

OSYRIS- Open System for Road Information Support

1. INTRODUCTION

OSYRIS is a European Union funded project developing an information technological infrastructure for the road construction and maintenance process. It shall enable contractors and road owners to build up new own knowledge bases and quality assurance systems that are capable for building up a knowledge base about the road and at different stages of its production and life cycle.

The main challenge of OSYRIS-project is the state, in which still much time and money are lost all along the various phases of construction, during these phases and in between, due to the lack of information and the very poor quality of the management of this information, making very small use of newly available Information Technology (IT).

This becomes even more important as new contract models, i.e. "Public-Private-Partnership" (PPP) or "Build-Own-Operate-Transfer" (BOOT) and functional contracts put more responsibility on the contractor side.

There exists on the market a range of separate digital systems to support certain phases of the road construction: design, setting-out, levelling, compaction and assessment. However, the results of any of the construction phases cannot be used as an input for the next one given the non-compatibility of the different systems. Moreover, the mentioned systems are generally not component-oriented and not configurable (except for the levelling sensors). More and more, the construction machines are equipped with sophisticated sensors and digital networks, but the digital data are lost after the work due to lack of mobile services and database infrastructure.

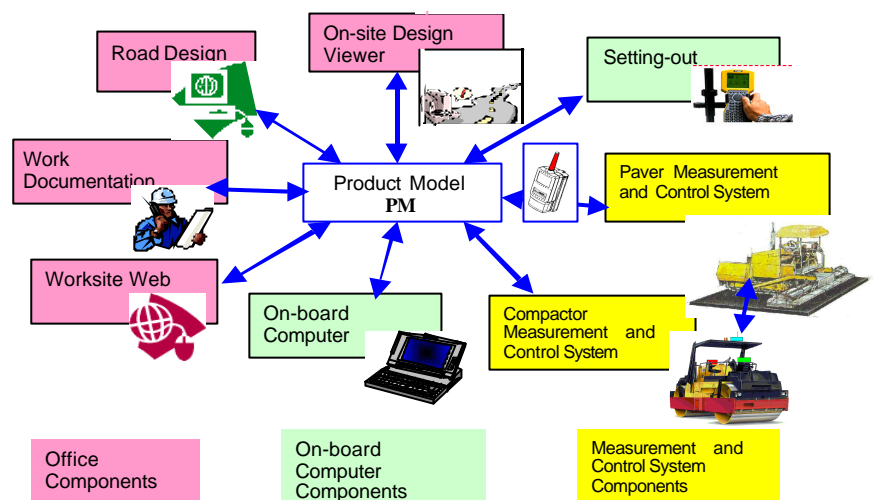


Figure 1. OSYRIS components.

The OSYRIS project aims at filling these missing links and providing a common infrastructure with open interfaces, of which the specialised components may take the advantage.

The OSYRIS project was started in February 2000 and will last until the beginning of 2003. Partners of the Consortium are: University of Karlsruhe (IMB) - Germany, LCPC – France, Moba – Germany, Tekla Corp. – Finland, Skanska – Sweden, funded under the European Union Program "Growth" (Contract No: GIRD-CT1999-00080).

Main features

The OSYRIS system philosophy lies in openness and modularity, being built by compliant components.

OSYRIS data storage and management is based upon a product model of the road, especially designed in order to be compatible with the latest road management databases, object oriented, and geographically located in 3D. This way, the documentation files coming from the work sites using OSYRIS, would be immediately used by the new road data management systems under development at the national road authorities.

The benefits of the use of OSYRIS system will be double: on the short term and on the long term.

On the short term, direct savings for contractors will mainly come from the use of smart control and documentation systems running permanently on the various pieces of equipment (pavers, rollers, etc.). The system can significantly reduce the number of traditional punctual tests and provide the contractor with a digital, continuous quality management system. Both road-owners and contractors will also save significant time and reduce the risks of error when using OSYRIS files for their daily exchanges.

On the long term, road owners will make benefit from using the information provided by the OSYRIS documentation by saving additional surveys, always costly and dangerous, and keeping relevant information for the next phases of road life cycle, as maintenance or rehabilitation works.

