

Development of Simulation and 4D Visualisation model for Earthwork Operations in Road Projects

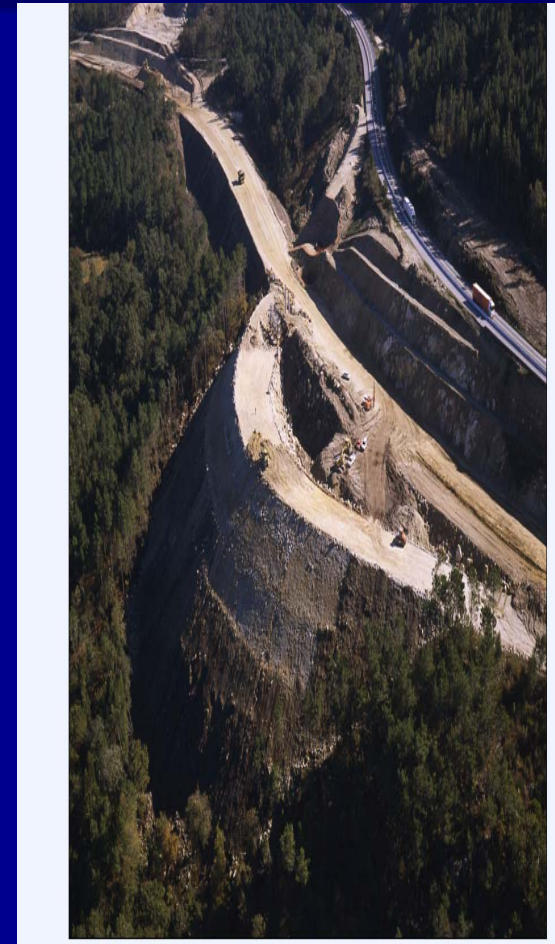


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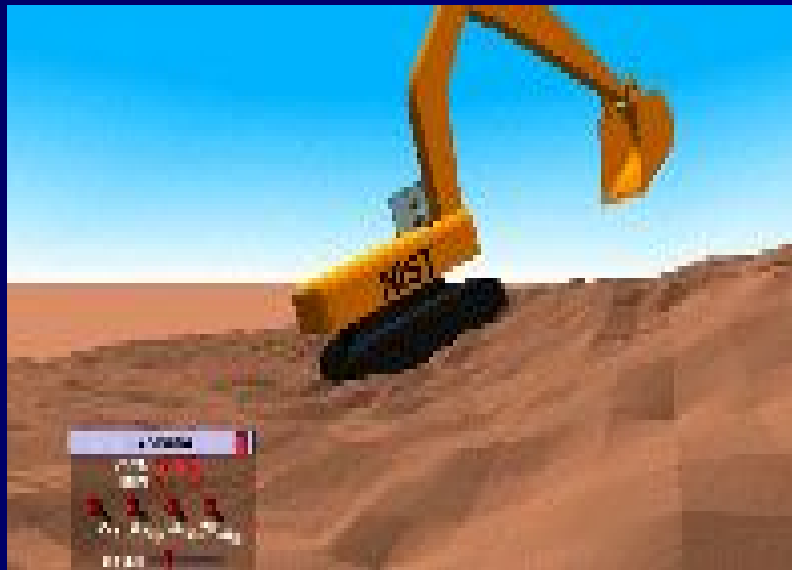
Introduction

- The Research Project Joint collaboration with CCIR, UT and MOTA-ENGIL, Portugal.
- The research project consist of mainly two parts:
 - RoadSim (Simulator)
 - 4D Visualisation model
- RoadSim is a site knowledge base construction planning, scheduling and simulation system.
- 4D Visualisation model that focus on the simulation and visualisation of earthwork construction process in road projects is the key part of the research.



