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Design and Implementation of GIS prototype for the fulfillment of a highway's works

Conception et développement d'un prototype SIG pour la gestion du suivi d'exécution des travaux d'une autoroute

OUTLINE

- Introduction
- Problematic and Objectives
- Adopted Methodology
- Database design
- Components of the GIS prototype
- Application
- Conclusion

INTRODUCTION

- Urban and rural context
  - Roads play a strategic role in the socio economic development of a country,
  - very useful in transporting travelers and merchandises as well
- Advantages
  - - Ensures the economic exchanges between regions
  - - Ensures the economic exchanges between urban and rural centers
  - - reduces the transportation costs
  - - facilitates accessibility in the urban and rural centers.

INTRODUCTION

- The study of any project of a highway passes through 3 Phases:
  - The study of definition
  - The study of preliminary draft
  - The study of the execution project
- After its construction and its putting into operation an attention have to be allocated to the highway's production run
  - feasibility of the highway
  - Caused expenditure…

Problematic and Objectives

- Moroccan highway inheritance counts thousands of structures (bridges, aqueducts,…etc.).

- These structures change in the course of time and in space.
- information concerning the daily follow-up of the structures carried out are :
  - graphic and alphanumeric documents for its follow-ups

Data problems:

- Difficult collection: multiple sources: divergence of data, Topicality and precision
- are managed in a heterogeneous way with the tools that do no longer respond to user's needs

Problematic and Objectives

Consequently

- the decision-making concerning an operation of positioning raises enormous difficulties of management and very long time of research.
- adding problems of data collection after construction of a highway.

Therefore, the development of a GIS then becomes a necessity.

- Within this framework, and with the assistance of the Division of the By-pass Highway of Casablanca that we propose to
- **Design and implement a GIS prototype for the fulfillment of a highway's works**

and

- **prepare a management system of the highway's inheritance**

METHODOLOGY

- Classification and design of a data base for a highway's works.
- Exploitation of this data base by the Geodatabase object model of ARCINFO 8.1, in order to develop a GIS solution for a highway's works accomplishment
- Implementing a GIS prototype for the follow-up of a highway's works

GIS

For the decision makers:

- spatial data distributed and well structured in order to be able to extract some syntheses useful for the decision.

For the users:

- Data base management system for collection, storage, extraction, data query, analysis, presentation and drawing.

GIS Applications

GIS Applications in highway works

- Determination of highway corridors.
- Management of the highway inheritance.
- Management of works and structures
- Achievements of simulations
- Impact studies...

Objectives of the projected GIS

- set up a single reference frame concerning the geographical information of a highway
- provide a geographical support common to each entity of a highway
- provide visual aids on the highway's inheritance
- provide an access to the data of the common GIS

Objectives of highway data base

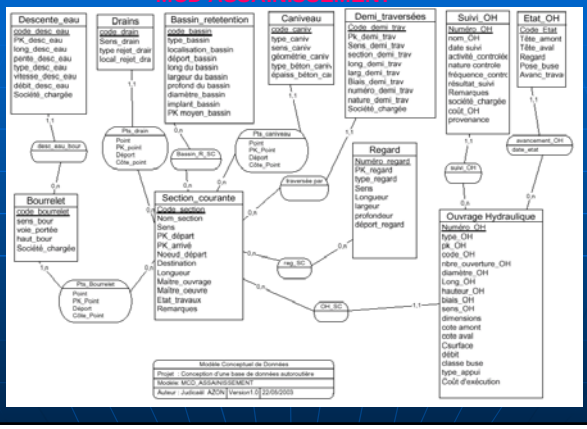
- facilitate the access and the use,
- facilitate the update
- ensure a single occurrence of information
- propose coherent data
- allow a safe data use

Structure DB

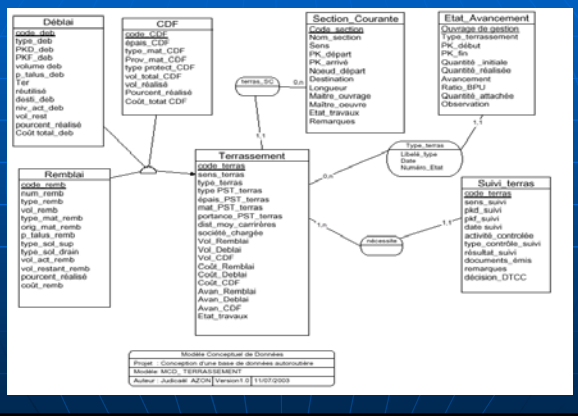
Entities are classified by themes

- Road
- Cleansing,
- Earthworks,
- Structures,
- Roadway,
- general Work and inheritance.

