

 **Talk to the Bridge**  
**FIG Working Week SOFIA 2015**

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## Yeong Jong Bridge, Seoul KOREA



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## Yeong Jong Bridge, Seoul KOREA



The University of  
Nottingham

## Case Study : The Millennium Bridge



Designed by: Architect Sir Norman Foster  
Sculptor: Sir Anthony Caro and Engineers Arup  
Opened: 10th June 2000; Closed: 12th June 2000; Reopened: 27th February 2002  
Length: 330m; Width: 4m  
Height above river at high tide: 10.8m  
Handrail height: 1.2m

**Piers:** Concrete and steel  
**Cables:** 120mm locked coil  
**Decking:** Aluminium  
**Handrail:** Bead blast stainless steel

Construction cost: £18m  
Subsequent modifications: £5m

0

4



## Buildings and bridges join the 'internet of things'

09-Jul-2013 | Ryan Desouza



Virginia Tech Carilion School of Medicine and Research Institute, a building that uses SMART solutions. ©AECOM photo by Cameron Triggs.

What do the following things have in common?

### CONNECTED CITIES BLOG

Perspectives on built, natural and social systems for better urban environments.

#### Topics

Abu Dhabi Adelaide advanced modeling aerotropolis aging populations architecture Atlanta auralisation Bangkok Beijing Berlin Blackpool Bogota Brisbane Bristol Brooklyn C40 Calgary Cambridge Cascadia CDP Chicago Christchurch city branding Cleveland competitiveness construction Copenhagen COST courthouse cycling density Doha Dubai ecology economic development Edmonton

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One example of a SMART solution would be placing sensors like accelerometers, tilt meters, temperature sensors and acoustic sensors on bridges, dams, buildings and other structures to continuously monitor structural health. These sensors would allow us to receive an early warning of changing conditions, potentially extending the need for periodic inspections by human inspectors. This real-time remote monitoring approach is also able to capture changes in between inspections, which would otherwise go unnoticed. In addition, this helps reduce the risk of catastrophic failures and can reduce maintenance costs by supporting the move to preventative and predictive maintenance models.



The Rion-Antrion Bridge, a SMART bridge.

space Recife revitalization Rio de Janeiro Sacramento San Francisco schools Seattle seismic Sekondi-Takoradi Sendai Shanghai Singapore smart technology Sochi Suzhou sports subterranean development Sydney Tainan Taipei tall buildings Tianjin Tongzhou Toronto transportation urban agriculture Urban SOS Venice water waterfront WSUD Yokohama

#### Most Popular

Buildings and bridges join the 'internet of things'  
No cars in the city center, or something more?  
Coastal resilience through biomimicry  
The nanotechnology energy revolution

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Real Time Interaction between people and digital world thanks  
**sensors** and **actuators** (IoT) – MIT SENSEable City Lab