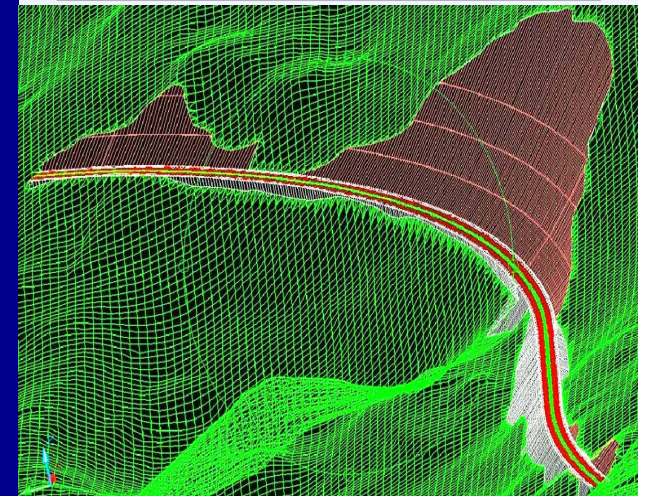
Research Aim

- Is to develop a methodology for a generative 4D Visualisation model of earthwork operations that will enable to identify, collect, analyse, develop measure and communicate site data in a lean and effective manner.



Research Objectives

- To encapsulate site operation knowledge & state-of-art techniques used in construction planning, simulation and visualisation.
- To develop a methodology and a prototyping for a generative 4D visualisation Model.
- To test site application of the model with case studies in road projects.

