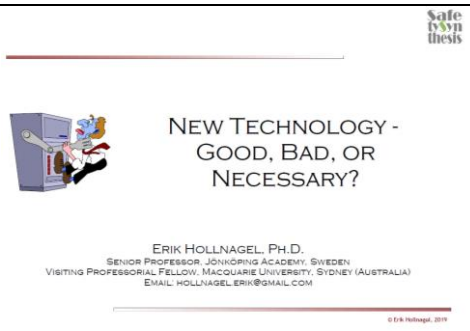
How could disruption in ATM look like?

Do not look at the core activity, rather concentrate on the periphery. Maybe automation in secondary activities (like drones or military) provide room for improvement in new technology and could possible create a risk of future disruption of core activity?

What about the human factor?

Is often perceived as an obstacle to innovation, but humans are the actual experts

Sustaining innovation for the traditional model will provide better coordination between the human and the machine whereas disruptive innovation in a subsidiary for fringe activities will bring more automation.



New technology – good, bad, or necessary?

Erik Hollnagel Ph.D Senior Professor
Jönköping Academy, Sweden

Professor Erik Hollnagel in his wrap-up of the day reminded the audience that the discussion on Artificial Intelligence, neural networks and the role of the human is not a new research topic. It started with the paper from Alan Turning in the 1950s about computing machinery and intelligence and the paper of Hebb (1949) from the organisation of behaviour: on Hebbian neural network[3].

In the past, the growing technological potential (Moore's law) solving technology-induced problems with even more technology, (with the hope of better performance {with maximum service being faster, better and cheaper} and stable {constant} human capabilities leading to a possible task decomposition and substitution of the human) was influencing the system's functionality, task complexity and compensating automation. Some main automation "philosophies" could be derived from:

- left over principles (proto HF)
  - functions that cannot be assigned to machines are left for the operators to carry out – the main concern being efficiency
- compensatory principles (HF; HMI)
  - functions are assigned based on juxtaposing human machine capabilities – the main concerns being efficiency and safety
- complementary principles (CSE)
  - function allocation aims to sustain and strengthen joint system capabilities – main concern: ability to manage a situation

The compensatory principle of automation has often been described as the MABA – MABA (men are better at – machines are better at).

Professor Erik Hollnagel explained the substitution myth from the late 80es where human operator is perceived as unreliable and inefficient and therefore should be eliminated from the system. Lisanne Bainbridge expressed this as the ironies of automation: Firstly, the designer error can be a major source of operating problems and secondly, the designer who tries to eliminate the operator still leaves the operator to do the tasks that the designer cannot automate. Closed loop control systems and decomposed human machine views were shown leading to the "separate" approach to the human and machine. Erik argues that we continue to focus with a different lense on the future joint system by concentrating on the

[3] Hebb, D.O. (1949). The Organization of Behavior. New York: Wiley & Sons.

interaction between human and machine as they could be seen, i.e. as constituting a joint system.

Erik commented on the joint system perspective by showing that the approach or perspective depends heavily on the Control (goals, variability) that take place on different system level. Looking to achieve synergies through a function-centred design on how the joint system performs should be the favoured approach. Prof. Erik Hollnagel illustrated the function-centred design by asking a few questions:

- which functions are needed to achieve the goals, for instance
    - Productivity
    - Quality
    - Reliability
- Which resources (human, organisational, technological) do the functions need?
- How do functions depend on each other and/or affect each other?

Any system change is disruptive – every change leads to a response from the system which leads to a new steady state – which might eventually lead at a certain stage to a final stable system, unless something else changes in the meantime.

Professor Erik Hollnagel concluded his speech by showing the original text from Turing (1950) on the Turing test.

We may hope that machines will eventually compete with men in all purely intellectual fields. But which are the best ones to start with? Even this is a difficult decision. Many people think that a very abstract activity, like the playing of chess, would be best. It can also be maintained that it is best to provide the machine with the best sense organs that money can buy, and then teach it to understand and speak English. This process could follow the normal teaching of a child. Things would be pointed out and named, etc. Again I do not know what the right answer is, but I think both approaches should be tried.

We can only see a short distance ahead, but we can see plenty there that needs to be done

Group work: the participants were split in 4 groups plus a regulator group and were ask all the same three questions:

1. How do we combine Humans and Machines to improve the system performance?
2. What is the role of the human in the Joint Human Machine System?
3. What is the impact of question 1 and 2 on change management?

These group sessions were moderated by Mr. François Bachmann, Marc Baumgartner, Tom Laursen and Prof. Toni Waefler. Each of the moderators brought back the results of the group work. The groups were asked to answer from the perspective of what they had understood from the presenters. In addition, a small group of regulators sat together and discussed the challenges for the regulators in the current and possible future environment.

From the group work the following elements can be clustered:

1. How to secure active involvement of the human?
    a. Critical properties between the human and the machine need to be identified and described in order to understand what they are;
    b. Ambitious research should dare to dig into the important questions of e.g. autonomous systems and identify if ATC remains at the front end;
    c. Identification of be the future role of the human and the necessary future skills;
    d. Identification of the needs on how to best use the combined performance of a human machine interface;
    e. How to maintain domain knowledge in the system (E.g. an AMAN calculates a sequence and not necessarily the minutes). This has created, in certain cases, a feeling of the human being a slave to the machine. It is important to understand why the human is asked to do some actions to improve the future there is a widespread miscommunication between the engineers and the end-users;
    f. The human has to be integrated into the design process
    g. How can experience be valued?

2. Societal problems

    a. A liability versus safety debate needs to be conducted;

3. Who is in control?

    a. Who is in control of the data, what is the purpose of the data and how is it used. What if the human is being used by the data?
    b. How to avoid cheating on the human to fully exploit the concept of control or of Joint Human Machine System?
    c. What can the machine and the human bring to the system, including "making sense"?

