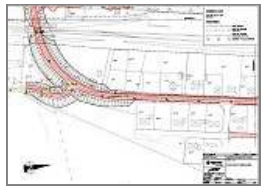
Experiences with BIM for infrastructure implementation
Measured value of toady's level - possibilities with future levels of BIM

Heidi Berg
Vianova Systems as

Evolution

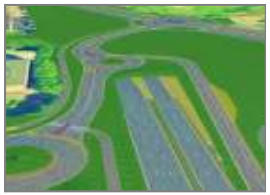
CURRENT → FUTURE

2D Drawings



Single discipline
Manual & CAD
Discipline
approach

3D Models

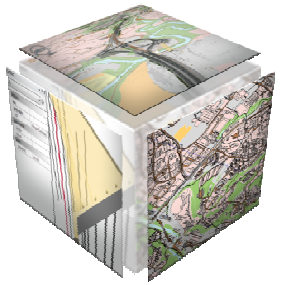


Single discipline
Limited
intelligence
Discipline
approach

3D Collaboration Models

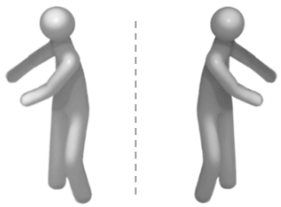
Multi-discipline
VR visualization
Project collaboration

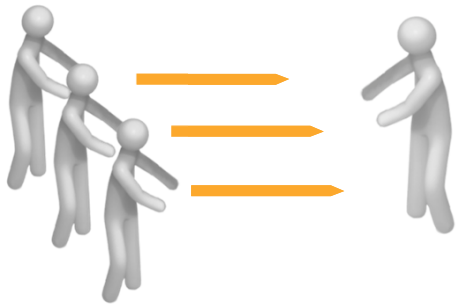
BIM for Infrastructure



Multi-discipline & workflow support
Intelligent object model
Lifecycle value

ISOLATED → COLLABORATIVE → INTEGRATED





Solution

VIANOVA

BIM in our industry – How mature are we?