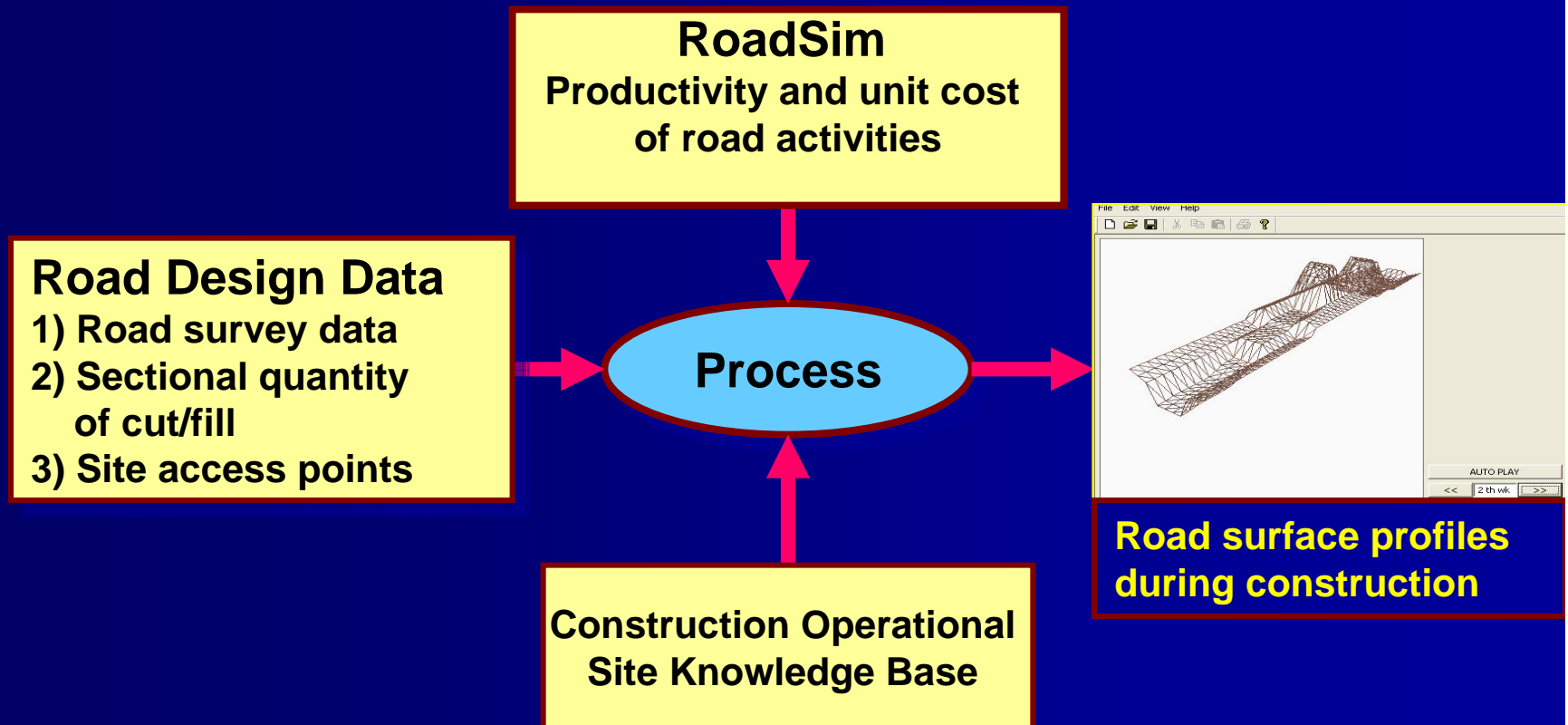


Research Methodology

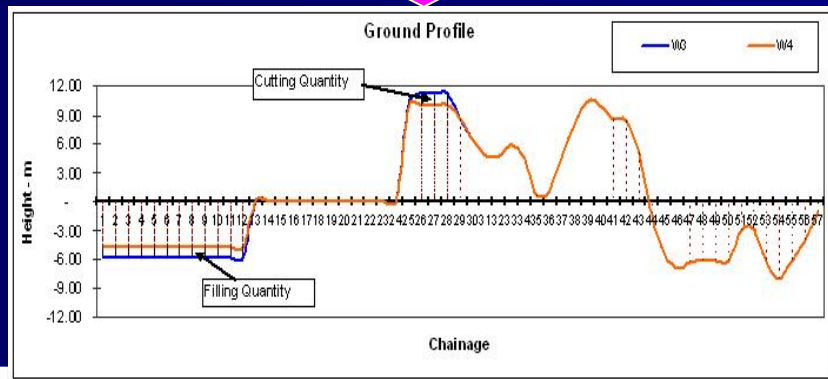
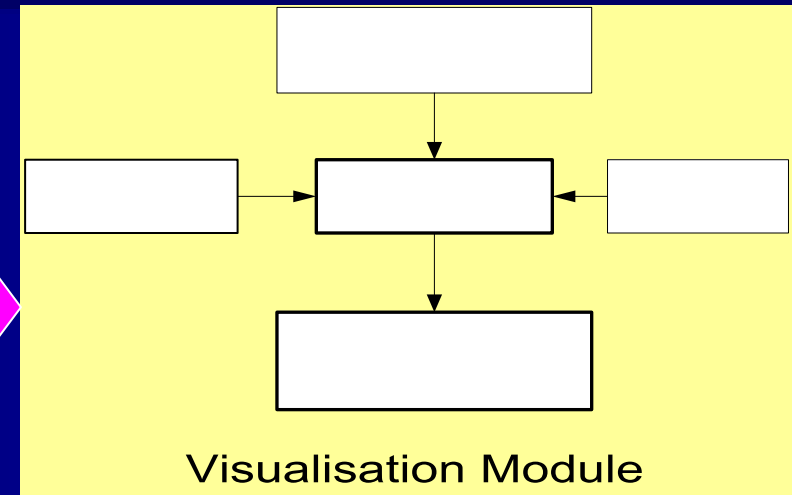
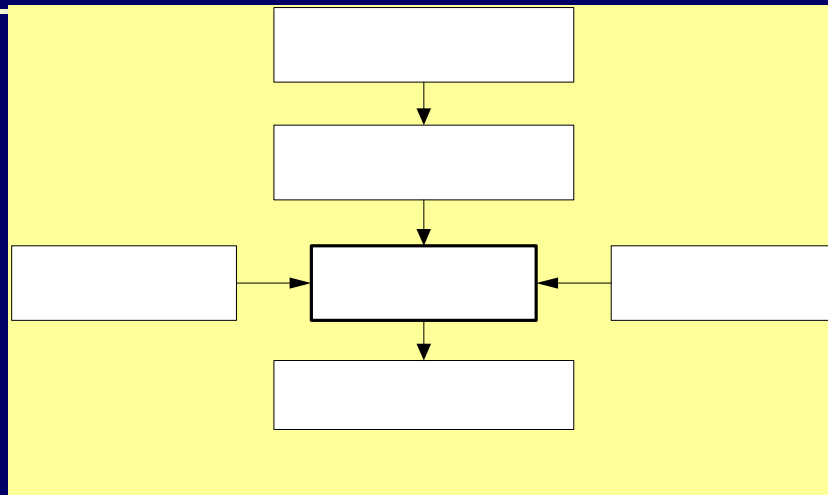
- Literature Review
- Design and development of a prototype of generative 4D visualisation model.
- Survey questionnaire and data analysis.
- Case study for validation of 4D visualisation model.
- Optimisation model of earthwork quantity for cut/fill.
- Establish the value of the model



