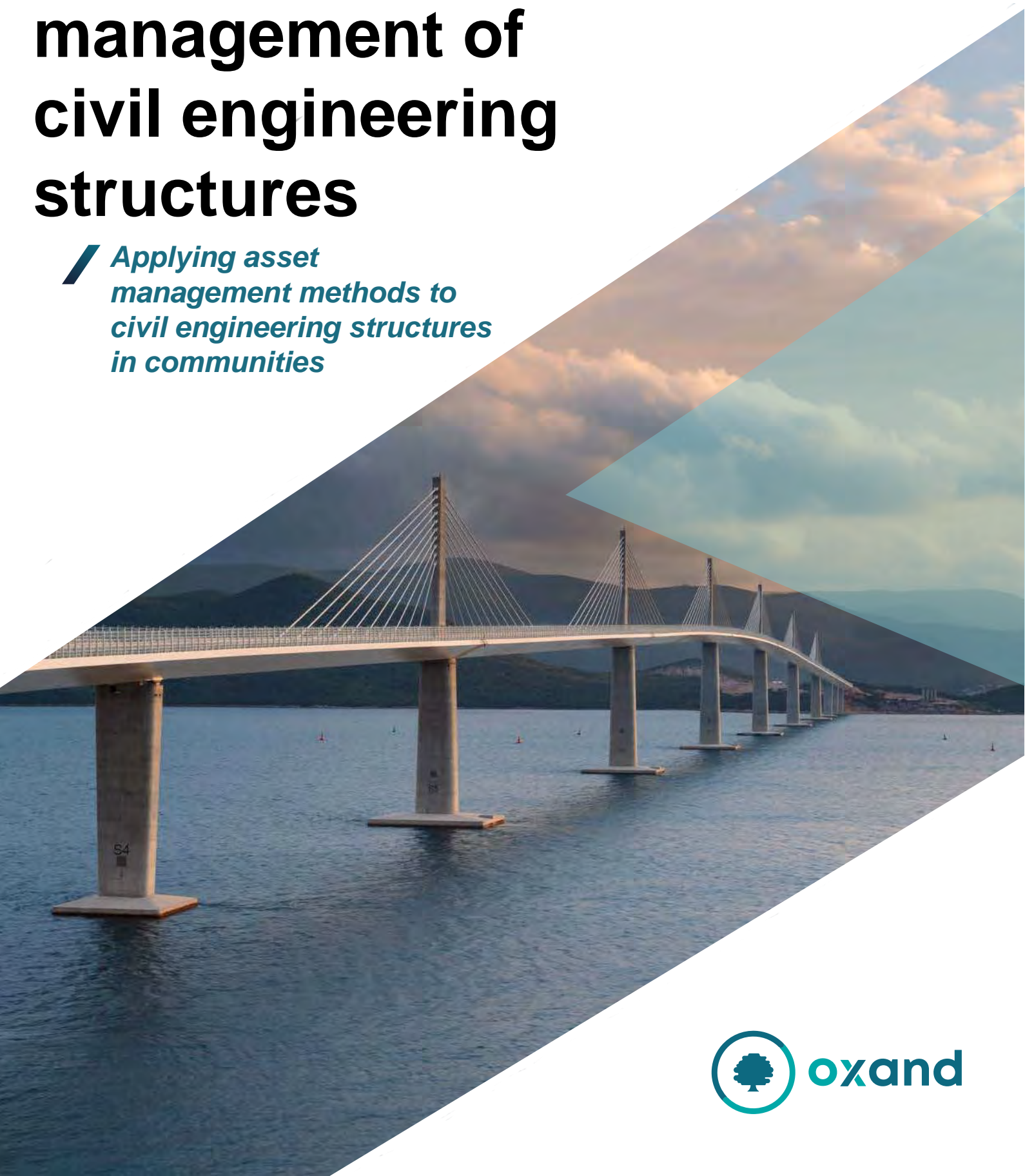


WHITE PAPER

Predictive management of civil engineering structures

Applying asset management methods to civil engineering structures in communities



Summary

Editorial

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Oxand support





/ Editorial

The management of civil engineering structures, particularly road bridges, was described as the "project of the century" by the Senate in its 2019 report.