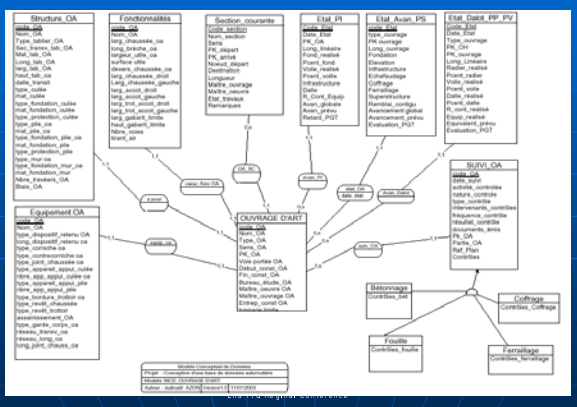
MCD ASSAINISSEMENT



MCD TERRASSEMENTS



MCD OUVRAGES D'ART



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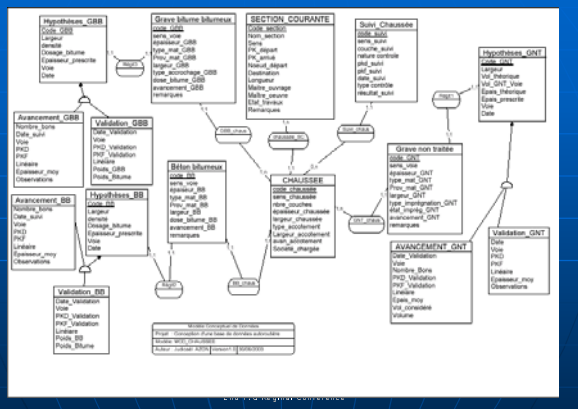
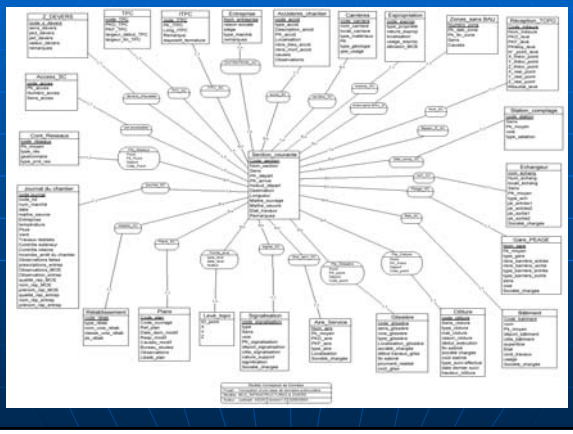
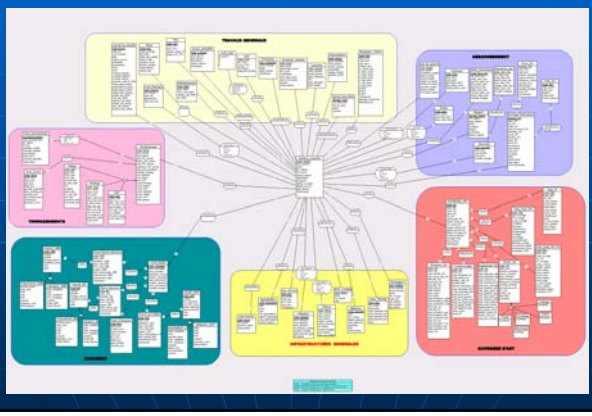


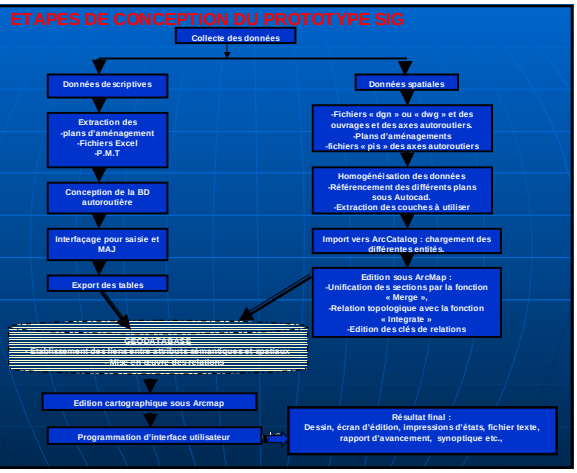
MCD TRAVAUX GENERAUX ET PATRIMOINE



MCD GLOBAL DE LA BD



ETAPES DE CONCEPTION DU PROTOTYPE SIG



COMPONENTS OF HIGHWAY GIS PROTOTYPE

For an effective exploitation of GIS prototype, we propose it's use via several components:

- A basic menu composed of several modules which allow:
  - the management and the follow-up of execution of the highway's works,
  - consultation, edition and the updating of the GIS data
  - various analyses and treatments such as the superposition of the tables of events, the automatic placement of structures
  - generation of graphs and reports of events

COMPONENTS OF HIGHWAY GIS PROTOTYPE

- A "highway Editor", it is a graphic interface of edition and configuration of a highway project
- An interface "digitalization of events"
- An interface "standard Tools of the GIS" which constitutes a personalized toolbox

Module PROJECT

- Configured section
- configure a new section
- Interventions works
- Expropriations
- Journal of site (fig)
- save project

Fenêtre de journal de chantier

Module ROAD

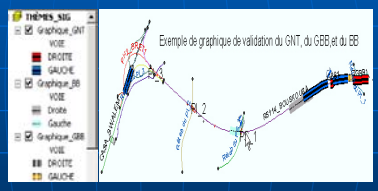
Allows the management and the follow-up of work of the roadway such as:

- General information: type of roadway of each section and its features; or configure a new roadway
- Follow-up of execution: follow-up of the quantities of the layers of the roadway (GNT, GBB), and the follow-up of works of roadway (topographic, quantities... etc).
- Progress report:
- validation of the layers of roadway (GNT, GBB, BB).
- consult the existing reports or add other validations, in this last case the addition is dynamically reflected on the graphic

Module ROAD

- Graphic advance:
  - establish the synoptic of advance concerning the three layers (GNT, GBB, BB) of roadway. A dynamic theme is created and added to the view (fig)
- positioning specific constraints and networks: natural and artificial obstacles (line telephone, electrical, railways)

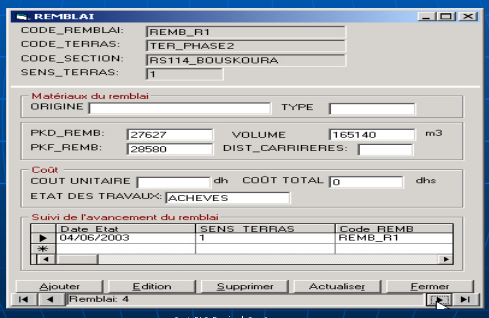
Exemple de synoptique graphique : GNT, GBB, BB



Module EARTHWORK

- Informs about the inherent operations with the management of the highway earthworks.
- consult all information on volumes and costs of clearing and embankment material (fig)
- clearing and embankment design features: PK Departure, PK arrival, date and state of works, direction, code; volume

Suivi et consultation des remblais



Module EARTHWORK

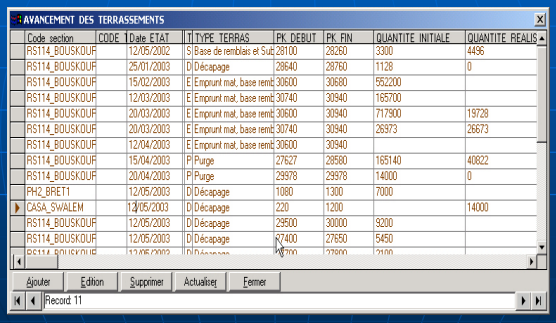
Progress report: (fig)

- gives the progress reports of the embankments, clearing, as scouring (decapage), the purging and substitution, the contiguous embankments.
- consult, collect and update the data on the earthworks.

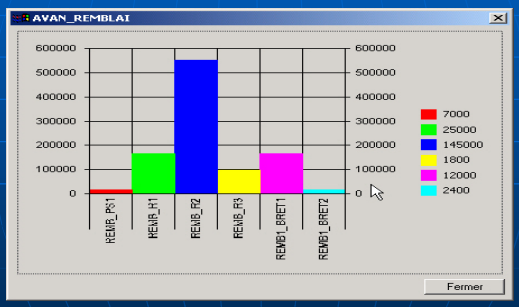
Graph of advance: (fig)

- can be modeled and posted automatically in the form of charts.

Etat d'avancement des terrassements



Exemple de graphe d'avancement



Module DATA BASE

facilitates the interactive management of the spatial data base

offers the possibilities of:

- Consultation of the GIS data
- Edition of:Structures, constraints and road, work of earthwork and cleansing, general work and inheritance
- update and modification of the entities of a theme
- add, remove or refresh the fields of a theme
- consult and update rules of validation defined on entities and on attributes, the rules of connectivity
- Add data tables (Excel, DBASE, oracle) to the project

Module TREATMENT

The most powerful module of this prototype GIS, treats

- spatial queries
- dynamic placement of events
- presents the results of the treatments.

