Remote-control, set the standard by designing a simulator and professionalize!

by

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ABSTRACT

This paper considers the goals, challenges, process and results of a reference design for remote operation of locks and bridges. By building a simulator for remote lock- and bridge operation, we set the standard and we can use it as a reference to professionalize the way remote control is designed and implemented.

The goal is to develop technical, functional and operational standards for remote operation of bridges and locks, integrating them into a training simulator and setting up a training course for operators.

We address the critical success factors for remote control; standardization and the combined optimization of human and technological factors.

A virtual world of waterways with different types of locks and bridges is created within the simulator. These virtual locks and bridges can be operated from a reference control room, serving as a realistic representation of a real control room.

The road during development and implementation of this simulator forces both engineers and operators to thoroughly reflect on each small operational and technical aspect of remote control.

Apart from the obvious benefits of standardization, such as increased flexibility in scheduling of workforce, cost-cutting, standardized training, speeding-up implementation of remote control projects and reduced design efforts, we point out some less evident benefits.

We are evolving towards a mesh-like overall control system, dispersed throughout the full territory. We are evolving towards a complete IP-based set-up, where data/server-center and control-room are not necessarily in each other's vicinity. We need the control centers to be interoperable. This allows for back-up and fail-over scenarios as well as shifting between smaller daytime and larger 24/7 control rooms according to demand or weekly and seasonal variations. At the same time, this allows to invest efficiently on redundancy and availability, not on a local level but on a system-wide level.

All this is possible, only when having a clear shared vision on how things should be done. Developing and building a simulator allows to develop and mature this shared vision.

1. Background

Remote operation of inland waterway infrastructure has been around for about 2 to 3 decades. It is now time to evolve towards a reference design so we can professionalize the way remote control is designed and implemented and benefit from the opportunities that lie ahead in the future of remote control.

De Vlaamse Waterweg (Flemish Waterway) is a newly formed government agency in Belgium. It was formed at the beginning of 2018 out of merger of 2 existing agencies with different territories; *Waterwegen en Zeekanaal* in the West and center of Flanders and *De Scheepvaart* in the East of Flanders.

De Vlaamse Waterweg NV now manages almost all inland waterways and infrastructure in Flanders, Belgium.

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Over the last 2 to 3 decades, both Flemish agencies have invested already heavily in technology for remote operation of Inland Waterway Infrastructure. The ambition of the newly formed De Vlaamse Waterweg, is to invest even more and utilize remote-control on a large and organization-wide scale.

De Vlaamse Waterweg NV has developed and built a simulator for the remote control of locks and bridges. The simulator will be placed in a special designated AWATAR-center.

2. Why do we not yet have a reference design?

2.1 Past

Each bridge or lock is typically designed for its specific boundary conditions and reflects the state of the art of technology at the time of construction. This leads to a wide variety of design and implementations of structures and systems. They were never designed to be connected. This is major technical challenge when implementing remote control.

2.2 Present

Currently, history repeats itself. Several locks and bridges are combined into increasingly larger corridors, operating from a specifically designed control center. When building these centers, several design choices are made based on the involved structures and systems. Often, these projects are the sum and connection of several legacy systems present in the involved area.

Then again, this leads to a wide variety of design and implementations of control centers and Human-Machine-Interfaces (HMI). Therefore, these centers are not designed to be interoperable.

We make design choices based on the task at hand, the technology at our disposal and we search for the best fit. We don't take the bigger picture and the future ahead into account, but we should.

3. Why do we need a reference design?

The introduction of remote operation is historically justified by two main arguments: increasing efficiency by saving manpower and expanding operating hours for waterways with lower volumes of traffic.

However, if we can evolve towards interoperable control centers and interchangeable HMI's, several more advantages can be achieved:

- Increased safety by systematically reviewing and auditing both technical and operational standards
- Speed up implementation of remote control projects by reduced design effort
- Cost-cutting by standardization
- Allow for standardized and professional training of operators instead of on-the-job training
- Allow for back-up and fail-over scenarios for control centers in a mesh-like overall system
- Even more efficiency gains by flexibility in the scheduling of workforce

We need the control centers to be interoperable. This allows for back-up and fail-over scenarios as well as shifting between smaller daytime and larger 24/7 control rooms according to demand or weekly and seasonal variations.

At the same time, this allows to invest efficiently on redundancy and availability, not on a local level but on a system-wide level.

All this is possible, only when having a clear shared vision on how things should be done. Developing and building a simulator allows to develop and mature this shared vision.

4. What are the challenges in establishing a reference design?

Usually, standardization efforts are mainly paper exercises, performed by technical experts. Paper exercises have the risk of not addressing the real-life problems and discussions experienced in the field during construction and operations. They are often open-ended.

Operational personnel often have useful practical knowledge about problems experienced during operations. They need to be involved. However, they sometimes lack skill to interpret technical drawings and documents. Thus, we need more than texts and drawings to communicate and discuss. We need to experience.

In the beginning, trust needs to be built and this is a slow process. This can only be achieved if the intentions are genuine and respectful.

Buy-in of higher management and understanding and support of the goals and intentions is a prerequisite

5. How do we establish a reference design?

De Vlaamse Waterweg NV has set up the AWATAR project. AWATAR stands for Automation of Waterways: Training and Reference.

The 3 main goals of AWATAR are:

- to establish and maintain the technical and operational reference
- to allow for standardized and professional training
- facilitate, professionalize and mature the way remote control is implemented

We made virtual 3D models of several lock and bridges, together with models of ships, cars, pedestrians, … inside a gaming engine. We connected these virtual models with real PLC and SCADA software and simulated different camera-viewpoints, traffic situations and weather conditions.

This allows us to discuss and try very different HMI designs, camera-view points, functional behavior, operational procedures, … all without disturbing any real-life operation and in great detail.

Operators are forming a crucial part in the engineering and construction of the AWATAR-center and simulator. We organized multiple participation sessions, workshops and feedback-loops with both engineers and operators. This process is supported by combining the most modern tools such as 3D modelling and Virtual Reality Glasses to design the operator desk.

6. What is the result?

- A dominant design well documented by technical and operational standards, manuals … supported by both operators and engineers
- A design thoroughly checked on safety issues
- A detailed design and working prototype of the training-simulator
- A camera-simulator, to test camera-viewpoints
- A fully developed training program
- A solid foundation of thrust between engineers and operators

- A modular design, to allow for future changes and technological advancements.

7. What are the lessons learned?

- It takes time and effort to build trust and understanding and to get the right persons involved, but it is worth it;
- Integration of knowledge and experience from operators in an early stage, results in a more useful design;
- The more tangible and life-like the simulator, the more detailed and interesting the discussions get;
- To keep the engineers involved and the results usable in the field, built it with real automation components and software as much as possible;
- Use a contractor with experience in automation of waterway infrastructure;
- The real value of training on a simulator vs on the job training lies in the training of exceptional circumstances or actions that intervene with normal operations, such as emergency situations and technical failures.

8. What is the future?

This simulator will be placed in an operator training center. This center is the meeting point where engineers and operators can thoroughly discuss issues, whereas the conclusions will then form the reference point for the whole organization. It is a physical location but at the same time, it forms a dynamic body of knowledge.

By having a clear and up-to-date reference, we professionalize our technology management. It allows to evolve to an interoperable and thus robust mesh-like setup of control centers. We will build a network of control centers, rather than separate islands.