NUMERICANAL

WP4 - Integrated Report on Pilot Actions in WP4

1. Why were the Control centre and new systems needed?

Numericanal partners had previously identified that “control centres” utilising state of the art ICT could help deliver more efficient and cost effective ways of managing inland waterways. A number of issues were explored and considered including technical and regulatory requirements, connectivity, security, data protection user restrictions and the supporting software.

Numericanal partners realised very early in the project that their individual circumstances meant that it was not straightforward to establish one single “common model” for North West Europe. It was recognised there were a number of common factors relating to functionality but pursuing a common model was not as good an output as a demonstration of a number of systems – in effect a hybrid using a Control Centre (building) but also flexible enough for the system to be run in a more flexible way – for example vial laptops and Apps through Mobile Phones and such devices.

The key driver for **Canal & River Trust (CRT)** was introduction of the control centre system to deliver operational efficiency relating to three aspects;

- Mobile working
- Resilience
- Automation of structures.

Mobile working - CRT needs a large operations maintenance team.to manage its 8500 structures, 2000 miles of canals and rivers in England and Wales much of which is over 200 years old, the A significant effort is put into programming maintenance and major engineering.

The maintenance and engineering teams had been reliant on paper-based systems. This lead to long delays in data being feed back to those programming the work. Before this pilot scheme it

could take 3 months for data on 1 weeks work to be feedback. The data from timesheets would show which tasks had been completed and how long these tasks took. This also affects overall costs. CRT wanted to harness the opportunities provided by mobile devices that could be supplied to all bankside staff to speed up and improve communication.

Resilience - A "Duty Supervisor" system is in place to respond to alarms and emergency calls relating to the waterways. The current system has teams of staff being on a duty rota where for 1 week in 6 they are on call 24 hours a day for 7 days. This raises two weaknesses. Firstly, the call system relies on the mobile phone network. The alarm/emergency calls are not always received by the team or time is lost in trying to reach the appropriate person. Secondly, the fact that staff are on call 24/7 increases the incidence of human error. Staff are woken up and may not be able to make the best decision after having been quickly awoken. Staff may not have all the relevant information available at that point to make the best decision. Then having been woken up, possibly several times, in the night staff may not function so well during the day.

In one example given a decision taken in 2015 in these circumstances led to costs of £200,000 being incurred by the CRT as the team member did not fully understand the situation and the implications.

Moving to a control centre staffed 24/7 and able to deal directly with these situations is therefore considered an improvement to the organisation's operational resilience.

Automation of structures - Waterways in other parts of North West Europe, partly due to being more commercial in nature, have developed automated structures (bridges, locks). Some of these can also be operated remotely i.e. by the skipper of a vessel or from an off-site control centre.

CRT was keen to look at the possibility of introducing these technologies in the UK. It was decided to focus the pilot on the Gloucester & Sharpness Canal which has 14 bridges. On some waterways road swing bridges need to be operated by an on the spot staff member and operational costs mean that the canal may be closed overnight or on certain days when it is not considered cost effective to man the bridge to open it for boaters. Introducing this technology which could be managed through the control centre would bring benefits to boaters as well as potential cost savings.

The key driver for **the city of Eindhoven** was the fact that they have responsibility for management of the Beatrix canal and wanted a secure, safe channel for their users or stakeholders. These range from commercial freight carrying vessels - to the 'leisure' users (such as canoeists and other unpowered boats)

The 'water bounded' companies in Eindhoven expect an increase in cargo throughput in tonnage from the current level of 100.000 tons p.a. to 600.000 tons p.a. Efficient and cost-effective administrative processing of shipping was therefore equally important to start to deliver the cost savings they envisaged and to help manage such an increase.

These companies and the drive in general for a modal shift from trucks to ships were key reasons why Eindhoven developed a Control Centre system using an App during the Numericanal project

In the Berzob study carried out by Rijkswaterstaat (RWS) it was recommended they improve the shipment from Veghel to Eindhoven by upgrading the *Zuid-Willemsvaart*, *Wilhelminakanaal* and the *Beatrixkanaal* waterways. This would facilitate ships on these canals with a length up to 110 metres long.

