

# **NEW DEVELOPMENTS FOR THE SYSTEMIC MANAGEMENT OF A MAJOR ENGINEERING & CONSTRUCTION PROJECT**

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## **Abstract**

The paper refers to a real case of a major infrastructural project in Europe. The author has led a team of consultants and University lecturers with high qualifications in Total Cost Management, Project Management, Information Technology and Quantitative Methods, in order to cooperate with the General Contractor to draw the project execution plan, complete with procedures for project management, project control, information system, etc.

A complex project can be managed according to the general theory of systems, provided that this philosophy be used starting from preliminary design up to completion of the project. From the above, has been proposed a completely new network data operation system, based on a full integration of all data relevant to the project itself, to be used by all parties involved. The basic idea was that, although each party can use different algorithms or criteria, the data to be used are the same and can be shared.

The network data operation allows for a cost reduction, for instance by reducing transportation and storage costs by means of a proper “object in time” procedure, optimizing the flow of object data set from design and planning to procurement and then to construction.

The same network data operation could be used for managing the project during the whole of its life cycle, extending the systemic management into the operation and maintenance, until the end of the life cycle itself.

## **General**

It is generally known that an engineering & construction project (hereinafter called only “project”) can be considered as a system, and then can be managed according to the general system theory and to its particular applications.

This is to say that the project as a whole can be managed in an holistic way, without losing consideration for its component parts at different levels, according to the project structure.

The focus of this management procedure is to create a data base as well as procedures that are shared between all the parties active in the project or, more generally, between all the stake-holders, anyone of them having its access protocols, authorized operation and so on, so that all application can be based on the same data.

This is to say that all data shall be shared and accepted by all parties, while each party will remain free to use such data with particular applications and algorithms.

This paper is based on a open-source project called “**Formula St@mnos - open source**”<sup>1</sup>. This project, in general, is referred to the management of production processes in limited territorial areas, but can be also referred to infrastructural projects and, by analogy, to any engineering and construction project.

The project is considered in the whole of its life cycle: design, engineering, construction, operation. The word **St@mnos** ® comes from the greek **σταμνος** whose original meaning is phial, small container. As a matter of fact, the management system is based on one or more data bases that will create a “shared data container”. Through proper software integration, each party shall continue using its operating system and its applications without even noticing the difference, while the data container will stay in background replacing or supporting the data base of each application or directly supplying data to the application itself.

This is to say that we create a “network-centric” data operation system that allows all parties to use shared data as well as to perform simulation and what-if scenarios based on the same data and on several assumption that by this way are checked before action, mainly in the case that corrective action are to be taken.

The **network data operation** system shall include:

- **baseline**, or original set of data as well as a series of historical data set regularly updated;
- **planned and actual data**, where data are updated in real time;
- **official data set**, to be used for legal purposes (book keeping, fiscal statements, etc.);
- **free data set** to be used for trying and simulating scenarios.