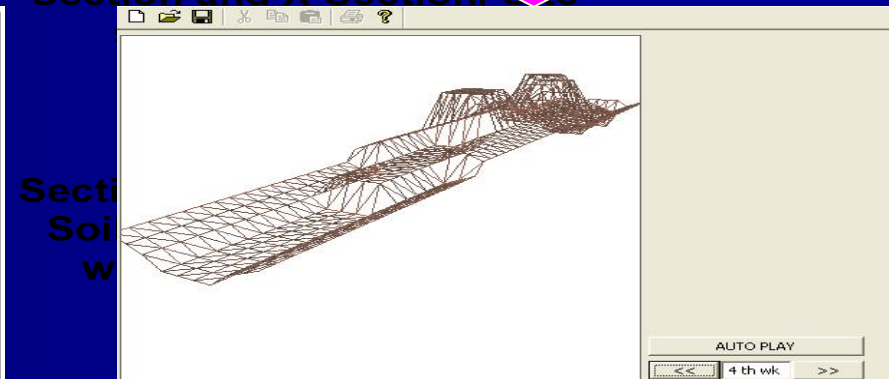
Framework of 4D Visualisation Model



Development of 4D visualisation model



Road Design Data: L-Section and X-Section.



Rate of Production of cut/fill activities produced by RoadSim

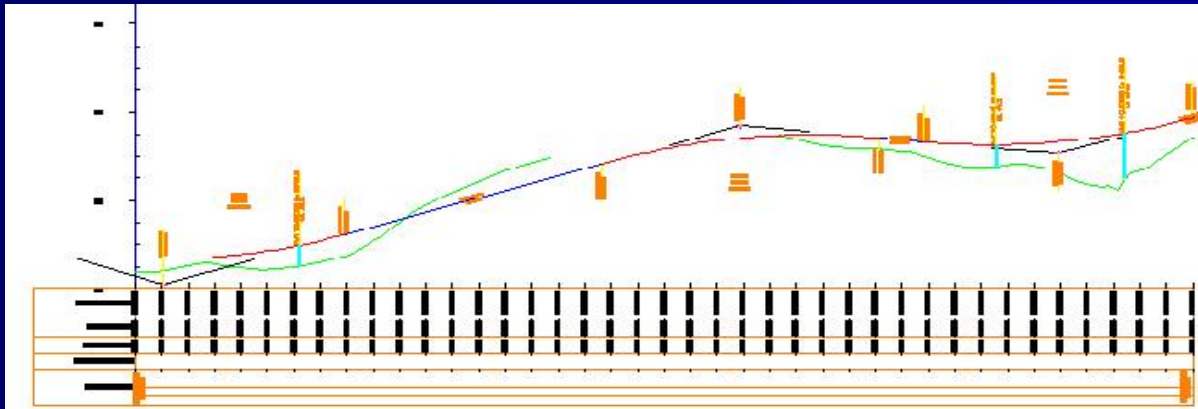
Process

Mathematical algorithms & Construction knowledge



Case Study

- 1.5 km road section that was completed in Portugal.