2. BACKBONE OF THE SYSTEM

OSYRIS system is built on three main component levels: office, on-board computer and measurement system. The components are assigned to one of the levels, only the framework components, i.e. Product Model and Mobile Services reside on all levels, linking them together (Fig. 1), hence building the backbone of OSYRIS. The OSYRIS framework alone does not provide any end-user functions. The functionality of the system results from the functions provided by the components. In the run of the project the components mentioned on the Fig. 1 and described below will be developed. Well documented interfaces to OSYRIS Product Model and the Mobile Services open the possibility to plug in other components.

OSYRIS Product Model

OSYRIS Product Model is a part of OSYRIS system that covers the whole framework. It offers the basic management of the information through several interfaces (services) and some analysis tools for further data manipulation and utilization.

Technically, the Product Model serves as a data storage for the OSYRIS information model, and secondly it provides the information inside product model to the users through several interfaces. Data structure design follows the well proven patterns of relational model. Because of the aiming to openness and scalability, full normalization of data is not always fulfilled. When this is allowed, the Product Model is able to support free object and property management.

Product model provides different levels of interfaces for several needs. Lowest level is programming interfaces for system's module development purposes. Well defined internal modularity and encapsulation of separate parts of the product model offers easier maintenance of the system and results in better defined functionality.

The second level of interfaces is for application development purposes. These public C/C++ interfaces offer the product model business functionality and data manipulation functionality for extended business applications and user interface development. Public programming interfaces make the product model available also for third party vendors, who may be interested to develop some functionality on top of the OSYRIS-system.

Third level of interfaces is file import/export level that provides information exchange between different systems using same data transfer formats like XML or VRML in visualization.

Mobile Services

Mobile Services stand for the physical communication means and protocols between the system components. The OSYRIS Mobile Services are used for the following tasks:

- on-line communication between the machines, so as to exchange relevant process information,
- communication between the machine and the office: exchange of specification and result information, real-time monitoring of the worksite (few times a day),
- communication between the worksite office and the headquarters: Web access, off-line monitoring of work progress (each few days)
- administrative tasks: Remote configuration and troubleshooting of the OSYRIS System

The Mobile Services are independent of communication technology. In the simplest form the services are based on disk exchange.

They are available on three levels:

- low level, messaging interface based on direct TCP/IP using Sockets API, based on UDP datagrams is used for online exchange of process information between the machines
- high level, file-oriented interface based on exchange of XML files is used to exchange bulky geometry and achieved work data
- remote file system access, configuration etc. - at an OS level via network removable drive

On the low level there is a continuous data transfer to guaranty the nearly real time communication. Moreover, the services are supporting also the request-response schema. Any information can be asked by any component from any other component at any time.

Interfaces

Following the open philosophy of the OSYRIS system, the component interfaces will be public and accessible to any party interesting in connecting to the framework on any of the three levels.

There are two levels of interfaces. The first one specifies exchange between the components. Any third party component, like for example an asphalt plant acquisition module can take the advantage of it and deliver data to the common data storage.

The second level is internal to a single component and allows to extend its functionality by supplying for example an additional algorithm.

It is foreseen to built the interfaces for the specialised road owner databases when such formats will be specified.

3. COMPONENTS

A set of components is developed during the OSYRIS-project, providing:

- Possibility to generate the information for computer aided planning and execution of the construction process.
- Improve the road construction process taking benefit of the new kind of information that can be provided thanks to the advanced link between planning software and on-machine computers.
- Generating the information about the execution of the construction of the road.
- Access from different places.
- Access of data at different levels of abstraction according to user profiles and requirements.

In order to provide the mentioned, following components are developed:

On Machine Sensors and Control Systems

Architecture

OSYRIS project is also intended to develop and demonstrate new types of on-machine, real-time measurement systems, providing key information for an efficient control of the machines and rich documentation system.

The design of Measurement and Control Systems must be based on modern communication network. The Controller Area Network CAN exhibits a highly reliable and predictable behaviour, as it is required by embedded real-time control applications.

A further approach for the on-machine communication structure is to use standardised protocols, which gives the different electronic modules the opportunity to communicate on the same rules.