4. How can we bring all the actors of the future together (engineers, programmers and

front enders);

   a. The human needs to be taken into the loop in new developments. If there is a need for an operational improvement, it must be done in conjunction with the human, who is already in operation. This allows for an understanding of the reciprocal limitations. Only if the limitations are understood integration can teaming up of the human and the machine be possible.
   b. How do we bring outsiders and maybe also opponents into the discussion?

5. Allocation of Functions;

   a. It is important to allocate functions for both actors (the human and the machine) but as well as for the overall system.
   b. Can artificial intelligence be used to create new training methods?

6. Autonomy;

   a. What kind of autonomy is needed, to become smarter and resolve issues, such as responsibilities, for both the actors?
   b. How can trust be brought into the discussion?
   c. How do we make sure that the system will not get "bored"?

7. Negative image from the past

   a. Explain the business model of ATM and its' limitations of the past.

Regulators group:

Forward thinking for regulation; we want to offer guidance, encourage industries to talk to us, and explore the concepts in advance.

There are different levels of approach in ATM: we start to see new innovations in ATM, which are lagging behind the whole aviation industry. The regulator should build cases to support these types of initiatives from the outset rather than be at the end of the chain.

Automation analogy: e.g. If you throw a frog in a boiling water he'll jump immediately out of the water versus the slow increase of heat killing the frog in the end. Small steps eventually will cross the line. We need to capture where automation challenges us and also challenges safety

Bow-tie risk modeling: bow-tie collaborative efforts are needed to update.

The next conference on DigitATMisation will be organised in the first quarter 2020. The title is yet to be decided.

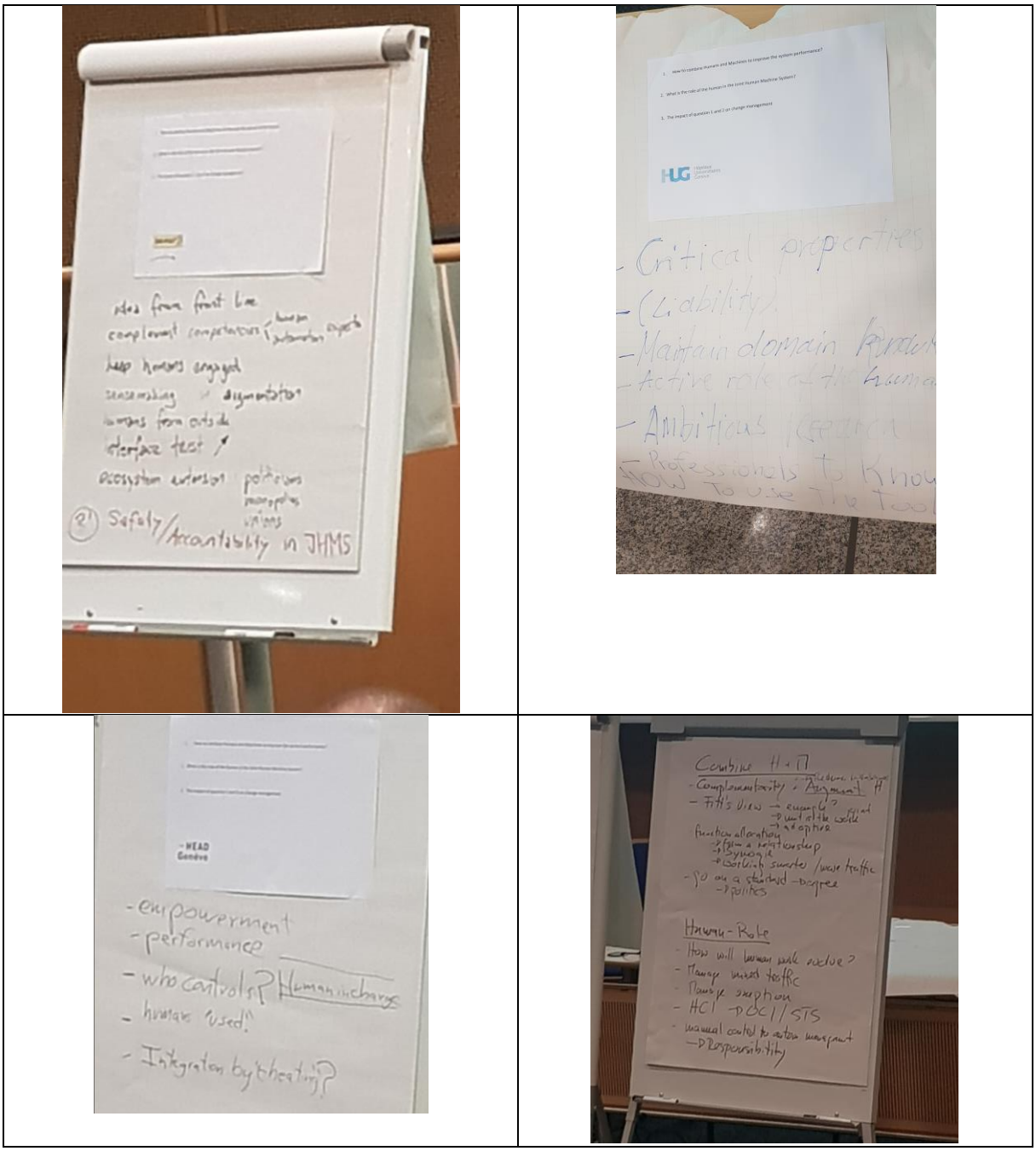


Figure 1 – the flipcharts which resulted from the group .