Selected Road section for case study

4D Visualisation Model (Earthwork operations)

4D Model (Earthwork Operation in Road Project)

DataGeneration

DataExport

4D Model (RoadViz)

Productivity Information

Filling Productivity

Cutting Productivity

Productivity (Production Rate) - m³/week

Earthwork Filling

5,059.46

Earthwork Cutting

7,554.85

Cost Information

Unit Cost of Filling

Unit Cost of Cut

Unit cost of Road Activity - £ / m³

Unit cost of Filling

6.14

Unit cost of Cutting

0.82

Exit

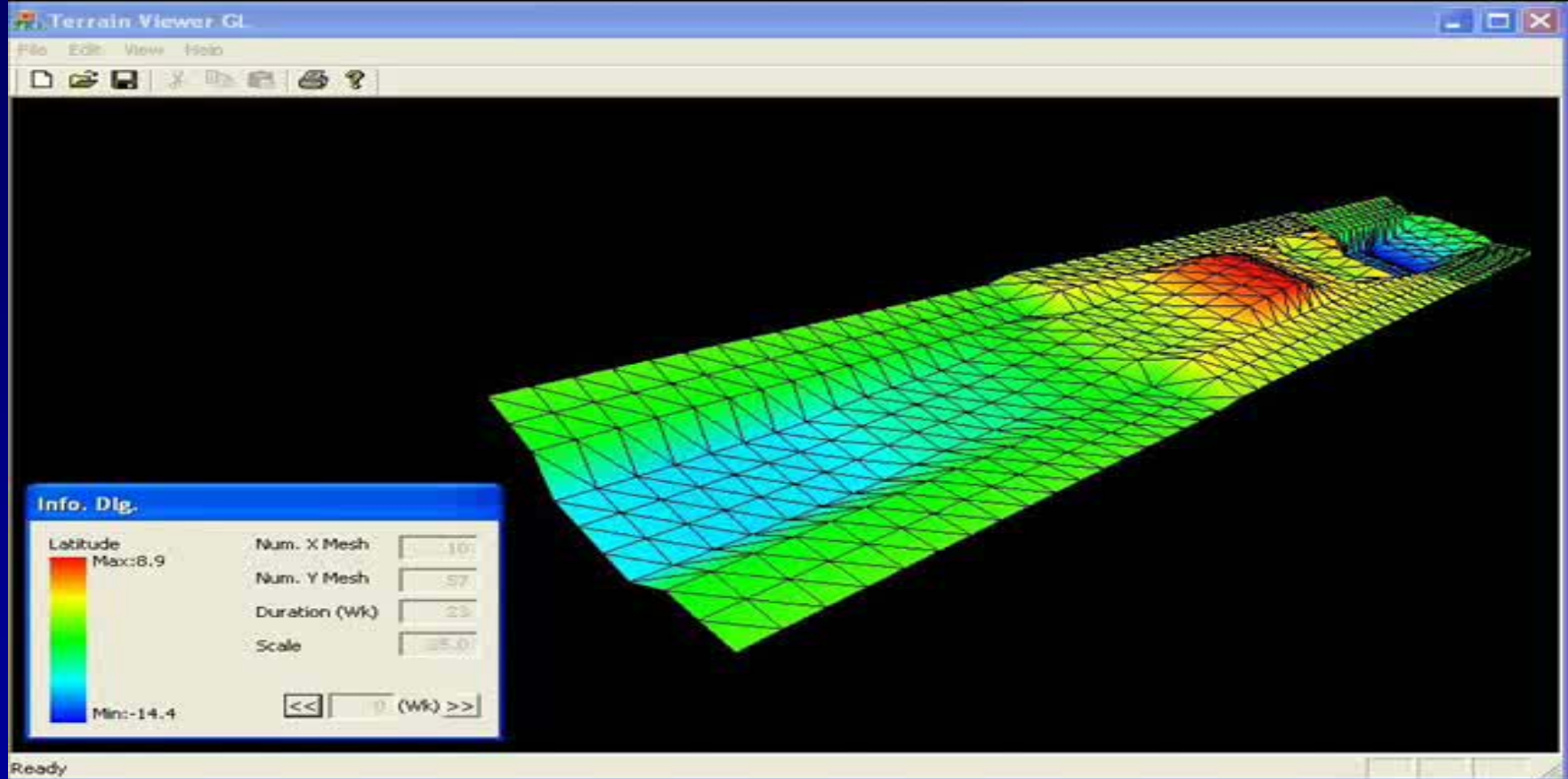


4D Visualisation Model (Earthwork operations)