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SMART CITIZEN

CGEOS IS CREATIVE GEOSENSING SPRL-S BELGIUM, NAMUR

MONTE SKX 1.1

LAST UPDATE: 10/01/15 9:58:11 AM

TEMPERATURE	22.5 °C	CO	388.9 K12
HUMIDITY	47.2 %	NO2	11 K12
LIGHT	263.1 LUX	NETS	3 NETS
SOUND	50 DB	SOLAR PANEL	0 V

SENSORS

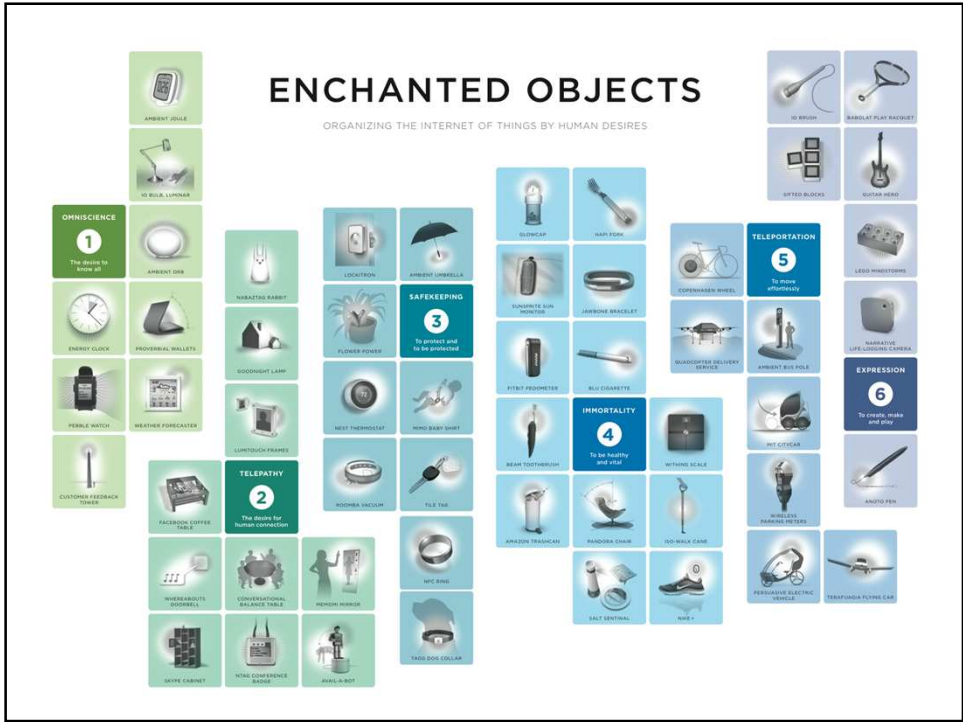
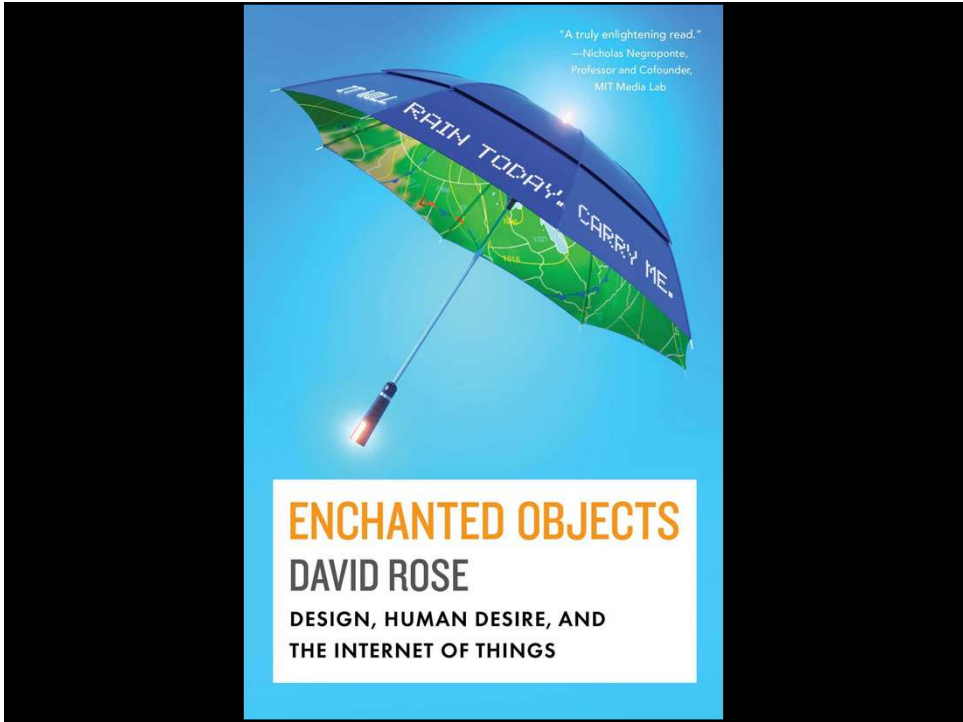
CITIZEN OWNER: joel

CGEOS IS CREATIVE GEOSENSING SPRL-S BELGIUM, NAMUR

TEMPERATURE 22.5

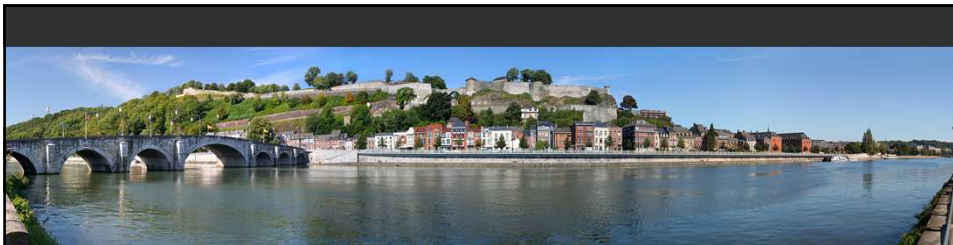
Smart Citizens will start sharing their data's like they share today photos, status, videos, ... to contribute real time representation of their environment in a large sense.