Market Maturity based on TAM / Autodesk

HIGH
BIM MARKED

MEDIUM
BIM MARKED

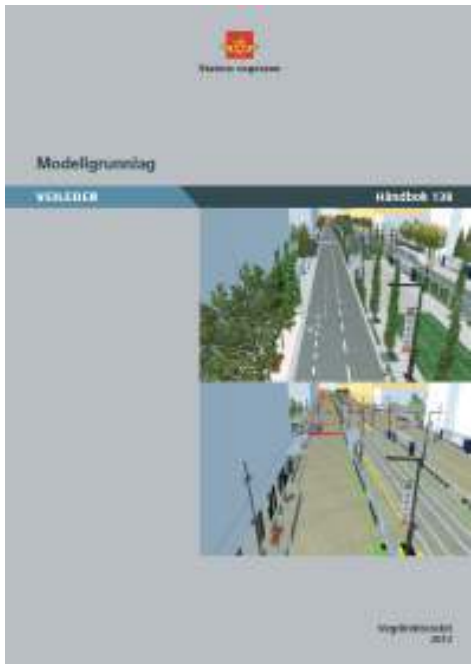
LOW
BIM MARKED

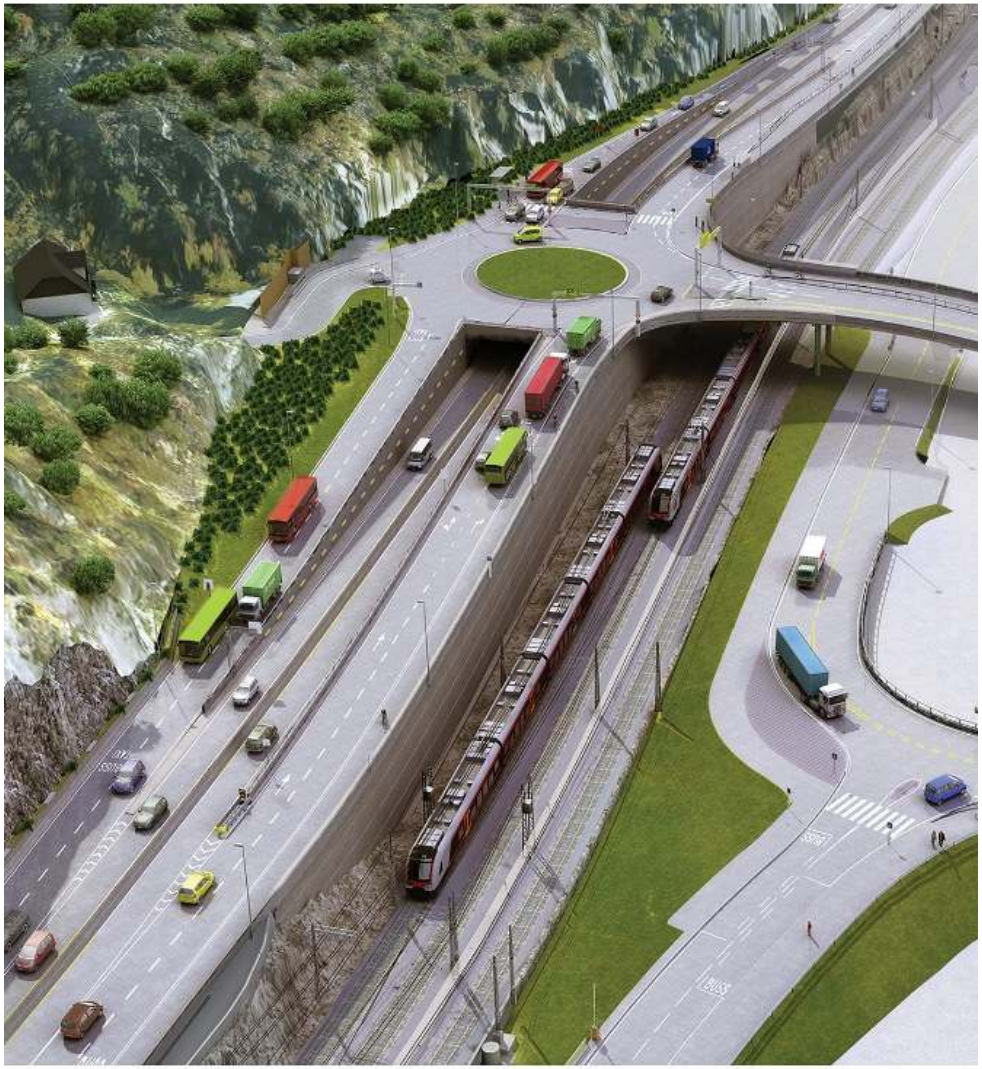
	HIGH BIM MARKED	MEDIUM BIM MARKED	LOW BIM MARKED
BUILDING (45%)	USA, Canada, UK, Australia, New Zealand, Scandinavia	Germany, France, Italy, Benelux, Japan	Korea, Brazil, China, Qatar + econ. growth countries
INFRASTRUCTURE 40%)	USA, Canada, UK, Australia, New Zealand, Scandinavia	Germany, France, Italy, Benelux, Japan	Korea, Brazil, China, Qatar + econ. growth countries
	EXTENDS BIM	ADOPT BIM	DEVELOP BIM