Calculation Sheet for WorkItem3 : Fill from cut or borrow

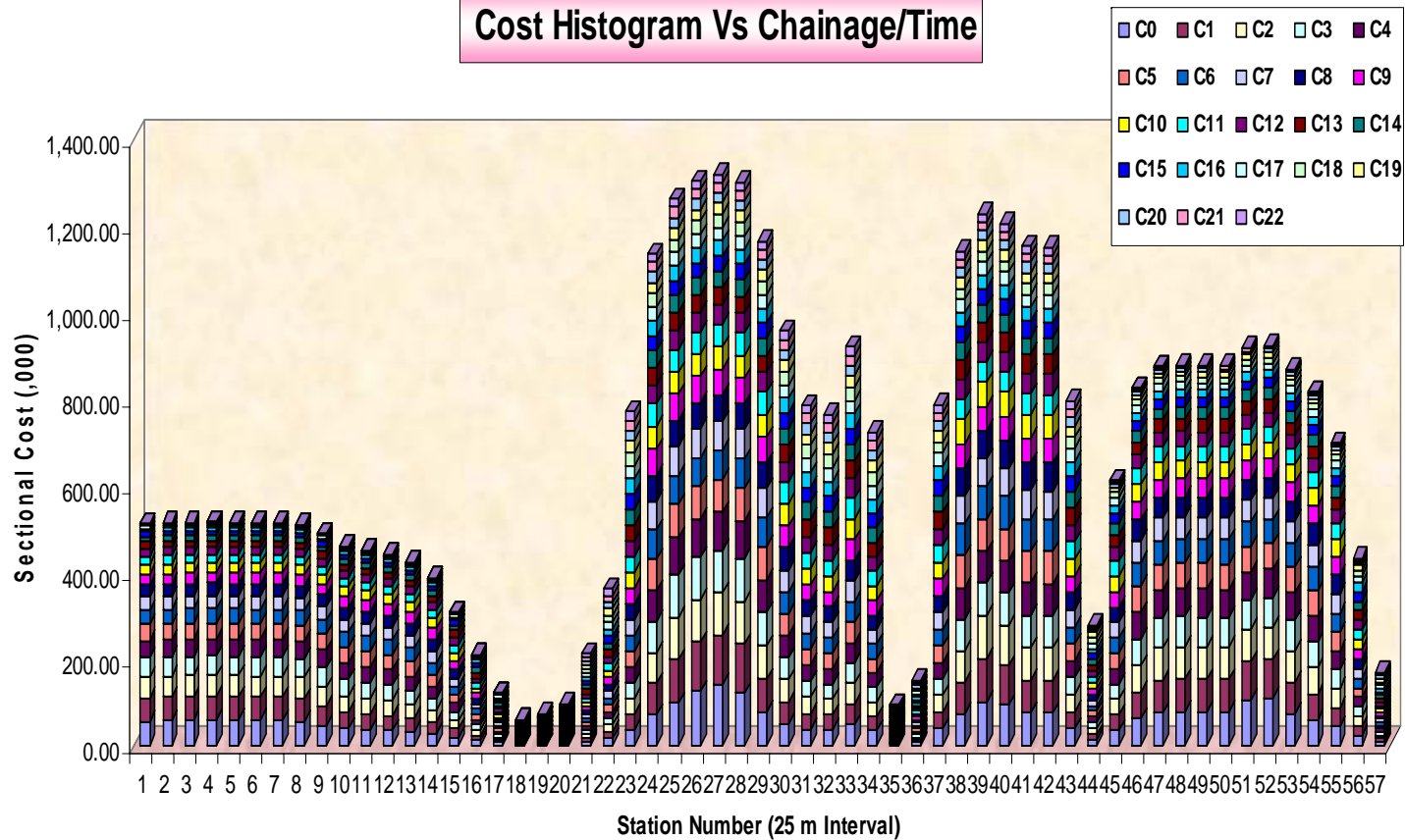
Option1	Option2	Option3
Excavator Excavating	Motorscraper Hauling	Bulldozer Dozing
EqCode: Exa	EqCode: Msa	EqCode: Tttb
RotAngle: 45	Ke: Average	Ke: Average
%CutHeight: 100	ϕ (phi): Gravel	ϕ (phi): Gravel
Material: Sandy-clay	D (m.) [50,500]: 100	D (m.) < 50: 20
MatCondition: Hard	Bulldozer Pushing	Payloader Loading
Ke: Poor	EqCode: Tttc	EqCode: Wplb
ϕ (phi): Sandy clay	Ke: Rather poor	WorkingConditions: Adverse
TipperTruck Hauling	ϕ (phi): Gravel	Ke: Rather poor
EqCode: Oht	D (m.) [0,30]: 30	ϕ (phi): Gravel
TravellingRoad: Site or minor road	MotorGrader Levelling	D (m.) < 15: 10
Ke: Average	EqCode: Mga	TipperTruck Hauling
D (km.): 20	TypeofWork: Mass earthworks	EqCode: Oht
Vm (km/h): 50	ThicknessRange: 0.20 - 0.40	TravellingRoad: Site or minor road
MotorGrader Levelling	Ke: Average	Ke: Average
EqCode: Mga	Thickness (m. in): .3	D (km.): 20
TypeofWork: Mass earthworks	WaterTruck Watering	Vm (km/h): 10
ThicknessRange: 0.20 - 0.40	EqCode: Wb	MotorGrader Levelling