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## SENSIBLE vs SMART CITIES

A Sensible City is the one who is able to sense and express its feeling, who reminds you and where you feel part of a community. It's the city where we are working, living, relaxing and having friends, lovers and family ... with enchanted places and infrastructures



Namur (French pronunciation: [namyʁ]), Nameur in Walloon) is a city and municipality in Wallonia, in southern Belgium. It is both the capital of the province of Namur and (since 1986) of Wallonia. It hosts the Walloon Parliament. Namur stands at the confluence of the Sambre and Meuse rivers and straddles three different regions - Hesbaye to the north, Condroz to the south-east, and Entre-Sambre-et-Meuse to the south-west. The language spoken is French.

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# NAMUR INNOVATIVE CITY LAB



*le Coeur des Wallons*



**NAMUR**  
CAPITALE



5 March, 2014

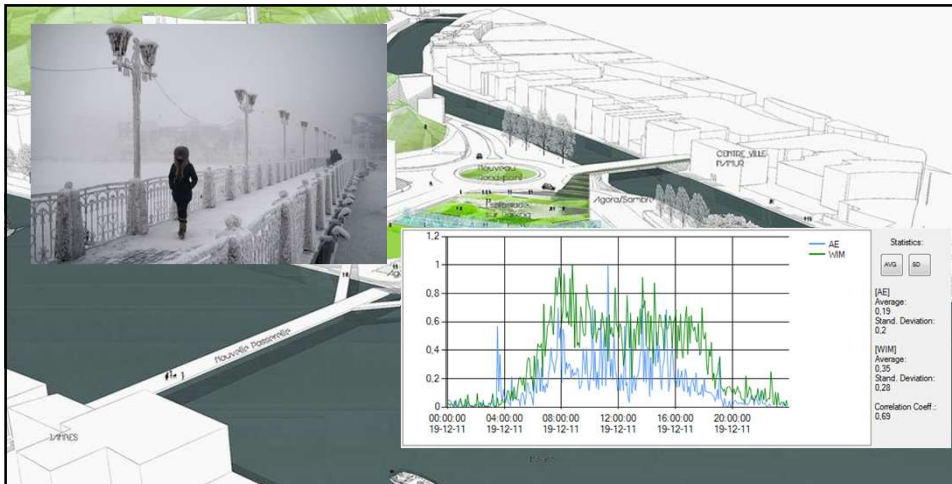
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## Building a Community

- To invite residents to use the footbridge instead of their cars, we suggest to engage them into an **experience** by joining a **community**
- By making the footbridge “**sensible**” (SENSEable) using IoT (sensors and actuators)
- Where the data’s will be open and the basis of **new App’s**