VIANOVA

Documented effects of model-based road projects

Effects by using the Norwegian Public Road Administration Manual V770 Model Data

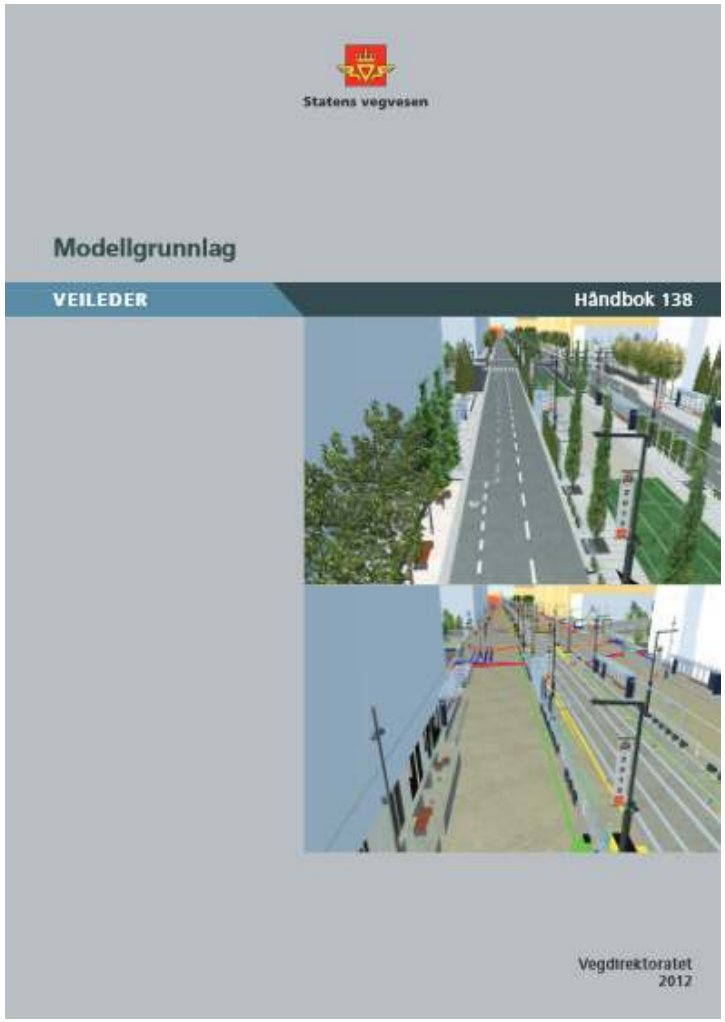




Sydhavna, Oslo - Statens vegvesen/VIANOVA

VIANOVA

Norwegian Public Roads administration: Manual V770 Model Data



- Released December 2012 *(former name: Handbook 138 Model Data)*
- Defines and sets quality requirements for model data
- Defines and sets requirements for model content
- Requires 3D modelling of all disciplines
- Consultants, constructors, surveyors and software developers participated in the development of the V770
- Experience from practical use forms the basis for revision of the manual