Behind this somewhat pompous term, intended to make an impression, lies a worrying situation for three main reasons.

Responsibility for many structures has been transferred from the State to local authorities, with an imperfect history due to lack of centralization and digitization. **A large portion of this heritage** therefore remains unknown.

We're talking about **a significant stock** of 250,000 works managed in France by local authorities, give or take 50,000 objects...

Historically, **park management has been reactive**, addressing issues on a case-by-case basis without taking into account a holistic view of the assets. Work was generally carried out when absolutely necessary, without any proactive approach.

In this context, local government infrastructure departments want to change their approach **to develop more heritage-based management of their engineering structures.**

This white paper aims to outline the ins and outs of managing civil engineering structures in France and to propose **a new approach based on the principles of asset management.**

Happy reading!

1.

**Management of civil engineering works,
a major challenge for
local authorities**



1.1Civil engineering structures: an important and little-known heritage

The engineering structures present on French territory mainly include road bridges with retaining walls and tunnels.

With the reform of the territorial map and the consolidation of inter-municipal authorities implemented by the law on the new territorial organization of the Republic (NOTRE), responsibility for the park was gradually transferred to local authorities. It is therefore mainly on them today that the burden of managing, maintaining and repairing the structures present on their territory falls.

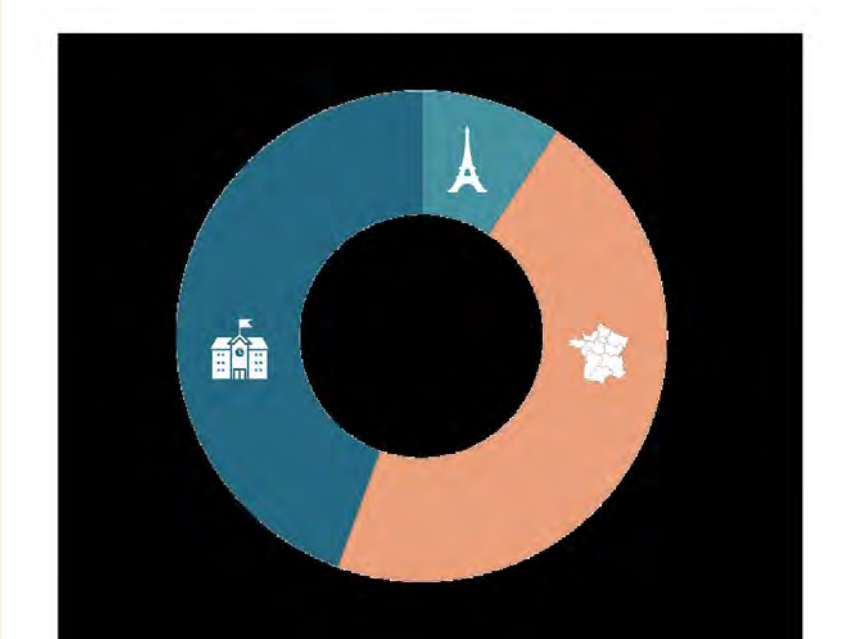
Not only is the number of civil engineering structures managed by local authorities unclear, with estimates ranging between 200,000 and 250,000. The transfer of responsibility has not always been accompanied by the transmission of complete data on the assets concerned or funding.

The first challenge for communities is therefore to understand their heritage and identify the condition of each of the objects that make it up.



Focus on the works of art

Who manages France’s 250,000 works of art?



-  **State**
The State manages the structures on non-concessionary motorways and on national roads
-  **Departmental councils**
The departmental councils manage the structures located on departmental roads
-  **Municipalities and inter-municipalities**
Municipalities, inter-municipal authorities, and metropolitan areas manage the structures located on their roads.

1.2 The construction site of the century

The reference to the "century" is not insignificant.

It will take at least decades for local authorities to fully master all civil engineering structures in France.