2. Programme of requirements

Eindhoven set out their absolute requirements. They wanted a Control Centre that is suitable for operation via a computer, cell phones or tablet (re-inforcing the partners view that the investment delivers a series of different ways of providing the services) They wanted Control Centre maintenance to be carried out by a specialised field assistant on behalf of the Area Manager.

Information or services provided by the Control Centre needs to include;

- General information water way for users
- Safety for boating, freighters, and canoes
- Reporting complaints by users to area manager
- Reporting work and calamities by area manager to users
- Admission for channel tax by freighters
- Tourist information to users User groups and access information - Beatrix Canal:
- Waterway users: via public website or app
- Area manager: dashboard via website
- Companies, Marina, Canoe Club: public website

Canal Users should be able to;

- View current usage of canal by boating, freighters, or canoes
- View relevant canal information (e.g. other boat movements in the vicinity, water depth data, channel width, bridge heights, water points nearest hospital, garbage bins etc.)
- Mooring and car loading / parking points
- Register canal usage (boating, freighters, or canoes)
- Register complaints / issues (pollution, damage etc.)

The Area manager needs to;

- View current usage of canal by boating, freighters, or canoes (information about shipping real time and the expectation when for example a ship passes)
- Register general information (POI, issues, activities) via interactive map
- Defining information flow user registration (canal usage, issues) to third parties
- Defining addressees of information about freighters entering canal, as observed via AIS
- Data concerning safety, AIS, speed data.

Automation needs to include;

- Option to alert traffic signs based on presence (waypoint and direction) of freighters
- Send weekly report of freighters entering canal, and registration status

(CRT requirements are set out in Section 1)

3. Who are the Stakeholders?

Eindhoven stakeholders include; Water bounded companies, Freight skippers, Marina, Canoe club, Scouting Groups. Indirectly involved were / are; Rijkswaterstaat, MCA, Vereniging van havenbedrijven, City of Best, Waterschap de Dommel, and Schuttevaer.

With the Marina and the canoe club there were meetings about 3 times yearly, with the water bounded companies and the skippers about 1 time yearly.

CRT stakeholders are primarily the UK boaters who will benefit from the more efficient systems and reporting of incidents, quicker emergency responses. Remote operation of bridges and other structures benefits not only existing boaters – but the provision of the ability to open such structure from a hand held device (via an App) or from the Control Centre itself can be of great benefit the less able bodied people unable to leave their boat. In this instance the automation delivered by

both pilots can be seen to be opening up whole new areas and opportunities to a new range of stakeholders.

In CRT's case the stakeholders differ slightly from those of Eindhoven – CRT have less of a relationship to National, Regional or Local Authorities. The charity is now less answerable to such bodies, having moved from (mainly) Government grant funded to being a charity. The users and stakeholders needs however have remained much the same I.e. provision of a safe and efficient, well maintained waterway network.

An important stakeholder group CRT had to engage with was residents at Sandfield in Gloucestershire, where there were concerns from local residents. They were concerned about safety, emergency road access as well as job security for the bridge-keepers and CRT held a series of consultation meetings to try to allay their fears

4. Summary of the Technical aspects of Control Centre Operations delivered

CRT's UK Control Centre itself became operational in April 2015 and was located at an established CRT regional site at Hatton, in Warwickshire in the centre of England.

Scheduling and mobile working
A team of three people (Schedulers) was recruited and undertook training which enabled them to schedule CRT's whole maintenance and (light) engineering operation. The new functions were introduced at a managed pace to enable the changes to bed-in properly. There was a concern that a big bang approach could be painful in terms of it not being able to deal with a large volume of queries adequately.

The Schedulers look at the tasks which need to be carried out in the short term, working approximately 2 weeks in advance. They assign and schedule team members to undertake tasks which have been programmed

764 handheld devices were configured and given to the maintenance and operations teams, generally known as "bankside" staff. These tablet devices give the bankside staff access to far more information than before – they can now also access exactly the same information as office staff, e.g.HR and internal news as well as the all-important, task and technical information. The latter can help in diagnosing or pre-empting problems such as flooding.

The mobile devices use *Prometheus* software which was configured by MX Data for roll out to and use as an App by staff. The in house team worked with suppliers to deal with tweaks that were necessary during system implementation. The mobile devices have also widened the use of the pre-existing SAP software for scheduling amongst bankside staff.

