Improving sustainability and reducing infrastructure development costs through the application of Geospatial technology.

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What is Sustainable Transportation Infrastructure?

- “The goal of sustainable development is to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life, without compromising the quality of life of future generations”
  - (Defra, 2005)

- Sustainable development involves the integration of economic, environmental, and social elements, minimizing the trade-offs that have to be made between those elements
  - Source: Sustainable Development Strategy and Action plan for Civil Engineering July 2007, ICE, ACE, CECA, CIRIA, and the Construction Products Association
A sustainability-driven approach to civil engineering leads to adoption of some key objectives in practice:

- Dramatically **reduce the environmental impact** of our life and work
- Dramatically **improve the environmental quality** of what we create
- Maximise the utilisation of materials and their reuse
- Minimise waste in design, construction and use
- Minimise energy and water use
- Minimise pollution from all our activities – In construction and during operation

Source: Sustainable Development Strategy and Action plan for Civil Engineering July 2007, ICE, ACE, CECA, CIRIA, and the Construction Products Association
The Geospatial Technology Workflow

Planning & Feasibility

Constructible Models in Design

Machine Control & Site Positioning

Operations & Maintenance
So how does Geospatial Technology help?

- It starts with better planning

- No matter how efficiently you work through the construction and operation phases, if you start with an inefficient alignment you can never recover the full benefits of a sustainable approach to design.
Achieving a more sustainable infrastructure asset through the use of planning technology

- Quantm is a unique planning system for corridor and route alignment optimization
- Investigates millions of alignment alternatives to enable:
  - Faster Project Planning
  - Reduced Capital Construction & Operating Cost
  - Better Environmental and Public Outcomes
- Assists the management team in making the right decisions quickly
How is this achieved?

- By the **simultaneous** consideration of multiple factors during the alignment analysis phase:
  - Environmental
  - Engineering
  - Community
  - Cost

- An Expert system that encapsulates the learning of industry professionals over the last 20 years
Geospatial technologies at work in the planning process

The Planning Process

Scoping
- Use existing data.
  - Terrain, GIS, Design
  - Criteria, Estimated
  - Unit Costs

Pre-feasibility
- Financial Summary
  - Preferred Alternatives
  - Visualization
  - Public Consultation
  - Decision
  - Preferred alternatives
    - for detailed analysis
  - Decision
  - Detailed Design

Feasibility
- Quantum Output
  - Evaluate corridor options.
    - Summary comparison of
      the selected options.
  - Quantum
    - Exports costs
      and quantities to project
      management system
  - Quantum exports
    the preferred alignment

Detailed Design
- Release for bid
Sustainability result: Reduced environmental impact

- After 2 years of study using conventional approaches, Geospatial technology for alignment optimization was applied.
- Compared to the conventional approach, the technology reduced:
  - Impact to sensitive species by completely avoiding the habitat.
  - Wetland impact from 160 acres to 53 acres.
  - Impact on coastal scrub from 499 to 385 acres.
  - Residential displacement from 56 to 0.
  - Earthworks, reducing the risk of landslides.
- Reduced cost of construction by >$100m.
Sustainability results:
Minimised energy and water use
Minimise pollution from all our activities – During operation

- Australian Mining Pit to Port Rail link
- Sensitivity analysis to balance construction costs with operating (energy usage) costs
- Achieved a better outcome
  - Invested more in construction cost
  - Reduced environmental impact through reduced energy usage
  - Reduced total cost of ownership
Sustainability result: Improving Environmental Quality through better public engagement
Sustainability result: Improving Environmental Quality through better public engagement
Visualizing current and proposed alignments
When to be used: Quantm Project Cycle

Data Accuracy

Quantm Benefits

Project Budget Expenditure

1:50,000
1:20,000
1:10,000
1:5,000
1:2,000
1:1,000
1:100
90-97%

Scoping / Pre-Feasibility

Feasibility Corridor Selection

Planning Alignment Selection

Preliminary Design Value Engineering

Design Fixed Alignment

Environmental & Social Impact Minimization

Construction Cost Savings

When to be used: Quantm Project Cycle

1% 2% 5%
An example of a collaborative workflow enabled through the use of Geospatial technology

Information mobility across the entire workflow linking Planning, Design and Construction
The Geospatial Technology Workflow

Planning & Feasibility

Constructible Models in Design

Machine Control & Site Positioning

Operations & Maintenance
Constructible Models in Detailed Design

- Final civil design adjustments
- Full detailed reporting & detailed estimates
- Create basis for constructible model
- Digital sign-off & delivery
3D Constructible Model Drives Process Cohesion

OWNER

Allows provision of greater detail and accuracy

CONTRACTOR

Empowers with better quality data for a better finished product

AS-BUILT

More efficient construction and living record throughout the project lifecycle
The Geospatial Technology Workflow

- Planning & Feasibility
- Constructible Models in Design
- Machine Control & Site Positioning
- Operations & Maintenance
Machine control and site positioning
Automated Grade Control for Sustainable Construction

Sustainable construction – this subset of sustainable development refers to the creation, maintenance and operation of infrastructure and buildings that shape communities in a way that sustains the environment, generates long term wealth and enhances the quality of life.

What is Automated Grade Control?

- Simply put, it is numerical machine control for construction
Sustainability results: Minimised energy use
Minimise pollution from all our activities – During construction

Technology method
CAT D6 Dozer

- Fuel consumption – 2,801
  - Savings 35%*
- Hours of operation – 62
  - Savings 50%*
- CO² emissions – 16,463lbs
  - Reduction 35%
  - CO2 Emissions Chart

Traditional Methods
CAT D6 Dozer

- Liters diesel per month = 4,310
- Hours of operation = 123
- CO² emissions per month = 25,333lbs

*Savings based on Caterpillar Road Construction Study – December 2006
**Sustainability results:**

Maximise the utilisation of materials and their reuse

Minimise waste in design, construction and use

- Technology produced a smoother surface resulting in better utilization of materials and lower material costs
- Minimized waste in construction – used less fuel
  - 42% faster
  - 68% lower labour costs
  - 24% saving in fuel
Intelligent Compaction

- Manage lift thickness
- Measure and manage compaction quality
- Record the asset quality and construction
- **Outcome** – A better base for the road resulting in
  - Longer asset life time
  - Reduced maintenance
  - Lower operating costs
The Geospatial Technology Workflow

- Planning & Feasibility
- Constructible Models in Design
- Machine Control & Site Positioning
- Operations & Maintenance
Geospatial solutions

- For management, maintenance and future planning
- Rapid data capture
- Automated processing
  - Sign detection
  - Lane marking
  - Road geometry
    - Rutting
  - Sight distance
  - Vertical clearance
Sustainability results: Maximise the utilisation of materials and their reuse

- 3D Mill & Pave operations
- Re-cycle existing materials using milling and re-laying operations
- Produce improved rideability through precision grade control
  - Reduces future road maintenance
  - Reduces vehicle wear & tear
  - Smoother ride for passengers
Summary

Geospatial technology enables sustainable construction with benefits for everyone

- **For the Client & Engineer**
  - Better quality
  - Easier project management
  - Transparency
  - Improved reporting
  - Improved site safety
  - Elimination of “human” errors
  - Faster change management
  - Earlier project completion
  - Longer infrastructure life

- **For the Contractor**
  - Faster construction
  - Less re-work
  - Lower construction costs
  - Less down time for change management
  - Easier collaboration
  - Better quality control
  - Improved site safety
  - Lower environmental impact
Questions?