France is falling further behind

How can we explain France's delay in properly managing its road infrastructure and its difficulty in sustainably managing our engineering structures?

Constantly increasing traffic, harsh winters, and declining maintenance investments have led to a deterioration of road infrastructure.

As a result, France fell from the top of the World Economic Forum's barometer of 1st place in 2012 to 18th place in 2019 for the quality of its road infrastructure.

This decline is not surprising, as numerous studies conducted in the country have highlighted the deterioration of France's road infrastructure.

The situation continues to deteriorate

Initially estimated at 25,000 in 2019, the number of structures in poor condition has unfortunately been revised upwards.

By 2022, the number of buildings in poor structural condition is estimated at 35,000.

An ambitious plan for small municipalities, the National Bridges Program (PNP), led by Cerema, has been defined, but the resources deployed do not appear sufficient to halt the deterioration of bridges managed by local authorities.

A competitiveness issue for France

Since 2007, the World Economic Forum has published the "Global Competitiveness Report," which assesses the competitiveness of 140 countries based on several criteria, including road infrastructure, information and communications technology, education and training, health, the labor market, the institutional framework, market size, innovation capacity, and other key factors.

Road infrastructure is an important factor in a country's competitiveness, as it facilitates trade, encourages investment, and stimulates economic growth.

Pays	Rang	Note sur 7
Singapour	1	6,5
Pays-Bas	2	6,4
Suisse	3	6,3
Hong Kong	4	6,1
Japon	5	6,1
Autriche	6	6
Portugal	7	6
Emirats Arabes Unis	8	6
Corée du Sud	9	5,9
Espagne	10	5,7

Pays	Rang	Note sur 7
Oman	11	5,7
Danemark	12	5,6
Taiwan	13	5,6
Croatie	14	5,6
Etats-Unis	15	5,5
Luxembourg	16	5,5
Qatar	17	5,5
France	18	5,4
Namibie	19	5,3
Suède	20	5,3

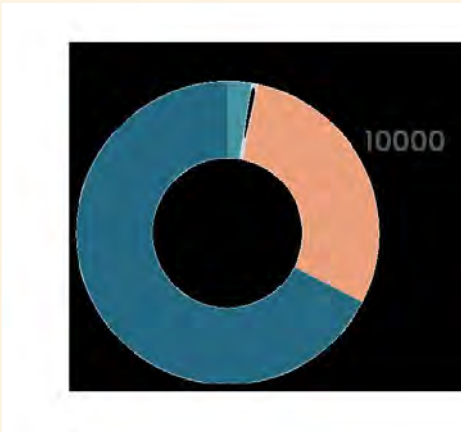
TOP 20 countries for the quality of their road infrastructure in 2019

Municipalities and inter-municipalities on the front line.

In 2022, 66% of structures in poor structural condition are managed by municipalities and inter-municipal authorities.



The works of art are in poor condition



- National road network not under concession
- National road network concession
- Departmental network
- Municipal and inter-municipal network

1.3 Tricky challenges to overcome

Responsibility for civil engineering structures presents several delicate challenges for local authorities.

Mastering your heritage

Maintaining control and understanding of their engineering structures remains a challenge for local authorities today.

Local authorities have taken over the management of these objects, which their teams do not always have knowledge of, and while the inventory is gradually being completed, it is still far from exhaustive.

Guaranteeing the sustainability of civil engineering works

As a manager, it is the community's responsibility to ensure the condition of its civil engineering structures..

This involves assessing the obsolescence and risks associated with road bridges, retaining walls, and tunnels.

Can the books be borrowed safely?

If risks are present, what actions should be taken to ensure the sustainability of the problematic bridges and structures?

Which ones should be treated as a priority?

Optimize budgets

Finally, given a tight budget, how can work be prioritized to make the best use of public funds to repair and maintain existing structures within the community and minimize the constraints imposed on the various users of the affected roads?



2.

