GIS based Data Management in Pipeline Construction Projects

DMC1 GmbH
Werksgelaende DOW, Gebaeude B18
06258 Schkopau
Germany
Data management in Pipeline Construction Projects

- Definition, checking, analysis, collection and distribution of project data and documents in all project phases

- Objectives:
  - Use of consistent data formats and interfaces
  - Distribution of correct and reliable data to project participants
  - Early recognition and correction of data errors
  - Improved communications
  - Information for project analysis and control
  - Effective creation of the Project and As Built Documentation
Implementation

Flow Diagram:
- Client
- Planner
- ROW
- Contractor

Nodes:
- Definition Check Co-ordination
- Data management
- Format Structure Content Flow
- Misc…

Arrows:
- Access to PMS (read only)
- Provision of analyses as needed
- Client instructions to third parties

Layers:
- Information provision
- Analysis/comparison (plan-actual)
- Implementation
- Build up
- PMS

Activities:
- Project-planning
- Project-control
- Project-documentation
GIS based Data Management

- GIS is a suitable tool to process data that includes geographic information
- GIS combines the capabilities of CAD with those of a database
  - Generation of additional information
  - Reduced effort for working with many types of project data
- Creation of a common information platform for the project
Motivation / Benefits

- Increase effectiveness and efficiency through
  - Use of analysis capabilities for project management
    - Project analysis (plan/actual comparison)
    - Project control (decision support)
    - Reporting (status reports)
  - Effective creation, processing, checking and correction (through data specifications)
  - Reliable data exchange and better version control (definition data flows and interfaces)
Motivation / Benefits

- Reduce risks and costs through:
  - Early identification of errors
  - Increase the proportion of errors identified
  - Immediate correction of errors
  - Reduce effort for error correction
  - Reduce occurrence of decisions based on incorrect data
## Calculation Assumptions

<table>
<thead>
<tr>
<th>Item</th>
<th>Minor</th>
<th>Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correction Cost (€)</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Consequence Cost (€)</td>
<td>2,000</td>
<td>250,000</td>
</tr>
<tr>
<td>Consequence Probability</td>
<td>5%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Correction cost monthly increase</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Consequence cost monthly increase</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Monthly error rate</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
Costs of errors versus time

Costs of minor errors versus time

Cum Costs in thousands
Cost per error in thousands
Costs of errors versus time

Costs of serious errors versus time

Cum costs in thousands vs. time

Cost per error in thousands vs. time

- Cum Costs in thousands
- Cost per error in thousands
Motivation / Benefits

- Improvement in quality of data and documentation through:
  - Reduction of error frequency
  - Traceability of data and information
  - Earliest possible, complete and correct documentation

- GIS System for operations available for implementation at end of project
Application areas

- Route planning
- Right of way
- Permitting
- Data control
  - Survey
  - Pipebook
  - Engineering data
  - CAD data
- Progress measurement
- Documentation production
Implementation
Implementation / Specification

- Definition/Specification of data formats and procedures
  - All data (identification fields, revisions...)
  - Survey data (co-ordinate systems, accuracy, …)
  - Planning data (route, valve stations, ROW,…)
  - As Built data (layer structure, naming files, …)
  - Technical documentation (digital data, lists, …)
## Example definition pipebook

| Tabellename: | Pipebook_xxxRxxn | xxx – Dienstleisterkürzel  
| mm – Versionsnummer |
|-------------|------------------|-----------------------------|