VIANOVA

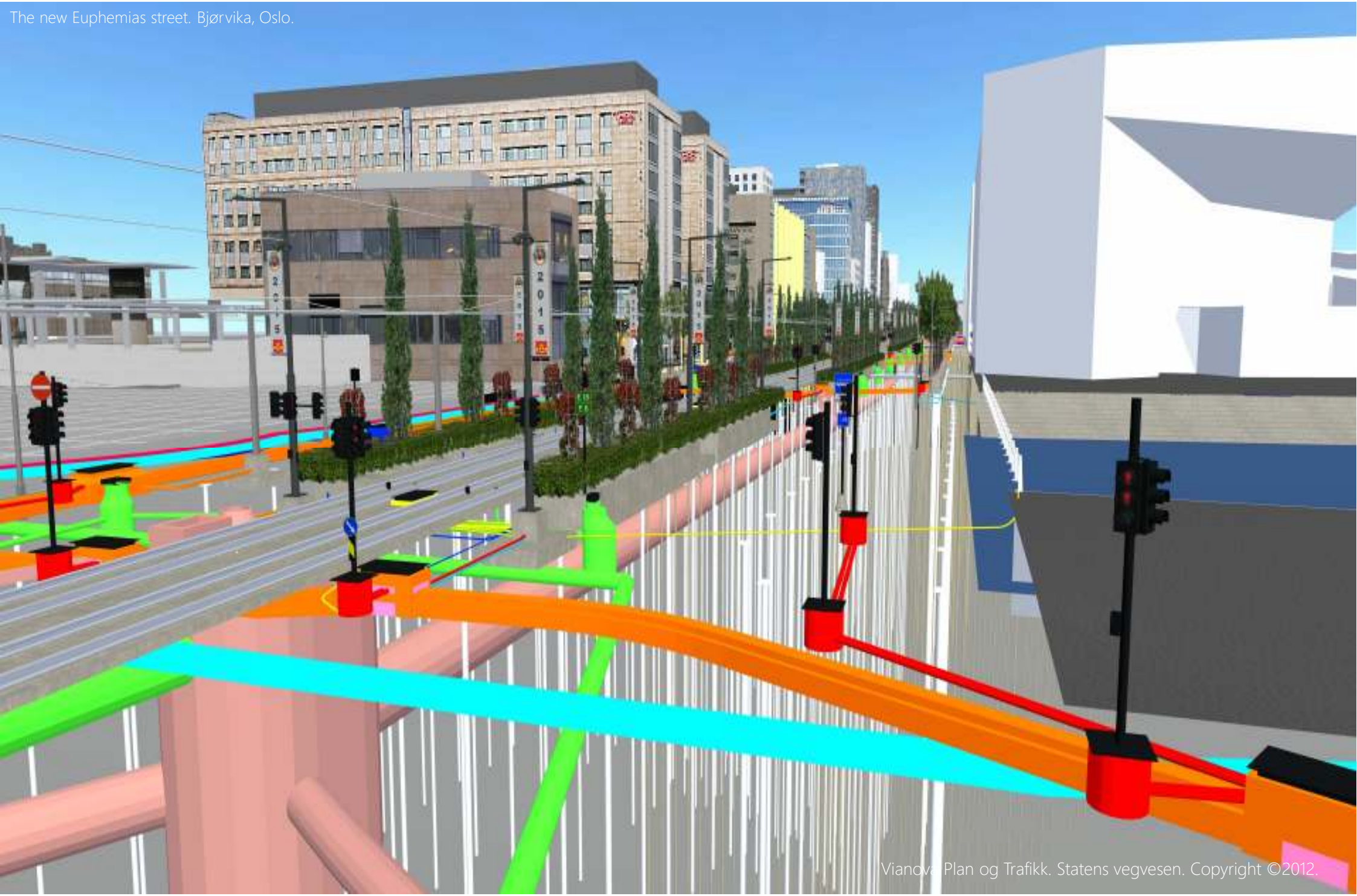
Purpose of Manual V770 Model Data

Reduce cost-increasing changes and conflicts at the construction site

Cost development of road projects - as a % of the contract price and cost estimates

VIANOVA

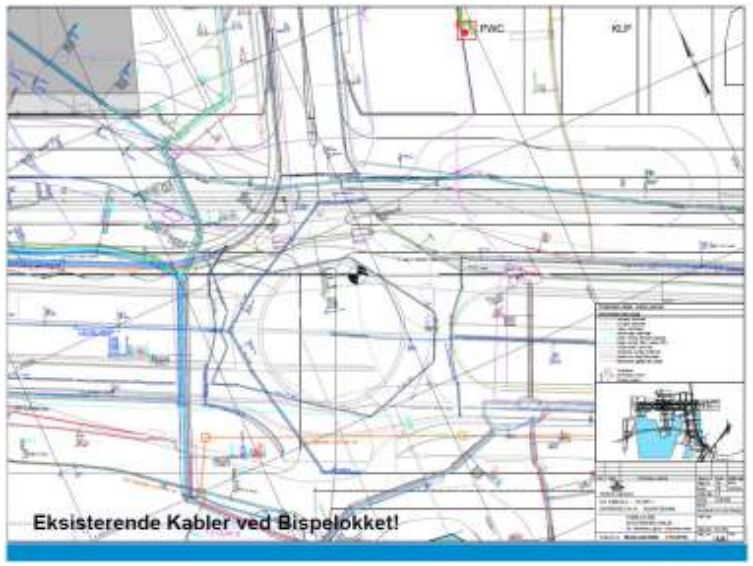

The new Euphemias street. Bjørvika, Oslo.
Vianova Plan og Trafikk. Statens vegvesen. Copyright ©2012.



The new Euphemias street. Bjørvika, Oslo.

Can positive effects of BIM methodology be documented?

- Analysis of BIM effects in the building industry has been done domestically and abroad
- Similar analysis are not easy to find for infrastructure projects
- BIM for infrastructure is relatively new
- Not all effects are simple to measure
- Vianova and The Norwegian Public Roads administration has analyzed change order documentation from model-based projects and compared them with results from "traditional" 2D road projects.



Kabler og ledninger ved Bispelokket, modellert

VIANOVA

BIM implementation - Project study
assumption for the analysis

1. Data from six completed projects were analyzed in two categories
   A. Traditional deliveries, 2D drawings, little collaboration
   B. Model deliveries, 3D models and collaboration (according to V 770)

   Some disciplines in some projects may be a combination of A and B (e.g. Cable and W&S at Økern E22)

2. The projects are solely transport infrastructure projects
   A. The comparison includes projects of varying size and complexity
   B. Construction projects completed 2009 to 2014

   The numbers are not index regulated

3. The projects analyzed the reason for each change order (CO) and systemized them in categories

VIANOVA

Our study counted the categorized change orders on site

=>Changes on site, trigger that change orders are sent from contractor to owner

Categories/Reasons for change:

1. Errors and omissions in design
2. Errors and omissions in the basic model data (apart from soil surveys, see point 7)
3. Unforeseen events (accidents, natural conditions, other)
4. Errors and omissions in the development plan (for little controlled areas)
5. Lack of construction start permit
6. Changed technical solutions
7. Mass changes beyond what the contractor has reason to expect (15 % of total)
8. Changes of plan initiated by the builder
9. Changes that require change of development plan
10. Extensions of the project in length or number of fields within the development plan

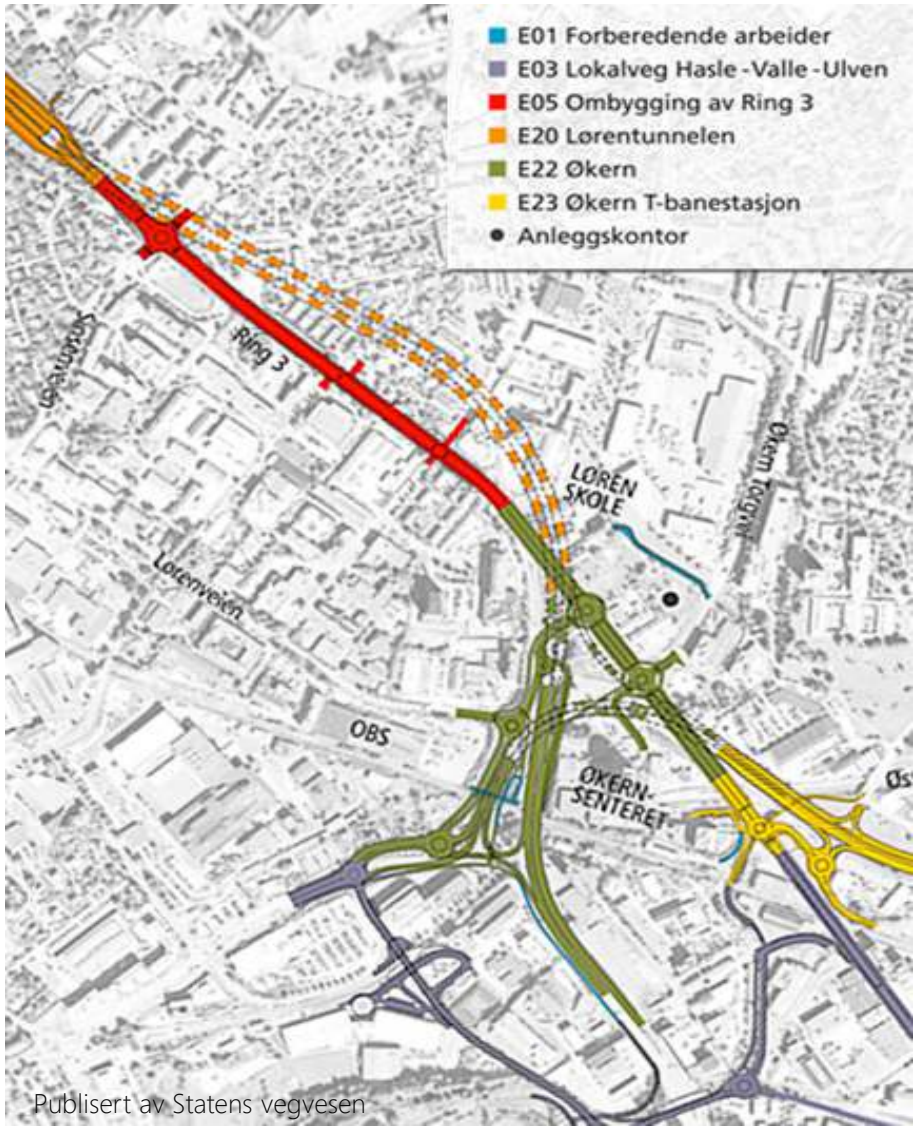
VIANOVA

Selected transport infrastructure projects included in the analyzes

1. RV 150, E03; Ring 3 Ulven-Sinsen (traditional)
2. RV 150, E22; Ring 3 Ulven-Sinsen (model-based)
3. E6 – Nordre, Trondheim (model-based)
4. FV 456, Vågsbygdveien, Kristiansand (model-based)
5. Joint project Dovrebanen-E6 Skaberud-Kolomoen, 4-lane E6 (traditional)
6. Joint project Dovrebanen-E6 and double railway track Strandlykkja and Kleverud/Labbdalen (model-based)