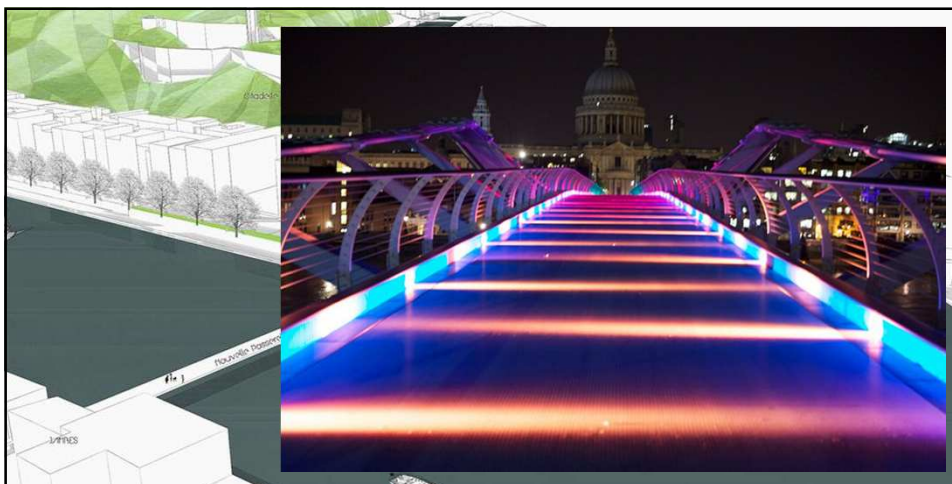




**TEMPERATURE:** This is an important parameter to analyze the structure

**BENEFITS:** preventing the frost (faster than on the streets) provide salting

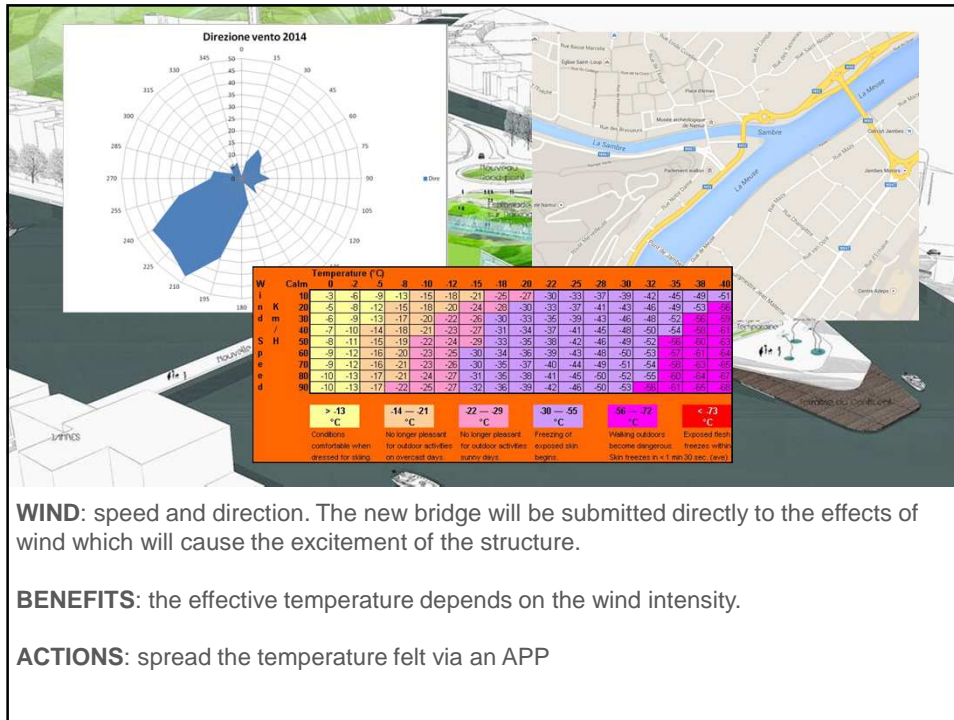
**ACTIONS:** broadcast excerpts from "Four Seasons" by Vivaldi according to the T °



**MOVEMENT:** 90 meters on the footbridge will expand under temperature

**BENEFITS:** part of the analysis. The footbridge also becomes a thermometer!

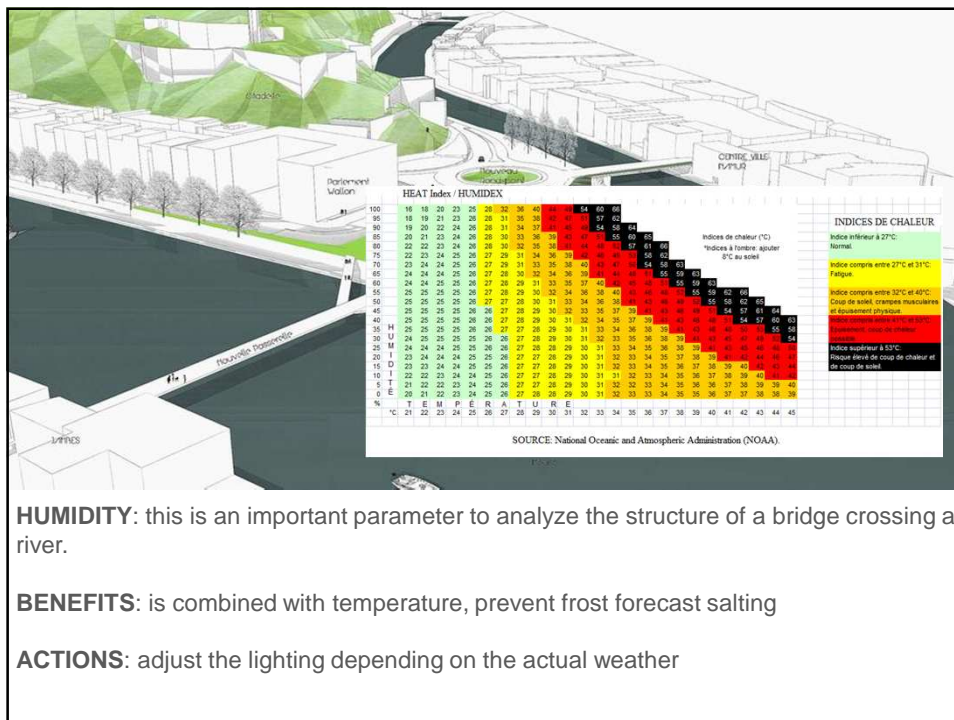
**ACTIONS** effect on RGB LEDs to illustrate the elongation of the footbridge