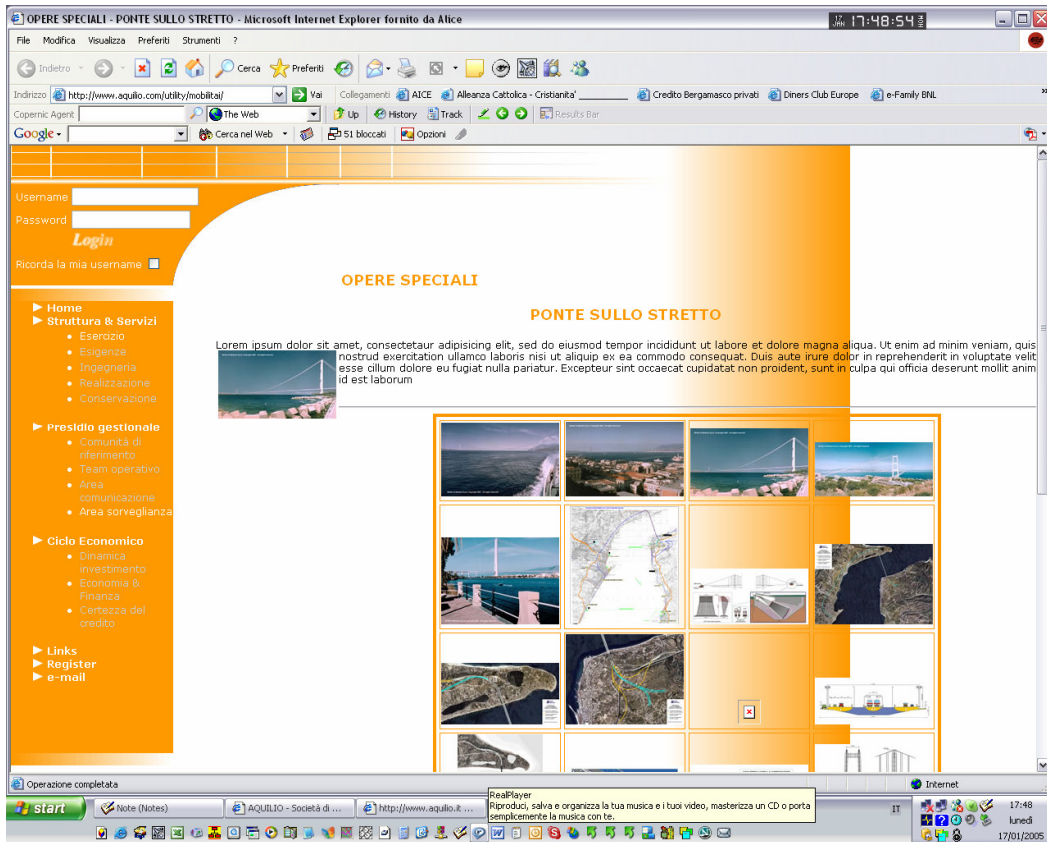
The network data operation we are to describe is referred to a major infrastructural project and it is focusing mainly on engineering and construction, without giving too much relevance to operation. This is why the system described herein has been studied, at the beginning, before becoming an open-source project, under request of a general contracting company. However, the management system under “Formula St@mnos” should more properly be referred to the owner itself.

Notwithstanding the fact that all data are to be shared between parties, it should be decided case by case whether data can move through various applications directly, in real time or it will be preferred a controlled data export procedure to allow safety controls as well as human intervention on data.

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<sup>1</sup> More information and details can be founds at <http://www.stamnos.com>. Unfortunately all material, for the time being, is written in Italian language.

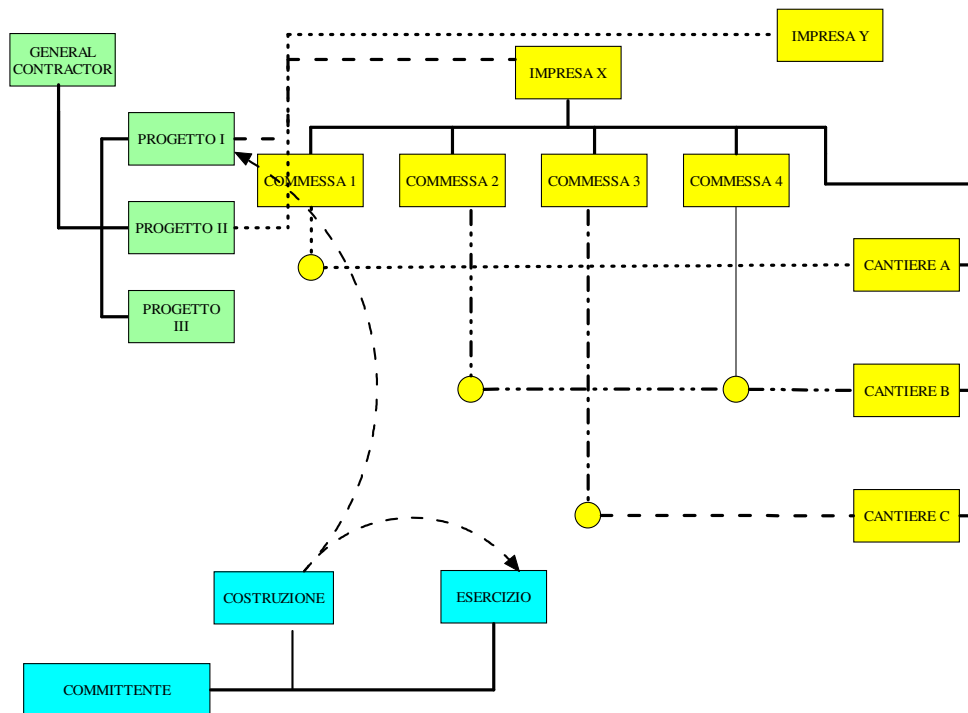
## Network data operation: the structure.