Bankside staff receive details of the tasks to be carried out through the mobile devices and can either update the device immediately or later to confirm that a task has been carried out and how long it took. This information is uploaded once a week (on a Monday morning) so the feedback to Programmers is very quick.

Automation of Structures
The remote operation of Sandfield Bridge will continue to be trialled and tested. A significant amount of development has been necessary (helped enormously by Numericanal funding) but there will need to be further tests and tweaks as issues are 'ironed out'.

A Wi-Fi hotspot has been created around the bridge; boaters wishing to open the bridge will need to have downloaded and App to their Smartphone or mobile device and the use of Wi-Fi makes

the system reliable where mobile phone signals are not reliable. Only boaters who hold a boat licence can download the App.

A pre-set sequence for bridge opening was established. For safety and security reasons this cannot be over-ridden by a boater. Emergency (road) vehicles needing to lock the bridge can send a signal to the control centre which needs to be manually inputted. Lasers have been installed on and around the bridge along with lights and barriers to check that the bridge deck and the water either side is clear. Additionally CCTV cameras have been installed for off-site monitoring at a control centre. Bankside communication equipment has been installed so that boaters or passersby can contact the control centre if necessary. Other protocols have been set up, for instance creating a limit to the number of times that the bridge can open at rush hour and other times of the day.

The biggest problem in developing and implementing the technology has been in the ability to relay CCTV images and data to the control centre. Bridges are in remote locations without fibre optic cables or 3G coverage. The solution so far has been to link the Sandfield Bridge to the nearest CRT centre at Gloucester by a slower connection and to slow down the CCTV image refresh to accommodate this connection. All the CRT's offices are connected by fibre optic cable and so data/images can be quickly transferred between them. Therefore the images can be viewed at the Hatton control centre as well as at the Gloucester offices. The internet infrastructure in the Sandfield area is due to be upgraded in 2016 and this should solve the problem. The software used in remotely operating the bridges is seen as being straight forward "off the shelf" and reliable.

Initially the bridge remote operation will continue to be monitored by bridge-keepers.

Eindhoven's programme of requirements was defined and translated in a Proof on Concept, and in a feasibility study. The purpose of this study was to define the (feasibility of) their proposed use cases as well as study the technical feasibility.

Leisure Users of the canal required use of a mobile application or the monitors at the harbour or Canoe club for viewing the current usage of the canal by boating, freighters, or canoes, assessing the current canal usage and wish to register complaints/issues

The Area manager requirements were to view the current usage of the canal by boating, freighters, or canoes, register general information or activities. They also wanted to consider the way information coming from user registrations on canal usage and complaint registration should be distributed to relevant third parties and see information about ships entering the canal and observe them via AIS. Eindhoven pilot technology also includes an option to automate and alert to optional traffic signs, based on presence of freighters, their GPS location and direction.

The overall system was "built on top of" (based on) the middleware solution of Open Remote. Existing elements are a controller which manages the protocol adapters, message flows between different sensors and user interfaces, and facilitates the messaging services. The messaging service enables the area manager to set rules for e-mail notifications, based on different sensor inputs or user inputs (complaints or registration) The user interface applications was built on an HTML5/JS framework enabling responsive designs for smartphones, tablets and kiosk / monitors at the Harbour and Canoe club. For the interaction with the controller, the controller API will be used.

Two technical feasibility studies were carried out;

(1) Tracking different ship types. Freight ships can be monitored using AIS. However quality of the signal on the Beatrix canal was very limited, so during the implementation it was decided to install an extra AIS antenna with own software, to increase the reliability

(2) Tracking canoes and pleasure boats is possible via GPS trackers. A brief study tested a few trackers. In the first evaluation it was decided that detecting the presence of canoes and pleasure boats will continue to be done (for now) by manual registration. The problem was that adding digital trackers creates a false sense of safety to freighters if not all ships / canoes carry them. Eindhoven also decided that they as they can't enforce the use of trackers at this stage it is safer to communicate clearly to waterway users that they should manually register themselves to be noticed by freighters

The Control Centre is a cloud service on a dedicated server within the City of Eindhoven: It features;