Integrate the principles of proactive management to the Multi-Year Investment Plan



2.1 Learn about the park of civil engineering works

The inventory process involves establishing a single repository of civil engineering structures, their typology, and their components using all available sources of information:

- **Inspection reports:** every 3 or 6 years, local authorities carry out inspections on the ouvrages pour établir des quotations selon le référentiel IQOA (indice qualité ouvrage d'art).
- **The history of repairs** carried out by community services or service providers
- **Interviewing experts** , technical service agents or infrastructure management staff who have practical knowledge of heritage
- **Statistical data**

In a smart data approach, a few data points are enough to digitize knowledge of structures and their condition.

- Apron
- Enchantment
- Restraint device
- DR stringer
- Cornice
- Trimmer
- Stringer or stiffener
- Sole
- Veil
- Intermediate support
- End support



SMARTDATA OXAND APPROACH:



Oxand uses smart data to **simulate the aging of civil engineering structures and anticipate maintenance and investment needs.** Thanks to aging laws developed by a team of engineers, the decision-making solution proposed by Oxand requires only a small amount of input data, making it a real asset, especially since 73% of elected officials say they do not have a database for recording their civil engineering structures. (Senate Report 2022)

Specifically, to diagnose the condition of bridges and simulate their evolution over time, the Oxand Infrasim software relies on data such as:

- Geolocation data
- Usage data (traffic, vehicle type, etc.)
- Materials used in the bridge structure
- Date of the last safety work

2.2 Prioritize the risks associated with structures according to their condition and impact

After listing all the civil engineering structures for which the community is responsible, the next step is to assess the consequences that their potential failure could cause, based on their condition and the challenges they represent.

Developed using interviews and data models, **this risk inventory** makes it possible to classify bridges according to their associated risks.

Identify the condition of the work

The structures are identified according to their technical condition using the following scale, indicating their obsolescence, from F1 "good condition, very infrequent component failure" to F4 "very frequent or even certain component failure."

Assess the stakes of a failure

Taking into account traffic volume and the types of bridge use makes it possible to determine the impact that a failure would represent, based on a severity scale ranging from G1 (minor) to G4 (catastrophic).

Mapping the risks associated with bridges by crossing these two criteria

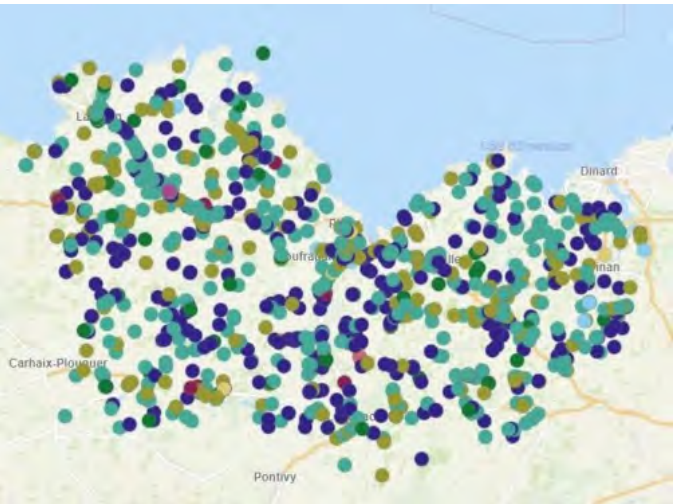
Ultimately, based on this data, a map of structures can then be created, combining risk severity and condition.

Four groups of engineering structures representing a greater or lesser risk can then be defined.

-  R1: Low risk
-  R2: Moderate risk
-  R3: High risk
-  R4: Very high risk

2.3 A clear and dynamic vision of renovation priorities

Predictive models based on aging laws make it possible to create a map of structures and project it over time.



Mapping of engineering structures highlights the condition and risk level of the assets and its components.

This comprehensive and up-to-date view of risks can then be projected over time according to different scenarios, allowing the structures to be maintained and kept in good condition. These models therefore help create **a clear basis that facilitates decision-making and budget forecasting.**

Operational staff can thus better present their renovation projects to elected officials to obtain the investment budgets they need.



3.