**WIND:** speed and direction. The new bridge will be submitted directly to the effects of wind which will cause the excitement of the structure.

**BENEFITS:** the effective temperature depends on the wind intensity.

**ACTIONS:** spread the temperature felt via an APP



**HUMIDITY:** this is an important parameter to analyze the structure of a bridge crossing a river.

**BENEFITS:** is combined with temperature, prevent frost forecast salting

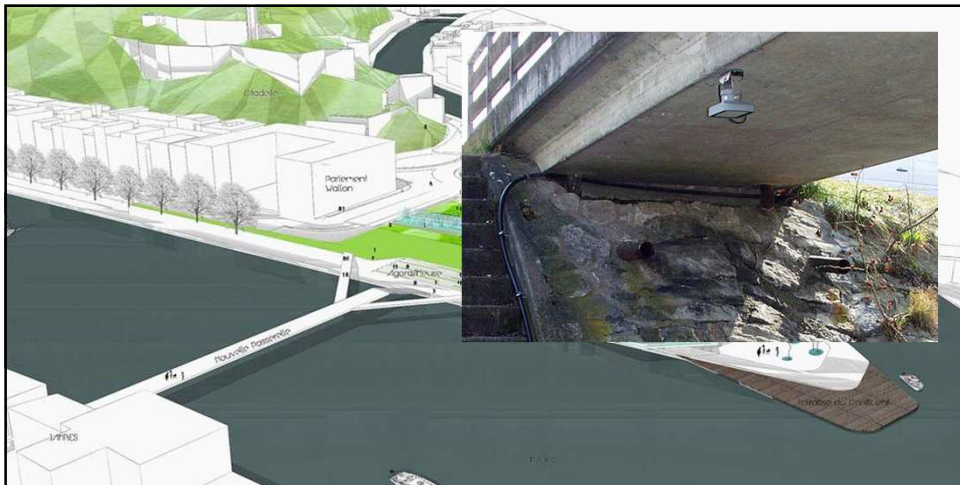
**ACTIONS:** adjust the lighting depending on the actual weather



**ACCELEROMETERS:** get the frequencies of the bridge that characterize the different modes.

**BENEFITS:** study the influence of pedestrian traffic, weather ...

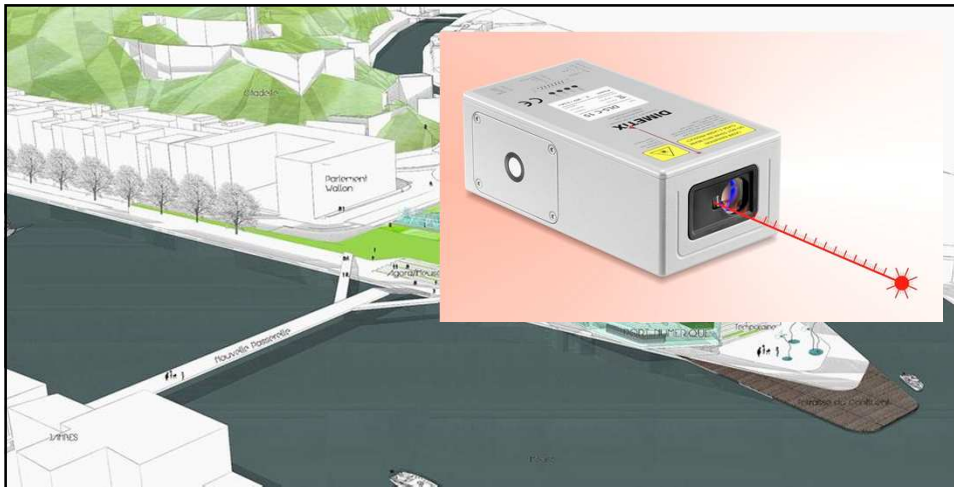
**ACTIONS:** the song of the footbridge! The footbridge has its own frequencies like a guitar. Under the passage of pedestrians, wind, ... It is singing !