- Integration of AIS and controller API
- Set-up controller API for user applications
- Set up of monitoring for controller performance
- Implementation workflow rules, automation and messaging service

The kiosk provides user interfaces for canal users at the Marina and Canoe Club, functioning as the user interface for end-users. It contains the following elements;

- An overview map with an overview of 'markers' (information on POI's, Attention items, Agenda items)
- The number and type of ships present in the canal, with live data on location of freighters,
- Reporting on canal usage by pleasure boating, canoes and freighters,
- A send complaint notification system, including relevant categories

The mobile applications for Android and iOS, functioning as the mobile user interface for end-users, containing the following elements;

- An introduction explaining objective and use of the mobile application
- An overview map with an overview of 'markers' (information on POI's, Attention items, Agenda items)
- A number and type of ships present in the canal, with live data on location of freighters,
- Reporting on canal usage by pleasure boating, canoes and freighters,
- Send complaint notification system, including relevant categories

A webserver running the area manager application, links to the Open Remote messaging service. The above kiosk user interface and mobile applications will be linked with the back-end controller to enable notifications to the persons registered in the area manager dashboard.

5. How were the technologies appraised and who was involved?

- CETIC delivered a Technical Evaluation of the Eindhoven CC system. With them they studied the existing electronic communication and ICT systems like AIS and reported within the project. The technical support from CETIC was very important as they acted as validators for the technical feasibilities, specifications, etc. prior to engaging the actual App developers. The "Forge" project development tool, encouraged partners to share their technical development work with them.

- Eindhoven worked in close co-operation and participated in information exchanges with other Dutch partners Waterrecreatie Nederland and Eijsden-Margraten. Eijsden-Margraten, had the same needs as them with regard to safety and discussed this in meetings held in March and June 2014. However through this they realised and reported that their situation was very different compared to them. Eindhoven, as waterway administrator need more information such as port taxes, complaints registration etc. Waterrecreatie Nederland

provided great help with with their information of “veilg varen” and maps of dangerous junctions. Their APP is connected to their sites to provide this important safety information. Waterrecreatie Nederland and Eindhoven held an information evening at the marina and the canoe club, promoting the safe boating programme and the Eindhoven Control Centre and APP

- Partner Exchanges and Reviews at Meetings CRT and Eindhoven studied the existing regulations and reported these in WP1 within the project. VNF showed their APP development with very interesting subjects. Demonstrations held at SG Meetings, the Brussels PR Event and at the OMC Event in Hatton was very important to see how the technologies work in reality

- The CRT team drew on technical knowledge gained from visits and exchanges with colleagues at Eindhoven and Eijsden-Margraten in the Netherlands and Voies Navigables de France Eindhoven visited CRT and both partners benefitted from the visit to Gloucester in June 2014 and were able to take account of issues discussed on that occasion. CRT did likewise during their visit to Eindhoven in June 2013. Of particular interest was the subject of remote control and working with lasers

- A comprehensive report of these was completed on behalf of the partners by Hyder Consulting and should be found on the Numericanal website (Numericanal.eu).

6. Problems and Issues encountered during set up

The programming and technical staff involved in establishing the CRT control centre believe that this was relatively straightforward with no issues encountered that were outside the scope of those expected in any such development. Problems encountered appear to relate to the remote locations of waterways, for instance in there being insufficient mobile phone network coverage and the ability to relay CCTV images from the site of a structure to be remotely operated to the control centre.

This was a problem encountered in both pilots. Eindhoven’s feasibility studies found that although Freight ships can be monitored using AIS quality of the signal on the Beatrix canal was very limited. Hence during the implementation they decided to install an extra AIS antenna with own software, to increase the reliability.

Eindhoven wanted to track canoes and pleasure boats via GPS trackers and tested a few trackers. However they decided that presence of canoes and pleasure boats should be done (for now) by manual registration. This was because;

- Adding digital trackers creates a false sense of safety to freighters if not all ships/canoes carry them.
- As they can’t enforce the use of trackers at this stage it is safer to communicate clearly to waterway users that they should manually register themselves to be noticed by freighters.

Within CRT there were some delays in developing the pilot actions because of internal procedures required in delivering a development on this scale.