Therefore the measurement systems are based on CANopen network protocol standard. CANopen ensures easy expanding of the on-machine network and provides possibility to merge a wide range of sensors from many manufacturers, as well as data coming from the machine.

Paver Measurement and Control System (PMCS)

The PMCS is based on the standard levelling control for the screed. Furthermore it allows to plug in the following newly developed sensors and systems or a subset of them:

- Thickness measurement and control
- Width measurement
- Evenness measurement and control
- Material Core Temperature measurement
- Volume measurement
- Wind speed and temperature measurement

Compactor Measurement and Control System (CMCS)

The compaction measurement system is placed on a roller and is assessing on-line the compaction grade of the material. This is carried out by evaluating the following interdependencies:

- Rolling Resistance of the roller through the asphalt.
- Accelerative reaction of the roller on the surface when compacting in vibratory mode.
- Thickness difference measurement before and after the roller.
- Estimation of the core temperature.

Furthermore the following parameters, measured on the paver are used for the determination of the compaction achieved by the roller:

- Layer thickness.
- Wind Speed and temperature.
- Material core temperature during paving.

ON-BOARD Computer

The on-board computer is the joint between the low machine/sensor level and the office level. The main functions are:

- collect and save the measurement system data,
- display the information in a user-friendly, real-world related way,
- control the machine tool in the auto mode,
- prepare the achieved data for the office components,

- communicate with other parts of the working system,
- self configuration.

OFFICE

Road Design application / Onsite Design Viewer

OSYRIS Road Design is not actually in the project specified application, but it is an example of an approach and interfacing schema to connect and improve a road design system to the OSYRIS framework. The light version of it provides the functionality required on the worksite, it can be used without any separate database management system, which makes it advantageous in the worksites, where no full-scale road design system is available.

Work Documentation

OSYRIS Work Documentation is an application to provide the worksite and achieved work information during the construction work and offer different quality information for quality assurance purposes.

Work Documentation includes functions for displaying the information in the OSYRIS Product Model in on-screen or paper reports. Information can be used to make pre- or user-defined analyses for reporting the work achievements and quality. It can be also used as work control and follow-up tool.

Worksite Web

OSYRIS Worksite Web is a server-client based framework to deliver the information gathered in the OSYRIS Product Model. Especially Worksite Web application is planned to provide the work documentation data for the different users. This data can be presented as vector data with its properties, raster maps or as links to the written laboratory or work reports.

4. PROJECT STATE AND PLANNING.

Actual Status

At the half of the project, in August 2001 all paver on-board components were ready and tested on a test track. Concerning paving support, office software still requires the implementation of the information about the built-in material.

The system for the paver was tested and then demonstrated to various users (Machine Manufacturers, Contractors and Road Authorities, Positioning Systems Manufacturers) in the beginning of September 2001 in the following configuration:

- Office computer the Road Design and Onsite Design Viewer with environmental data, attribute modelling and road structural modelling, Work Documentation capable of displaying the achieved work and a fleet configuration, and basic Worksite Web infrastructure to presenting work documentation data in WWW.
- On Board Computer with Operator Guidance and Information and Storing Capabilities.
- Paver Measurement and Control System connected with all sensors developed newly (thickness, width and volume, evenness, wind speed and temperature).
- All components described were interacting using the information technological infrastructure built up by Product Model and Mobile Services.

Future plans

The Consortium will go on with developing further components and functionalities during the first half of 2002. Afterwards, the whole system will be tested on a work site. Steps to industrialise and to open the market for these new developments are being taken in parallel.

Further developments

Three kinds of further development still need to be carried out until June 2002:

- Compactor Measurement System and On-Board Computer being capable of the above described.
- Setting out aid for connecting the surveying to the OSYRIS IT-infrastructure.
- Releasing a second version of the OSYRIS Office applications capable of fulfilling all requirements.

Worksite validation and pre-industrialisation

During 2002, the final year of the project, the further developed components will be tested on construction sites. An intensive work-site validation will be carried out during this time. Results of the worksite trials will be used for turning the prototypes into validated products.

This phase will be accompanied by worksite demonstrations to promote OSYRIS framework and to advertise the components among various user groups, participating in the OSYRIS end Users Club.