- **Public information:** this section is used to issue the information that are to be available for everybody, through the project website. For safety reasons, it could be advisable to keep this section divided from the network data operation.
- **Management network:**
  - **Community:** this section shall be used for all documentation needed for stakeholders, it will be basically a quasi-static section containing documents, reports, etc. with a proper indexing system.
  - **Competence centre:** the competence centre shall be a kind of scientific committee to assist the management. It shall be composed by experts in project management, total cost management, management science, information technology, software integration etc. together with representatives of the owner as well as of the main stake-holders
  - **Organisation:** procedures, organisation charts, flow diagrams, address book and contact procedures, project documents.<sup>2</sup> This section can be organised by activity

<sup>2</sup> To have this section actually working there is a must: all information generated during the engineering and construction have to be clearly indexed and referred to the project breakdown structure

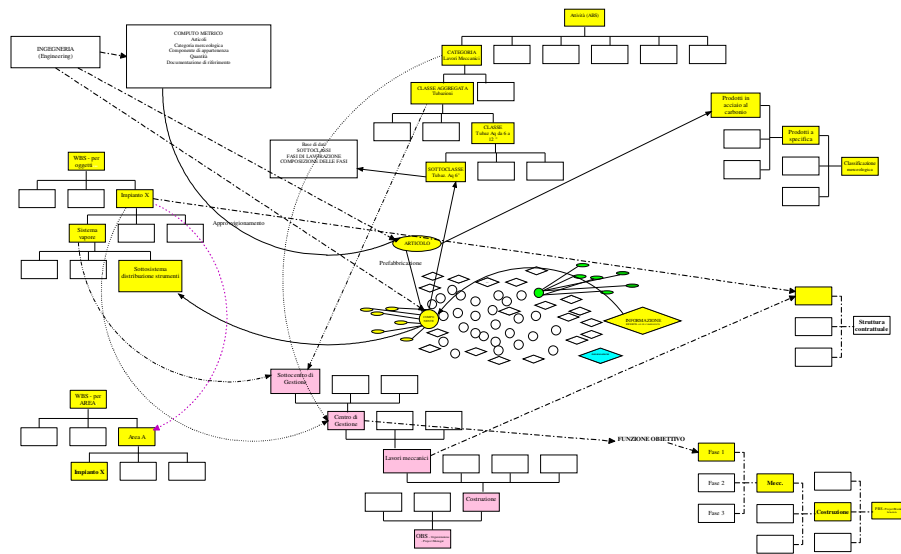
(design, engineering, procurement, construction, commissioning, operation) or by area.



- **Contract management**<sup>3</sup>: contract breakdown structure (CBS), contracts and contractual documents, contract organisation, contract book keeping (properly related to progress monitoring data, in real time or through data export procedure)
- **Quality**
- **Communications**
- **Telemetry, measurements**
- **Structure**
  - **Design** - Basic design and feasibility study
  - **System or Project Breakdown Structure**: Work Breakdown Structure (WBS), Organisation Breakdown Structure (OBS), Activity Breakdown Structure (ABS), Cost Breakdown Structure (CBS), Resource Breakdowns Structure (RBS), Risk Breakdown Structure, etc; Work Packages and Management Centres

<sup>3</sup> The project under “Formula St@mnos – open source” allows for a proper section to study innovation in contracting and contract management.