**RIVER LEVEL :** radar under the bridge can measure the water level ...

**BENEFITS:** measuring the bending of the bridge

**ACTION:** Action on lighting, sign, information on APP, ...



**DISTANCE:** the distance measurer is under the bank to bank footbridge (Namur - Jambes)

**BENEFITS:** Measuring the stability of banks, counting boats, Namur and Jambes how are they separated from ?

**ACTIONS:** display the number of boat ... pedestrians pass over, the boats below



**CAMERA:** can be used by the security services but also be broadcast on a website (indicating the position: "Smile, you're on camera!")

**BENEFITS:** surveillance, prevention (= Royal suicide concern)

**ACTIONS:** broadcast the deferred time sequences via an APP

**GPS:** set the milieu of the footbridge. RTK accuracy (using WALCORS of GPS reference station Boulevard Herbatte)

**BENEFITS:** determines in real time 3D movements (mm) of the footbridge and the frequencies.

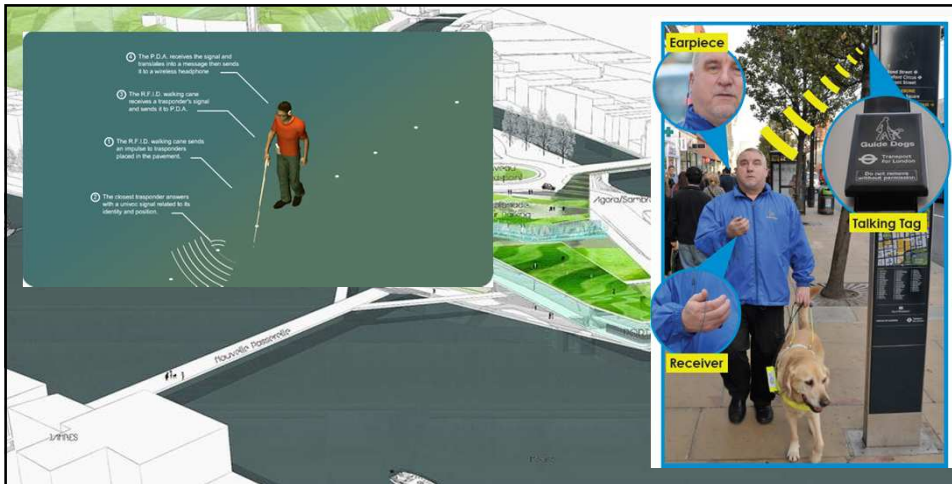
**ACTIONS:** correlation with radar

**COUNTING OF PEDESTRIAN ANONYMOUS:** it is an important parameter to analyze the structure (the bridge is designed to withstand 300 kg / m<sup>2</sup>)

**BENEFITS:** display the number of users, is involved in the analysis of the structure. What about the Wallonia festivals?