The benefits of predictive management works of art

Predictive management of bridges involves using technology to monitor and assess the condition of **bridges and other structures**. Oxand's method allows, with minimal initial data, to predict **future maintenance and repair** needs by simulating the aging of bridges in order to plan maintenance operations accordingly and thereby optimize investment budgets. This proactive approach thus helps avoid service interruptions, extend the lifespan of bridges by optimizing costs, and thus, in the long term, ensure **the reliability and durability of bridges** while maintaining an efficient and safe transportation service.



The advantages of predictive management of civil engineering structures are numerous

Visualize the risks to civil engineering structures and improve user safety

Through continuous monitoring of bridges and structures, predictive management enables the detection of anomalies as soon as they appear. The "smart data" approach implemented by Oxand is based on simulating the aging of structures under various stresses (humidity, vibration, traffic, etc.).

This data can be used to predict potential damage and plan maintenance activities, thus ensuring user safety.

Facilitate and objectify decision-making

Simulating different maintenance scenarios over time makes it possible to determine the best scenario under constraints (budget, safety, operations) and to structure a PPI by justifying the necessary budget to decision-makers.

Optimize investments and smooth maintenance debt

Predictive management helps reduce costs related to the maintenance of engineering structures because the cost of preventive action is generally lower than that of corrective operations.

Anticipating maintenance needs therefore allows for more efficient and cost-effective planning of activities in advance, avoiding exceptional expenses, and limiting the risk of service disruptions. Ultimately, this reduces the generally very high maintenance debt for engineering structures.

Manage investments, monitor results and improve communication

Organizing predictive maintenance allows you to manage your investment plan and track operations and their impact on the condition of your structures. With Oxand, you benefit from a centralized, summarized view in monitoring dashboards and simplify communication between stakeholders.

4.

The Departmental Council of the Meuse

Optimize your resources with Infrasim to better manage your assets



Context

The CD55, a French local authority, is responsible for the management and maintenance of numerous civil engineering structures within its territory. To answer this question, the CD55 has decided to integrate two key parameters into its civil engineering structure management strategy.

On the one hand, it wants to **accurately monitor the aging of its assets**, using reliable and up-to-date data to assess the condition of each structure. This approach will make it possible to quickly identify structures requiring renovation or maintenance.

Next, the CD55 wants precise information to **prioritize funding for building renovations and infrastructure maintenance**.

This approach allows to optimize the use of available resources by concentrating intervening on the most critical structures, while ensuring that public buildings are also maintained in good condition.

Infrasim deployment in 5 months



Infrasim was deployed in five months, and a **complete inventory and detailed diagnosis of the engineering structures** and their components is now available.

Applying the laws of aging made it possible to determine their **current state** and remaining lifespan.

An **inventory of maintenance actions** to be carried out is then established, taking into account **the risks, age, and criticality of each infrastructure** e.

Automatic generation and comparison of **maintenance scenarios** is now available, helping you find the best compromise between investment and efficiency.

Finally, **the multi-year investment program** was developed to plan the necessary short- and long-term maintenance actions.

Needs

The project aims to meet several needs, including:

- **Strengthen knowledge of the infrastructure** art in order to better understand their current state and determine the necessary maintenance and renovation actions.
- **Create a single repository** to facilitate the analysis and management of data relating to civil engineering structures.
- **Have a clear, reliable and up-to-date vision of the state of the structures** to make informed decisions regarding maintenance and renovation.
- **Justify budget requests** by providing accurate data and analysis of costs associated with maintenance and renovation work.
- **Facilitate decision-making by elected officials** by providing them with accurate and up-to-date information on the condition of civil engineering structures and the costs associated with maintenance and renovation work.