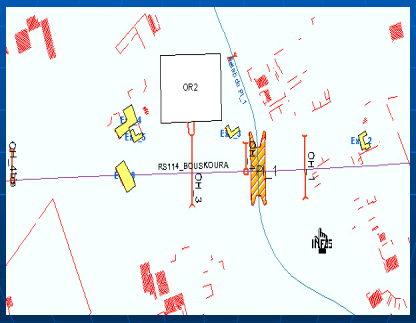
Module TREATMENT

spatial queries

- - based on the spatial relations (intersection, union, inclusion in…) of the entities
- - expropriation : determine the properties to be expropriated within a highway corridor. the figure shows an example

Creation of the progress reports: personalized reports, which can contain all information derived from the descriptive data tables of the entities.

Highway corridor



Module TREATMENT

Dynamic placement of punctual or linear objects per PK.
Creation of dynamic graphic themes from text files

- creates a graphic theme for any information referred by Cartesian coordinates (x, y), stored in the data base (table or text file) the theme will be added automatically to the view

Adding CAD plans in 2 ways

- As a drawing: viewed such as conceived in the CAD software, preserving its characteristics: no analysis possible
- As a layer: plan converted with GIS format, used as a theme and possibility of analysis

Posting graphic symbols of the PK and PC
Analysis of events

- punctual-linear analysis,
- linear-linear analysis.

Exemple de représentation graphique d'événements ponctuels représentant les accidents

Exemple de représentation graphique d'événements linéaires

Qualité de la chaussée sur différentes sections

Functions of the "highway Editor"

- Placement of the PK in length: automatically on a portion of the selected road, starting from the PK D of the road. (the Pk No origin , the scale factor)
- Initialization of the Pk No: allows the user to specify, for a new configured road, starting Pk No, the Pk No arrival, the other Pk will be automatically interpolated
- Interpolations of the zones without Pk No: starting from the sections where PK are defined, PKs can be calculated for all the zones without PK No
- remove all the PK of the activated road.
- reverse the order of the PK : allows to change the order of the PKs and to traverse the road in the increasing direction of the PK or in the contrary direction.
- change the origin of the PK

Application

Phase II of the highway of the by-pass Casablanca

- length approximately 6 km
- Connects the exchanger of the RS114 at the origin of the highway CASA-El Jadida.
- Composed of
  - A section of highway (4.5km approximately)
  - 4 ways of re-establishment
  - A junction.(bifurcation)

Application to phase II of the highway of Casablanca

Projet de la phase II

liste des sections configurées avec caractéristiques sémantiques

CODE_SECTION	NOM_SECTION	TYPE_SECTION	PK_ DEPART	PK_ ARRIVE	LONGUEUR
CASA_SWALEM	Autoroute_Casa_Had_ Soualem	Autoroute	0	1+200	1200
PH2_BRET1	Bretelle1	Bretelle	0	1+303.492	1303.492 m
PH2_BRET2	Bretelle2	Bretelle	0	0+773.323	773.323
PH2_PI1	Voie de rétablissement du PI1	Rétablissement	0	0+381.044	381.044
PH2_PI2	Voie de rétablissement du PI2	Rétablissement	0	0+980.291	980.291
PH2_PI3	Voie de rétablissement du PI3	Rétablissement	0	1+327.91	1327.91
PH2_PS1	Voie de rétablissement du PS1	Rétablissement	0	0+811.207	811.207
PH2_PV1	Voie de rétablissement du PV1	Rétablissement	0	0+213.211	213.211
RS114_BOUSKOURA	Phase II	Autoroute	27+394.682	31+600	4205.682

Extrait de la table de configuration des ouvrages d'art

CODE_OA	CODE_SECTION	TYPE_OA	PK_OA	BIAIS_OA (gr)
OH_3	RS114_BOUSKOURA	Ouvrage hydraulique	27+700	100
OH_7	RS114_BOUSKOURA	Ouvrage hydraulique	30+650	98.78
PI_1	RS114_BOUSKOURA	Passage inférieur	27+627	78
PI_2	RS114_BOUSKOURA	Passage inférieur	30+971.2	128.36
PI_3	PH2_BRET1	Passage inférieur	0+165.95	100
PS_1	RS114_BOUSKOURA	Passage supérieur	29+978.7	79
PS_2	PH2_BRET1	Passage supérieur	0+591.5	98
PS_3	PH2_BRET1	Passage supérieur	0+764.17	70
PS_4	CASA_SWALEM	Passage supérieur	0+33.626	100
PV_1	CASA_SWALEM	Passage véhicule	0+300	70

CONCLUSION

- Prototype remains open to the development of other applications
- Constitutes a first solution GIS for the phase exploitation of road and highway work.
- Tested successfully for the follow-up of a section of highway in the area of Casablanca.
- Constitutes a reliable base that allows indicators of the follow-up and measurement of the performances

Thank you for your Attention