**ACTIONS:** display statistics via an APP. Encourage use the gateway!





**RFID:** to guide blind people on an electronic route

**BENEFITS:** helping people with a disability to cross the bridge safely. Electronic guardrails.

**ACTIONS:** meets the Namur Innovative City Lab wishes



**SIGN:** write your name digitally via SmartPhone / iPhone

**BENEFITS:** form the community of "passers footbridge"

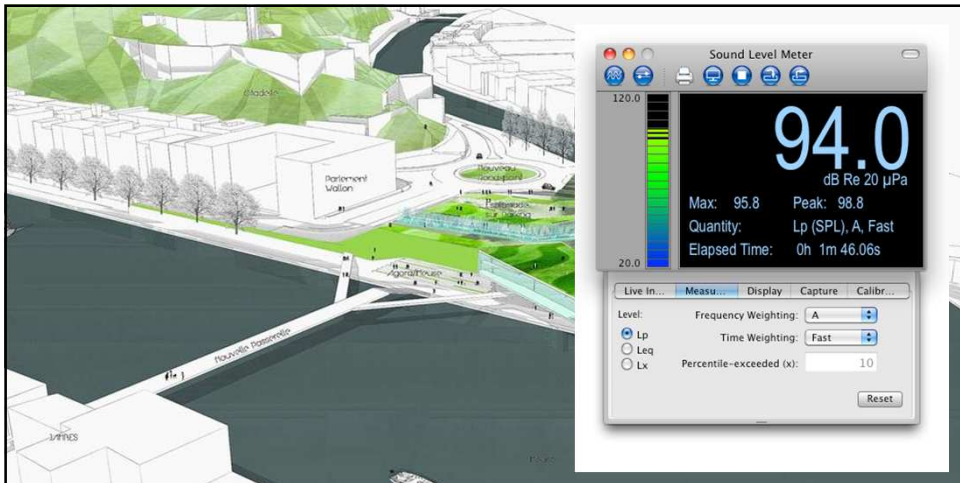
**ACTIONS:** statistics and "award" for the way that uses most often. The footbridge can greet "Hello!" ... Guestbook ...



**LIGHTNING:** switches on the street lighting in modular way ...

**BENEFITS:** correlation with the perceived temperature, sunshine

**ACTIONS:** available for APP



**DECIBEL:** to measure the noise on the bridge

**BENEFITS:** correlation with the number of walkers

**ACTIONS:** Namur is a student city that speak loudly ...



**CO2, Nax:** to measure the level of air quality ...

**BENEFITS:** better to cross the Meuse by foot than by car. We can put sensors on nearby bridges and inform profit.

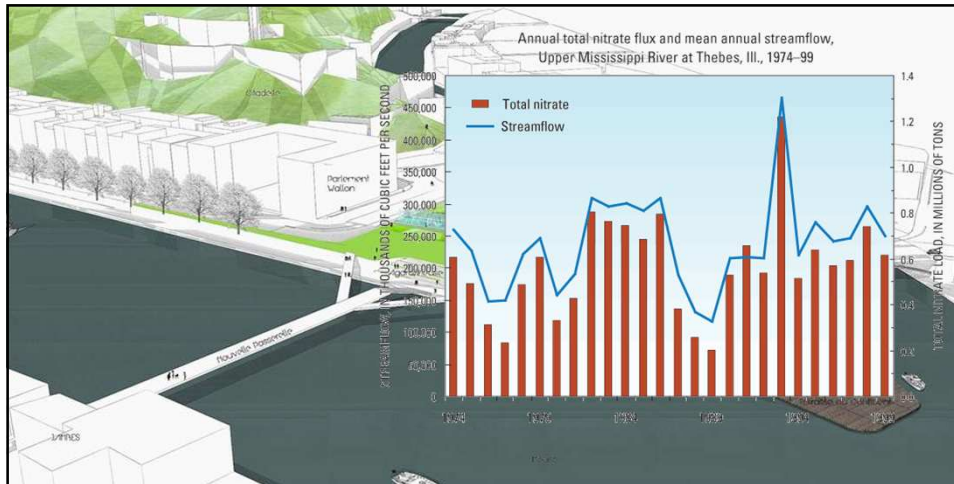
**ACTIONS:** The footbridge is a "sensor" that provides information on the air quality of the city



**MANAGEMENT OF TRASH BINS:** Trash bins can be "monitored" and emptied on time. They are equipped with a sensor and a low-power radio to report the height of the waste via a Web application and prevent City services.

**BENEFITS:** keep own footbridge , encouraging passers-by to use the bins

**ACTIONS:** available for development of new APP's



**TEMPERATURE OF THE MEUSE, SPEED CURRENT WATER QUALITY:** This is important information for learning "Meuse" to users of the bridge.