Visualisation of Road surface Profiles



Cost Histogram of Road section

Cost Histogram Vs Chainage/Time



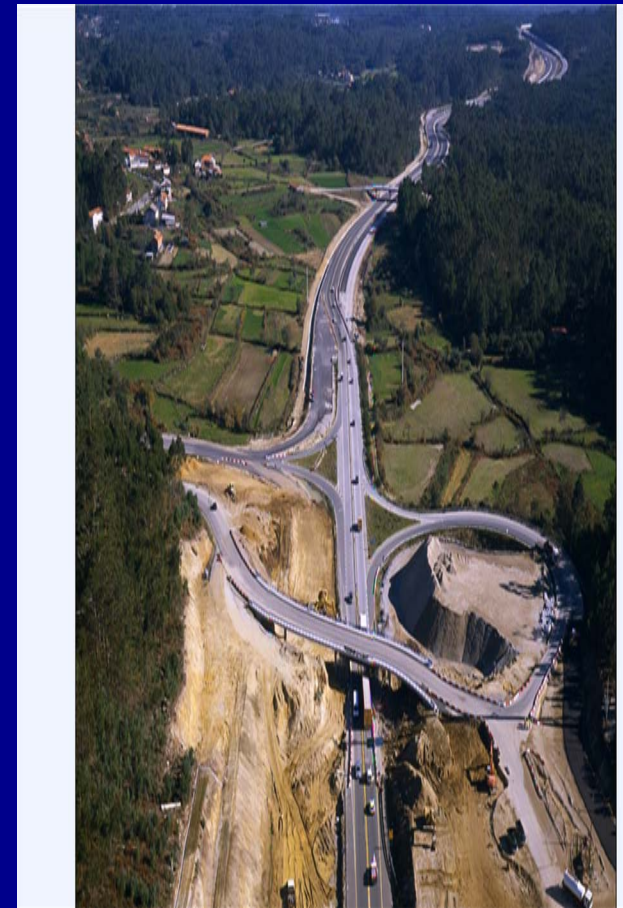
Deliverables

- A decision support tools that will assist the project managers/planner to
 - Improve communication.
 - Simulate and visualise the progress of cut/fill soil mass with spatial aspect.
 - Cost profile along road section
 - Facilitate a logical decision making process in developing construction schedule in a lean and effective manner.



Research Significance

- Road construction and civil engineering contractors
- Academic and Industry research centres
- Software developer



Thanks