<table>
<thead>
<tr>
<th>Feld</th>
<th>Datatyp</th>
<th>Feldbreite</th>
<th>Bemerkung</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFD_NR</td>
<td>Character</td>
<td>100</td>
<td>fortlaufende Nummer</td>
</tr>
<tr>
<td>LOS</td>
<td>Character</td>
<td>10</td>
<td>Bauabs.</td>
</tr>
<tr>
<td>TEILENR</td>
<td>Character</td>
<td>100</td>
<td>Teile Nr. / Fabrik Nr.</td>
</tr>
<tr>
<td>TEILBEZ</td>
<td>Character</td>
<td>100</td>
<td>Einbauteilbezeichnung</td>
</tr>
<tr>
<td>ROHRDURC</td>
<td>Real</td>
<td>100</td>
<td>Rohrdurchmesser in mm</td>
</tr>
<tr>
<td>WANDDIC</td>
<td>Real</td>
<td>100</td>
<td>Wanddicke in mm</td>
</tr>
<tr>
<td>MATRIAL</td>
<td>Character</td>
<td>80</td>
<td>Werkstoffbezeichnung</td>
</tr>
<tr>
<td>HERSTELL</td>
<td>Character</td>
<td>80</td>
<td>Hersteller des Bauteils</td>
</tr>
<tr>
<td>CHARGE</td>
<td>Character</td>
<td>80</td>
<td>Zertifikat Nr.</td>
</tr>
<tr>
<td>BAULANG</td>
<td>Real</td>
<td>in m, Länge Baulelement</td>
<td></td>
</tr>
<tr>
<td>KLM_LANG</td>
<td>Real</td>
<td>in m, Kumulierte Länge</td>
<td></td>
</tr>
<tr>
<td>NAHT_NR</td>
<td>Character</td>
<td>100</td>
<td>Nicht ist immer die hintere, in Strömungsrichtung von Stange</td>
</tr>
<tr>
<td>SCHWDAT</td>
<td>Datum</td>
<td>Datum wann geschweißt</td>
<td></td>
</tr>
<tr>
<td>SCHWIVON</td>
<td>Character</td>
<td>100</td>
<td>geschweißt von wem</td>
</tr>
<tr>
<td>US</td>
<td>Character</td>
<td>10</td>
<td>Ultraschall</td>
</tr>
<tr>
<td>US_PROTO</td>
<td>Character</td>
<td>40</td>
<td>US – Protokoll</td>
</tr>
<tr>
<td>DS</td>
<td>Character</td>
<td>10</td>
<td>Durchstrahlung</td>
</tr>
<tr>
<td>DS_PROTO</td>
<td>Character</td>
<td>40</td>
<td>DS – Protokoll</td>
</tr>
<tr>
<td>X</td>
<td>Real</td>
<td>Schwechnahokoordinaten</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Real</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>Real</td>
<td>Hohe Rohrbereitschaft</td>
<td></td>
</tr>
<tr>
<td>Z_GEL</td>
<td>Real</td>
<td>Hohe Gelände</td>
<td></td>
</tr>
<tr>
<td>CODE</td>
<td>Integer</td>
<td></td>
<td>Code für Einmeßpunkte (Bogenanfang, Bogenmittelpunkt, Bogenmitte, Vertikalbogenmittelpunkt, Vertikalbogenmittelpunkt unten, Schweiffschnitt); eine entsprechende Code-Referenzliste ist beizulegen</td>
</tr>
<tr>
<td>BEMERK</td>
<td>Character</td>
<td>100</td>
<td>Bemerkungen</td>
</tr>
</tbody>
</table>
Implementation / Coordination

Collection, control and distribution of data in accordance with specification:

- Instruction, training and support of third parties who produce or process data
- Quality control (plausibility/correctness)
- Data control and management of error correction
- Organisation of data flows between project participants
Implementation / Analyses

■ Production of information and documents:
  - Provision of information to the project management team for
    ➢ Decision support
    ➢ Project progress measurement
    ➢ Analysis of problem locations along the route
    ➢ Analysis and evaluation of supplementary costs
  - Support of As Built documentation
Examples and Experience

Construction of a 350 km ethylene pipeline

■ Re-routes
  - 46 revisions with circa 105 planned and 92 confirmed re-routes
    ➢ Rejection of unnecessary re-routes

■ Crossings
  - 21 revisions, circa 980 crossings
    ➢ Circa 20 missing / duplicate crossings
    ➢ Two crossings without permits at construction start
Examples and Experience

■ ROW
  - 4 ROW contractors, 1 planner
  - Central data comparison weekly, one common database
  - Administration of around 4150 land parcels, 5440 owners, 4175 tenants
    - Circa 150 problem cases, missing permit / contract
    - Missing contracts with tenants and owners (e.g. 1 x plot still in route despite refusal of owner)
    - A few km with incorrectly digitised cadastral data
Examples and Experience

■ Planning / Construction
  - Rejection of two construction equipment/team movements
  - Prevention of incorrect route marking 3 m from foreign line instead of 2 m

■ Survey data
  - Weekly delivery of weld data
    - Pipeline laid too close to parallel line in 3 sections
    - Multiple instances of variances from plan, leading to ROW changes
Examples and Experience

Differences in the result with / without specifications

- **As Built data**
  - Pipebook: problems with only 11 datasets (of approx. 31,800)
  - CAD drawings: incorrect cadastral information, missing data (valve stations, CP, profile)
- **Lists / survey data**
  - Numerous errors in: coding, coordinates, weld numbers, calculation/drawing errors in drillings
  - Rejected 6 times
Examples and Experience

- Integration and analysis of ROW data
Examples and Experience

- Checking ROW safety by comparison of detailed design route vs. planning route and later vs. as built route
Examples and Experience

- Control of surveyed pipeline route against planned route and e.g. parallel foreign lines.
Examples and Experience

- Analysis of ROW „Ready for design“
Examples and Experience

- Analysis and presentation of project progress
Examples and Experience

- Construction status reporting
Summary

The earliest possible introduction of GIS based data management leads to:

- Reduced (pre-) planning costs and time
- Reduced engineering costs
- Reduced documentation costs
- Measurement, control, and reporting instrument
- Earliest possible, complete documentation
- Pipeline Management System available for operations use