Benefits

Thanks to Oxand's support, the Meuse Departmental Council was able to optimize its management of engineering structures by adopting predictive management, which enabled it to:

- **A complete mapping of the state of the heritage** with the condition of the various components and the as risk level, thus providing a precise and detailed view of the condition of the structures.
- **Prediction of different maintenance scenarios** according to budgetary and operational constraints, which for optimal planning of work based on priorities and constraints.
- **Budgetary arbitration between heritage and works of art**, with precise and objective data to decide on t distribution of budgets between the maintenance and renovation of civil engineering structures.
- **Access to decision-making dashboards** which enable budgets to be defended to elected officials by providing accurate and up-to-date data on the condition of civil engineering structures and the costs associated with maintenance and renovation work.

qui permettent de dé budgets auprès des élus en fournissant des données précises et actualisées sur l'état des ouvrages d'art et les coûts associés aux travaux de maintenance et de rénovation.



5.

The County Council from the Côtes d'Amor

Implements asset management for its civil
engineering structures with Infrasim



The context

The Côtes d'Armor Departmental Council was facing a **difficult situation related to several engineering structures** , including bridges, viaducts, and tunnels, located within its territory.

The deterioration of this infrastructure, essential for **the movement of people and goods, could have serious consequences, ranging from simple traffic restrictions to potential accidents.**

Faced with this situation, the Departmental Council has decided to change its method of managing civil engineering structures by adopting a **more heritage-based approach based on the principles of asset management.**

An ambitious project



- To this end, an ambitious project was launched to achieve several important objectives for the management of the 1,005 civil engineering structures in the CD22.
- Develop a **relevant multi-year investment plan to better plan maintenance and renovation work based on priorities** and budgetary constraints.
 - Moving from a short-term to **a long-term vision** to better anticipate maintenance and renovation needs
 - Take into account **the concept of risk to prioritize work on structures** with the greatest impact on users, based on the risks incurred in the event of failure of the structures.
 - Switch to a **maintenance strategy** focused on defective components rather than systematically resorting to comprehensive renovation of structures. This approach helps reduce costs and extend the lifespan of structures.
 - **Empower decision-makers to prioritize** work budgets between building renovation and infrastructure maintenance, using precise and objective data on the condition of structures and the costs associated with maintenance and renovation work.



Key actions

- As part of the project, several key actions were defined to improve **the management of the CD22 engineering structures.**
- **The key stages in the management of civil engineering structures** have been clearly established in order to best structure the framework within which maintenance and renovation processes can take place.
 - **The key processes** that ensure consistent and coherent management of the entire infrastructure portfolio have been defined and documented.
 - **The roles and responsibilities of the stakeholders** involved in bridge management, from local teams to central teams, have been established.
 - **A precise schedule of key milestones** in the management of civil engineering structures has been established and coordinated with the budgetary process. This allows for better anticipation of maintenance and renovation needs and ensures optimal use of available resources.
 - **The scope and expectations of each tool involved in the processes** have been clearly established to optimize their effectiveness and ensure their consistency with the overall objectives of engineering structures management.

The benefits

- Thanks to Oxand's support, the Côtes-d'Armor Departmental Council was able to optimize its **management of engineering structures by adopting predictive management** , which enabled it to:
- **Better structuring of the organization of the management** of the heritage of civil engineering works
 - **Capitalizing on park knowledge** for more precise and proactive management
 - **Reliability and justification of the Multi-Year Investment Plan** thanks to a clear and reliable vision of the state of the structures
- Easier communication and **more informed decision-making for elected officials** .



6.

Feedback from APRR-AREA



The context



Autoroutes Paris-Rhin-Rhône , deuxième groupe autoroutier sur le territoire, a la charge de l'exploitation d'une partie du réseau autoroutier en France. APRR-AREA compte dans son ré - seau plus de **3 000 ponts qui font l'objet d'une surveillance continue** afin de garantir la sé- curité et le confort des usagers.

To improve the network user experience and ensure safety while **optimizing investments in bridge maintenance** , APRR-AREA wanted to define a multi-year investment plan incorporating a preventive dimension into the maintenance strategy, while capitalizing on existing data through a digital repository.