Specifically on the introduction of the pilot remote bridge operation at Sandfield in Gloucestershire, there was some delay due to concerns from local residents. At Sandford residents were concerned about safety, emergency road access as well as job security for the bridge-keepers. An information and consultation process with residents and local authorities was established to try and alleviate such concerns and ensure the pilot action could be implemented as planned.

Eindhoven reported no problems with their local population and stakeholders. They engaged very well with stakeholder groups and the partners' communications and promotion of the benefits elicited wide support for the pilot work.

7. How well were the Objectives for the pilot achieved?

CRT

Objectives set out in **Bold** – responses / findings normal text

- **Establish a functioning control centre for waterway management including tools, systems and interfaces;** This was delivered

- **Demonstrate ICT as a means for resource efficiency by enabling, through remote control and monitoring, effective deployment of manpower skills;** This was delivered. One example from the CRT Pilot report states; *"CRT Bankside staff receive details of the tasks to be carried out through the mobile devices and can either update the device immediately or later to confirm that a task has been carried out and how long it took. This information is uploaded once a week (on a Monday morning) so the feedback to Programmers is very quick. This used to take up to 3 months previously as the paper-based system had to be passed through supervisors either weekly or monthly and then passed monthly to a central point for scanning in before being made available to Programmers."*

- **Provide a catalyst for uptake of this approach in other NW Europe cities, regions and countries. Partners will use these strategically significant facilities to communicate opportunities and potential benefits to a wide and varied audience including organisations from the waterway, ICT and policy sectors;** The results of the pilot will be rolled out as part of WP5A17

- **Help increase awareness and appreciation of the waterways as a resource and, by advancing management practices, secure resource availability and engage stakeholders for longer-term sustainability;** We believe this being delivered. The results of the pilot will be rolled out as part of WP5A17.Feedback from the DBA was very encouraging;

"The Supervisory Control and Data Acquisition system demonstration was excellent. Being able to control and monitor assets remotely will be extremely beneficial to the end user navigating the waterway, eliminating the frustration of not being able to navigate at all due to low water levels and also eliminating the need to contact the navigation authority about the problem. At the moment you never know if the message was passed to the relevant section or 'taken seriously' when you call or email with a problem.

The concept of tracking work vehicles and vessels will also mean issues, including emergency issues, can be dealt with so much faster. The likelihood of the end user experiencing any adverse conditions would be greatly reduced; a great benefit.

If staff/operatives find the system easy to use on their PDAs (including paper time-sheets no longer need to be completed) they may be more content/happier in their roles and this may impact on their relationship with the end users - ultimately altering the view the end user has about them and the navigation authority.

The remote operation of bridges and /or locks could be extremely beneficial to many who navigate the system. With the need to moor up and get on & off their vessel removed, the chance of falls and trips is removed…."

(The final comment) *"Having read the reports of the tests undertaken, I am aware that many scenarios have been tested but believe some users would remain sceptical about the safety of remotely operating these structures. 'Training sessions', which were mentioned last week, would hopefully reduce this"* is being added to the Future Developments" Section

- **Deliver a report on the pilot action, which will be used to support the development of a roll-out strategy for Eijsden-Margraten and the wider dissemination of results**. This was delivered and is reported separately

Eindhoven

Objectives set out in **Bold** – responses / findings normal text

- **The use of AIS transponders and camera for tracking ships and mutual recognition. This will allow increased waterway traffic to be accommodated within the area of supervision. The ship data will be more complete and accurately recorded, and will allow information about the waterway to be fed back to the skipper** This was broadly delivered – Tracking of canoes and pleasure boats via GPS trackers is being done (for now) by manual registration because of the issue of Adding digital trackers creating a false sense of safety to freighters if not all ships/canoes carry them.

- **The development of the control centre, in which certain actions can be executed such as: Complaints – for example silting of the bottom of the canal, fallen trees etc. Administration - loading, tonnage, billing, arrival/departure time etc. Online booking systems for waterways users.** This was broadly delivered. Eindhoven reported that the signing along the canal is improved, the max. speed on the canal is reduced, the stakeholders(users) can foresee what ships are on the canal or will be shortly on the canal which will improve the safety, collecting the harbortax is almost automatic.

A comment that ties in with CRT scheduling work, discussions with VNF they have a greater understanding of waterway management and that the Eindhoven organisation is more clear around canal issues.