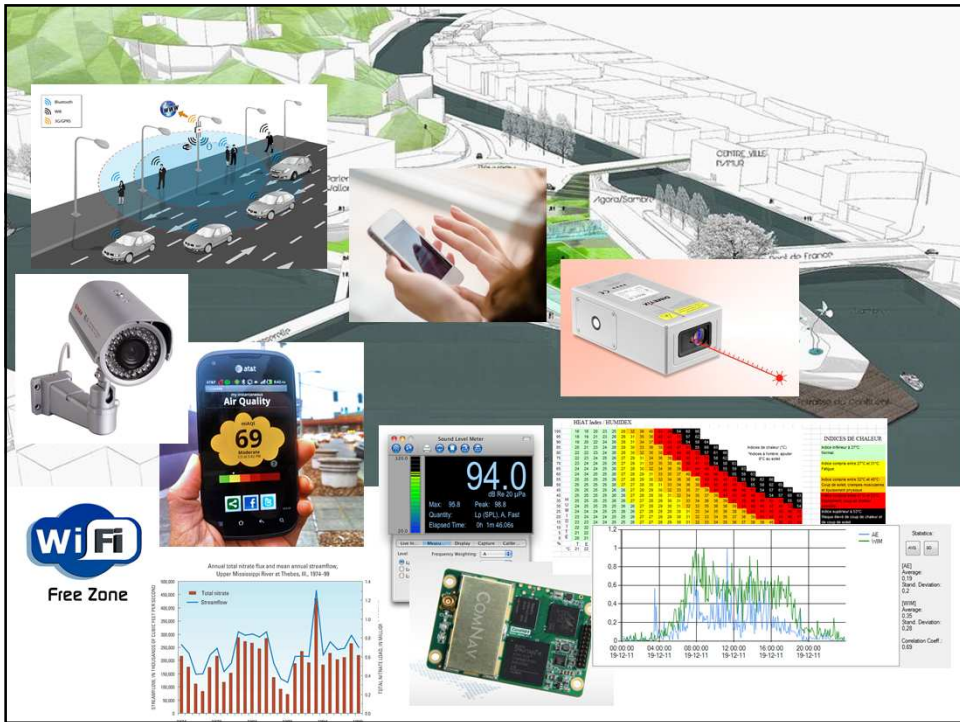
**BENEFITS:** better knowledge of the Meuse. "Loving" is protecting the river.

**ACTIONS:** available for development of new APP's



**COMMUNICATION:** to foster "community", the media can be offered. Free Wifi for example (which will connect all the sensors to digital port. BLE (Bluetooth Low Energy) to transmit information to the passers equipped with SmartPhone / iPhone

**BENEFITS:** direct interaction with users



Create a community around the footbridge. An eco-system that shares emotions! An enchanted footbridge in the heart of the Walloons ...

- temperature
- Relocations
- wind
- humidity
- frequencies
- Meuse level
- distance
- imagery
- 3D (x, y, z)
- number Pedestrians
- guidance
- signature
- brightness
- decibel
- air quality
- trash can
- number Boats



**Record your first kiss on the footbridge !** ( download the CGEOS Kiss on the Bridge Apps (iPhone & Android) for free – limitless use )



## Conclusion - Advantages

- **Surveillance of public infrastructure** is a valuable aid in their management and maintenance, user safety and **positive image of the administration**.
- Besides technical and ENVIRONMENTAL data, this approach creates a "**community**" around an inter-active **footbridge becoming enchanted**.



## Conclusion - Unique

- All data (sensors) are "expressions" that should be synthesized into a language specific for the footbridge.
- Let's "talk" to the bridge ... we did it say?  
**You need a "translator" between the footbridge and human language.** (like Basic or C++ to talk to a computer ?)
- Become "friends" of the footbridge (social network) and exchange ...

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## Conclusion - Exportable

- This ties the spirit of **Namur Innovative City Lab** that can develop new applications to citizen services and create economic development opportunities.
- **TALK TO YOUR BRIDGE** will be presented at other international conferences and introduced in China (**Europe China Sensible City Creative Lab**).
- Belgium innovates and exports its know-how.

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## Conclusion

- To recommend the FIG Commission 4 + 5 + 6 and also 1 + 2 + 3 and may be 7 + 8 + 9 to integrate our activities into :
  - **IoT Internet of Things/Surveying**
  - **Sensible Cities program (Smart Cities)**
  - **Open Source HW/SW**
- Surveying in the 21<sup>st</sup> Century is right now and surveyors have to “enchant” the world by helping creating communities !

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 **Creative Geosensing**  
Just now · 🌐

Paper presented at the FIG Working Week 2015 in Sofia, Bulgaria. Thanks to "Like" !

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## MANY THANKS FOR YOUR CONSIDERATION

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