APRR-AREA's needs

The project carried out for APRR-AREA aims to meet several objectives:

- Align technical needs and the company's strategic vision
 - **Improve network usage** by users by reducing the duration and scale of construction projects
- **Promote APRR-AREA data** by centralizing all information in a single digital repository
 - **Optimize the efficiency of maintenance and renovation projects** for civil engineering structures and reduce associated costs

Infrasim Deployment

In 2018, APRR-AREA installed Infrasim, a software application that provides a comprehensive map of the state of the infrastructure by centralizing the numerous scattered data (safety reports, IQOA ratings, etc.). With its integrated database linking the structure to its various components, the Infrasim software is easy to access and use and quickly enabled APRR-AREA to achieve its objectives.

Once the initial condition has been recorded in the software and the mapping established, Infrasim allows APRR-AREA to **simulate the aging of the components of the various bridges** in order to visualize the evolution of the overall condition of the structure and thus recalibrate the risk matrix. APRR-AREA also has a database listing bridge ratings and is updated throughout monitoring operations. Continuously updating this database allows for **the updating of Infrasim's projections. Thus, APRR-AREA checks** several times a year whether its maintenance strategy is optimized using the Infrasim software and, if not, can adapt it to ensure it always invests the right amount, in the right place, at the right time.

Optimized maintenance thanks to a preventive approach

P33

The use of Infrasim provided an additional level of detail in **the bridge criticality analysis** , as it was carried out at the component level. The risk matrix of the bridge components allows for an overall assessment of the bridge's condition. This refinement of the analysis at the component level enabled faster action on bridge maintenance and **the implementation of renovation campaigns by grouping operations on several structure** s.

The implementation of this preventive and predictive approach has enabled APRR-AREA to

- **Request additional budgets** by objectifying needs and proving the economic gain of a preventive strategy compared to curative maintenance
- **Aligner la stratégie de la direction** , les budgets concédés et les besoins techniques réels
- **Reduce the impact client** by grouping projects and anticipating maintenance in order to reduce project duration
- **Visualize the cumulative costs** to identify in advance the most appropriate time to invest in a maintenance operation
- **Implement renovation campaigns** by component, on several structures, in order to maximize construction site efficiency



/ Oxand accompanies you

Our job?

Digitize your engineering data to build an effective and preventive asset management strategy with you.

Our goal?

Making infrastructure more sustainable by using useful data in a smart data approach

Oxand supports local authorities in all stages of a PPI that is quickly usable and dynamic over time.

With Oxand's Infrasim, local authorities can now precisely manage the development of their engineering structures, thanks to decision-making tools:

- **Performance mapping** that allows you to visualize the condition of engineering structures and project them over time to see their aging
- **Simulations of maintenance scenarios** and strategies
- **Dashboards with performance indicators** on the evolution of the asset base and its components

Your profits

- Improving the quality of community service to users
- Budget control
- Aligning the technical vision of operational staff with the strategic vision of management and elected officials

Oxand goes even further



Beyond the current state of your assets, your data allows you to predict changes in the overall condition of your assets, based on your budgetary challenges and constraints.

You know how your structures will evolve and can compare scenarios. You have the keys to successfully implementing your strategy and deciding which maintenance operations and work to prioritize to reduce your maintenance debt as quickly as possible.

Contact us



Take advantage of the PrioReno Bridges diagnostic from Banque des Territoires now

Are you a local authority managing a portfolio of bridges? Do you want to improve and optimize the management of your bridges?

As part of its PrioReno Ponts program, Banque des Territoires, in partnership with Oxand, is offering local authorities a free tool for diagnosing engineering structures.

Thanks to the Mobi Prêt program, Banque des Territoires will assist you, once the free assessment has been completed, in financing your renovation work. You can apply for engineering loans to launch the studies and carry out the work.

What the Banque des Territoires offers you through PrioReno Ponts:

- A free digital tool that allows you to prioritize studies based on risk and to have a comprehensive view of the state of your assets and its evolution if no renovation investments are made.
- Engineering credits to launch these studies, establish work programs, and develop a master plan for the community's engineering works portfolio.
- Financing offered in the form of loans, thanks to the expanded eligibility of the Mobi Prêt (with a total budget of €2 billion and a term of up to 50 years), as well as equity, through investments in project companies with one or more communities.

I request my free diagnosis



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