A really positive spin off is that the stakeholders have more understanding for each other, and are interested to add other use on the system (for example reservations , regulate in-out going ships)

An interesting observation from Eindhoven was that;

"..it seems difficult to uniform the desired results. Eindhoven, for example, manages the canal themselves, where Eijsden-Margraten has no management function (this is done by Rijkswaterstaat). VNF manages more than 2000 km channel but has no AIS. CRT is especially interested in the remote control and more efficient organization."

However, despite these perceived issues – it was encouraging to see that the required outputs were on the whole delivered? Their comment bore this out;

*"This resulted that many experiences and ideas were exchanged, and that each partner has achieved its objective***.**

8. Future work and developments

Scheduling and Mobile working through the Hatton Control Centre
In February 2016 the Scheduling team will take on responsibility for assigning CRT's hire fleet (work boats). Fleet monitoring (vehicles) will start in April 2016 with a view to both of these being fully operational within 12 months.

Bankside staff have asked whether it would be possible to be all working on one system e.g. Apple, Android, and Microsoft. The Scheduling team report that they feel they can shape the service and suggest changes to processes that may become apparent as the control centre embeds.

Automation of Structures
The trial will be extended in 2016. As the trial operation is assessed the team will look at whether these structures will be monitored from the Hatton control centre or elsewhere. If this is to be from Hatton there is a view that this would need to be by additional staff to the Schedulers, perhaps with a different skill set.

Emergency response
Extending the control centre to encompass an emergency/immediate response function was widely anticipated by those interviewed.

At the moment the CRT operates a bespoke Supervisory Control and Data Acquisition (SCADA) system which monitors the waterways and triggers alarms for example if there is a flood or system breakdown. These are responded to by the "Duty Supervisor" process. There appears to be agreement that this process is due for an update and that having it operated through a control centre manned 24 hours a day could bring benefits. There would however be additional staff costs associated with 24 hour manning. It was thought these could be outweighed by saving on costs incurred where the current system fails.

Eindhoven like CRT have to be aware of the ongoing costs in maintaining structures and systems. This is a key message for those implementing such systems. Eindhoven's procedures describe the process well;

For management and maintenance the following services have been put in place.

The area manager has his own dashboard allowing him to change and maintain:

- Information markers within the map
- Define rules and contacts to define where and when messages related to 'canal registration' or 'complaints' are being send

For management and monitoring of the controller and AIS services, the following is in place:

- a remote monitoring service, allowing for active alerts in case of system failures
- remote access to the controller, allowing remote maintenance and debugging
- a service contract for 3 years, for technical maintenance

Evaluation of the system by users:

- regular reviews will be held with canal users to receive feedback on functionality and user friendliness
- updates are planned for the coming 3 years, allowing for changes or additions to the system with the purpose to improve its functionality

Inside the Eindhoven organisation the development and future use of the Control Centre and APP is organised by the maintenance department

“Having read the reports of the tests undertaken, I am aware that many scenarios have been tested but believe some users would remain sceptical about the safety of remotely operating these structures. 'Training sessions', which were mentioned last week, would hopefully reduce this”

9. Conclusions - Have the Pilots delivered or will they deliver positive results and outcomes?

Feedback from the CRT’s bankside staff has been generally favourable to the scheduling process. They can see that it saves them time in being able to access CRT systems and documents from remote locations and without having to go via a number of people. Initially there was some resistance as teams could previously decide when they did certain tasks, but once the new processes had been explained these seem to have been allayed. These teams are now coming back to the Schedulers when they see problems that have occurred and asking for useful changes to be made. There are some issues which appear to be solvable and perhaps could be seen as teething problems about:

- Duplication of work (having to input information and not being sure that the device has actually sent the information through as it seems to be requested again)
- Some attachments will not open on the devices
- Not being sure that the Hatton staff understand the logistics of some aspects of bankside work
- The system updates every few hours, not instantly.

Benefits have certainly been demonstrated. There is now a much better understanding of how long tasks take and which resources are required to carry them out. The speed with which information is passed back means that programmes and schedules of work are more effective. Mobile working devices have also enabled useful new information to be collected on “near misses” with regard to health and safety issues as well as “handling hours” where staff need to use water craft for which they need boat licences. There is a cost to the CRT in paying for boat licences so they aim to make efficient use of craft and licences.