# Schema di applicazione ad un grande progetto



## ○ Engineering

- Engineering documents, drawings (DWG files), technical specifications; drawings approved for construction, as-built drawings.
- Detail and shop drawings, sketches, etc.
- Specifications
- Applicable regulations, standard, good practices.
- Bill of quantities
- Construction budget
- Site engineering

## ○ Procurement

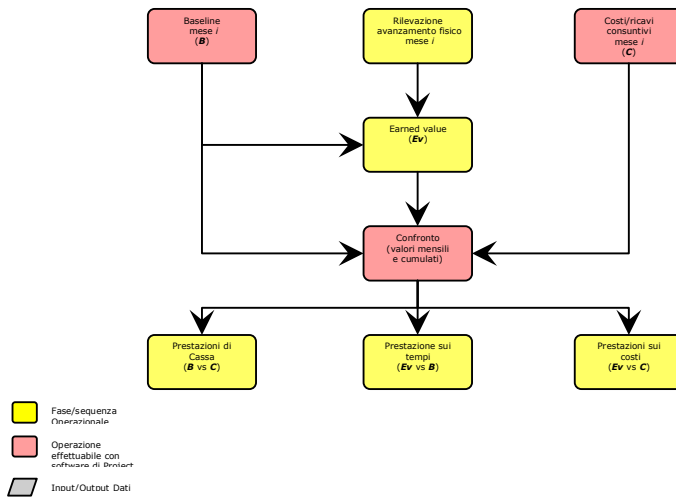
- Purchase requisition, classified by WBS and by purchasing market.
- Cost control, by comparing budget and actual costs; procedure to authorize purchasing extra-budget or emergency purchasing.
- Tenders, negotiation with suppliers
- Purchasing orders
- Expediting

- Transport (with telemetric GPRS control)
- Site warehousing
- **Construction:** all information are subject to be available trough proper aggregation procedures according to project phase, WBS, ABS, OBS and so on.
  - Item data base (from bill of quantities, through export procedure)
  - Activity data base (working class, subclass, phases)
  - Management centres and subcentres
  - Construction programme

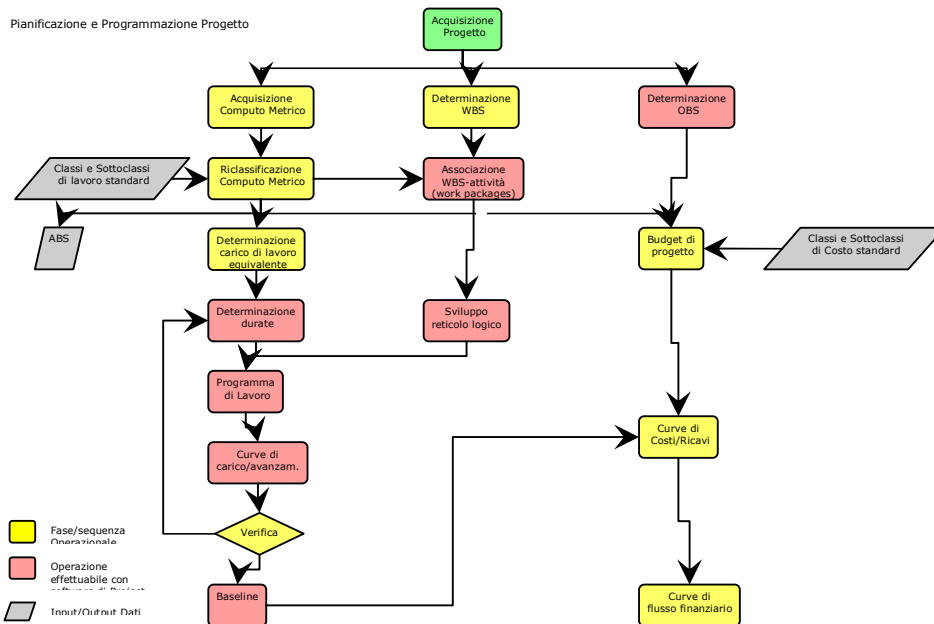
Attività	Mese 1	Mese 2	Mese 3	Mese 4	Mese 5	Mese 6	Mese 7	Mese 8	Mese 9
Alfa	10	20	30	20	10				
Beta	10	10	20	30					
Gamma			5	20	20	10	3		
Delta					3	5	2		
Delta					3	4	5	5	
Personale PROGRAMMATO									
Mese SMh	10	25	50	43	28	9	5	5	
Cumulativo SMH	10	35	85	128	156	165	170	175	
ESEGUITO									
Mese SMh	10	10	20	50					
Cumulativo SMH	10	20	40	90					

- Progress
- Workload and resource management

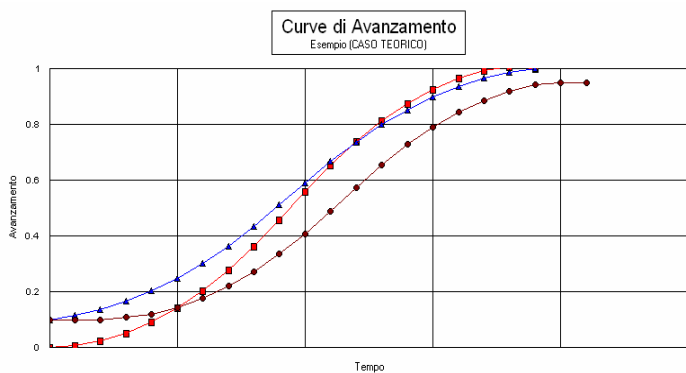
Controllo di progetto integrato (tempi/costi)



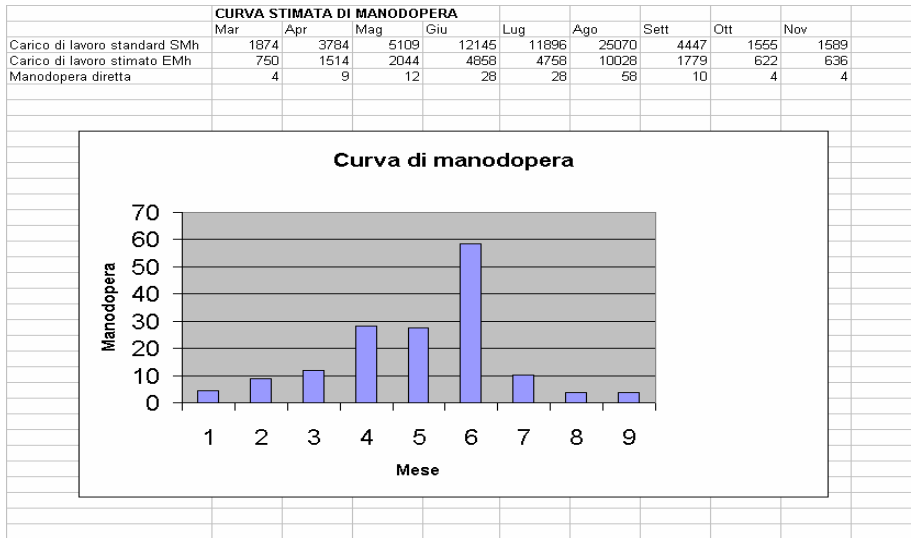
- **Cost analysis**



- **Earned value - cost control**
- **Reporting:** information can be obtained through export procedures, however human synthesis is required
  - According to WBS
  - According to ABS
  - According to PBS / OBS
  - By contract