In establishing this new way of working it has become clear that there is a difference in the skill set needed between Schedulers and Programmers. Schedulers concentrate on particular tasks and allocating that to the correct team. It was felt that this was a skill set that couldn’t necessarily be bolted on to existing jobs. The Schedulers believe that consistency in the processes implemented is essential. There has also been recognition that effective Scheduling relies on accurate and timely information being supplied by Programmers otherwise the wrong information is given to bankside teams. Training has been given to Programmers on the requirements of working within the new system. It has been very important to develop the relationships between the Schedulers and the staff receiving the task information.

CRT has succeeded in establishing a functioning control centre at Hatton for waterway management which currently enables efficient and effective maintenance of the waterway. Staff feel that Numericanal has brought about a huge step change in the way they work. These developments have been very much part of working smarter and delivering efficiencies. They should also lead to increased resilience and stronger risk management.

The mobile working devices and software in this pilot action have demonstrably improved the deployment of manpower relating to bankside operations. Programmers now have more accurate information provided much more quickly. Bankside staff have access to more information to enable them to work more effectively.

Although still at a relatively early stage, the remote control and monitoring of structures should also bring about more efficient use of the CRT's resources as well as bringing benefits to waterways users through increased opening hours of the canal.

Eindhoven believe they will they deliver positive results and benefits:

Automatic Identification System (AIS), used for professional ship tracking, is being made available to the public in combination with informational markers to improve safety.
Their management structure is greatly improved and they can maintain the canal by giving professional and recreational users the opportunity to easily report issues such as waste, damages and inappropriate behaviour on the canal. It also allows for digital registration or canal use by freight ships. This greatly reduces their overheads and administration when collecting the freight taxes due to them.

The many SG meetings or separate meetings with partners contributed on a lot of issues. Without the transnational cooperation the project would not have started – "now the use of the canal is safer, the collection of harbour tax more efficient and the Eindhoven organisation and stakeholders are working better together."
The benefits of their work also links very well to the City of Eindhoven's "Living Lab" based in Eindhoven (visited by partners during the SG Meeting in Feb 2015)-Numericanal is part of this project. The intention of Living Lab is that in different locations in Eindhoven real time information is obtained using sensors, cameras of e.g. sound, light, traffic situations etc. The work in Numericanal has enabled real time information about waterways to be included as well now.

Feedback on the remote operation work is so far limited. As set out on section 7, the DBA is positive about the development because it will mean the canal is open for longer periods.

There have been concerns from bridge-keeping staff about their positions. The largest section of feedback has been from the community around Sandfield Bridge for whom the bridge is a key access point. They have been very concerned about the ability of emergency vehicles to gain access as well as potential congestion and road travel delays. However it is felt that the major consultation and stakeholder process helps to address these concerns.

Automation of the 14 bridges on the Gloucester & Sharpness canal will cost £4.5m, however much of this cost is related to improving the bridge itself and would have been incurred as part of the CRT's maintenance programme. It is estimated that the cost of the technology specifically for remote operation (lasers, CCTV etc.) is around £70-89,000 per bridge. CRT believes that remote operation of these bridges will bring about a 10-11% efficiency saving, around £500,000 per annum
.
Because of delays in delivering the Numericanal project it is too early to confirm that this pilot action has provided a catalyst for uptake of this approach in other NW Europe cities, regions and countries. However there is already strong evidence that all the Numericanal partners have benefitted from this trial – the exchanges of technical knowledge and expertise have been useful to the CRT in developing these capabilities. The French and Dutch partners have stated their intention to remain in close contact to watch, advise and learn from the trial. There is still work to be done in communicating these developments more widely; the Numericanal website is one avenue for this but plans expressed as part of the overall Numericanal project to work with NIWE and to exhibit at the World Canals Conference should be carried out. The roll out strategy in WP5A17 should promote the benefits more widely – but will need partners to get involved in assisting those wanting to trial these ideas.

Overall there seems little doubt that by making Eindhoven and CRT more efficient and resilient this trial will contribute to providing a better waterway to boaters and other stakeholders who benefit from well managed canals and rivers.