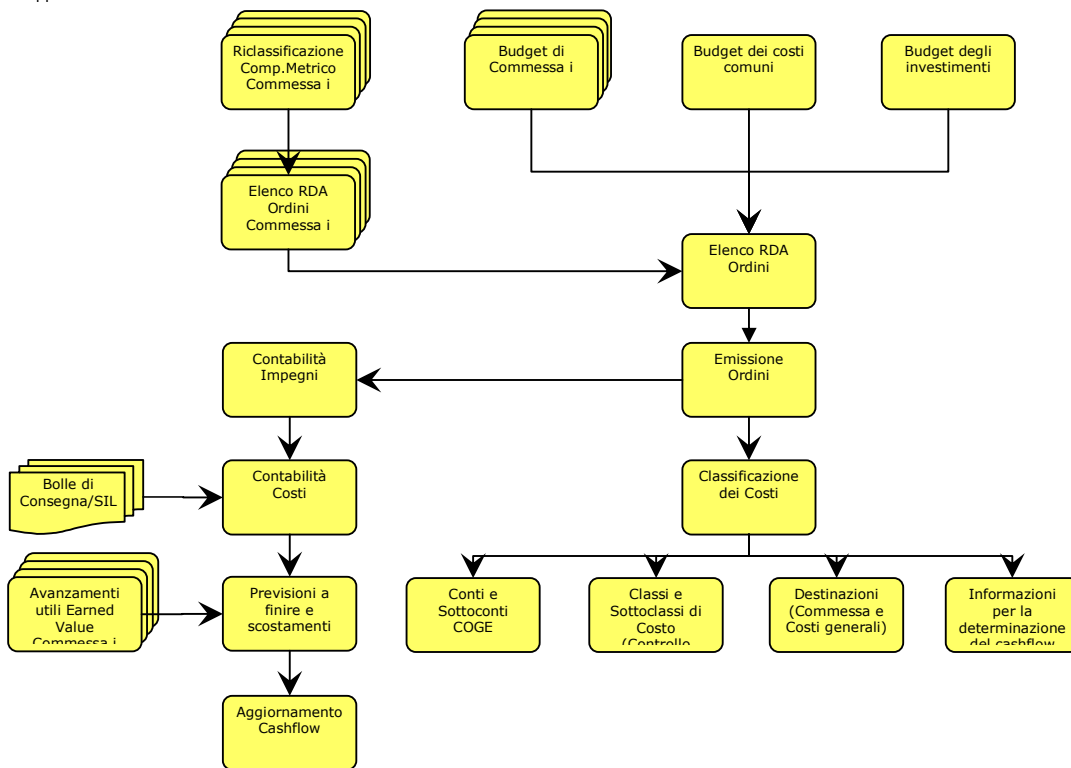


- **Manpower, actual manhours**



- Feasibility control
- Project control

Sviluppo dei costi



- Precommissioning - Commissioning
- Operation and maintenance
- Project Economics



- Investment
- Accounting and bookkeeping
- Contingencies
- **Project Finance**

### **Conflicting integration requirements**

To be noted that integration requirements of the various stake-holders can be conflicting between each-other, in the past this was a paramount difficulty, to be solved only by keeping separate and incongruent set of data, sometimes difficult or even impossible to compare. Now it is possible to study an integrated data system able to cope with all requirement.

In detail:

- From the **project manager point of view**, data relevant to the project and generated by various parties are to be integrated in the way they can be compared and used within the project and for project purposes, from several stake-holders. However from owner's point of view there could be the additional requirement to compare data from different projects belonging to him (in this case, in general, less detail is needed).
- From the **general contractor point of view** the main need is integration between several projects, belonging to different owners, so that data can be used for standard and estimating,
- the same could apply to other engineering or construction contractors;
- From **investor or banker's point of view**, the main need is to compare the investment under monitoring with other, different kind of investment and to keep the cash flow under control to make sure the return on the investment itself.

### **Conclusions**

The progress in data and information technology allows us to keep and manage data in a quantity that was unthinkable even ten or twenty years ago, it is possible to keep data and to work with them, to perform simulation and scenario analysis, to make in few milliseconds calculations that would take hours or even months.

The project under consideration aims at promoting the idea of sharing and integrating data as an instrument of a better management and then of more effective and efficient action. The emphasis that we have put up to now only on cost reduction has to be shifted on total cost management, and this can be obtained only through a systemic management using the opportunities given by technologies.