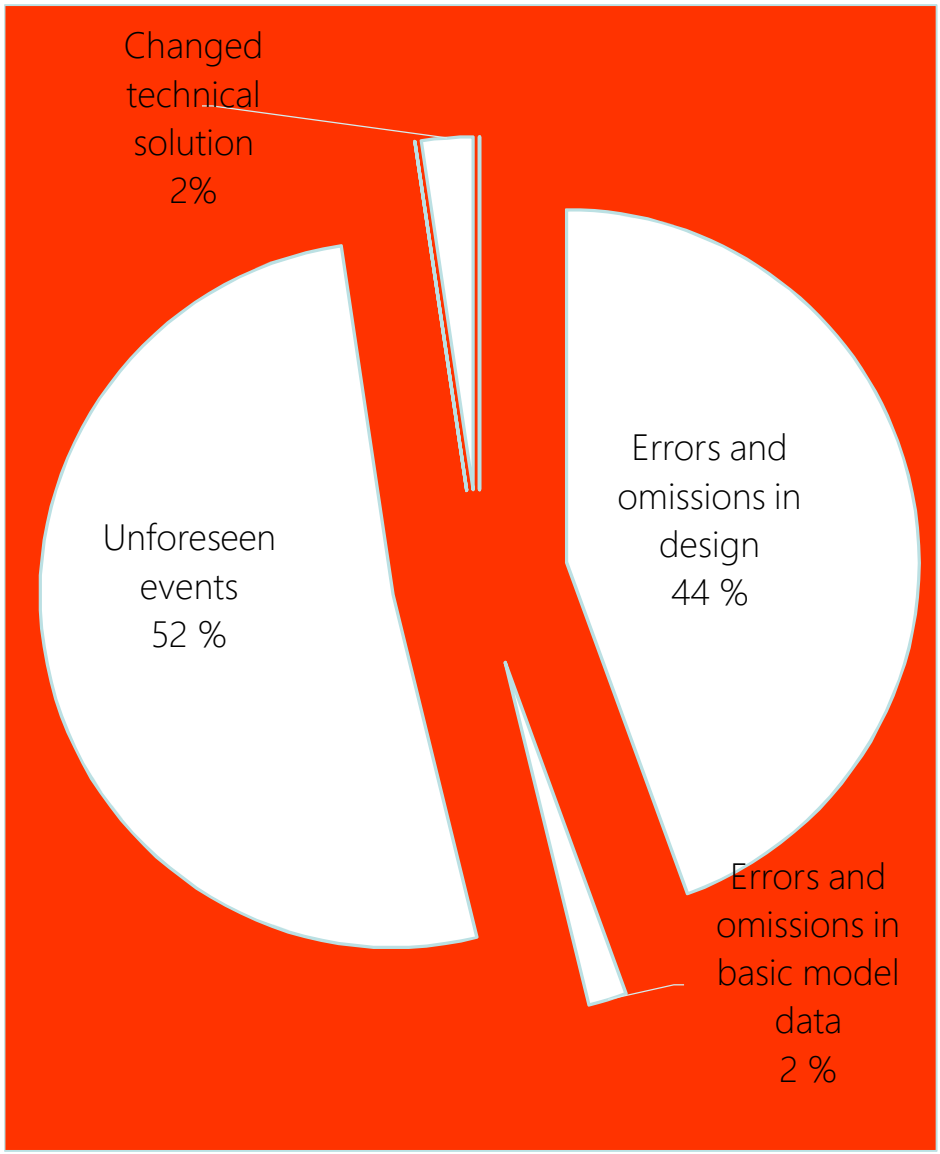
Project 1: RV 150 - E03; Ring 3 Ulven-Sinsen

Key information	
Contract type	Construction contract Unit price
Project method	Traditional
Contract sum	301 mill NOK
Extra costs (T-Nota)	57 mill NOK
No. of Changes (CO's, T-Nota)	682
T-nota % of contract sum	18,9%
Contractor	NCC Construction
Consultant	Multiconsult



Project 1: RV 150 - E03; Ring 3 Ulven-Sinsen

Key information	
Contract type	Construction contract Unit price
Project method	Traditional
Contract sum	301 mill NOK
Extra costs (T-Nota)	57 mill NOK
No. of Changes (CO's, T-Nota)	682
T-nota % of contract sum	18,9%
Contractor	NCC Construction
Consultant	Norconsult



VIANOVA

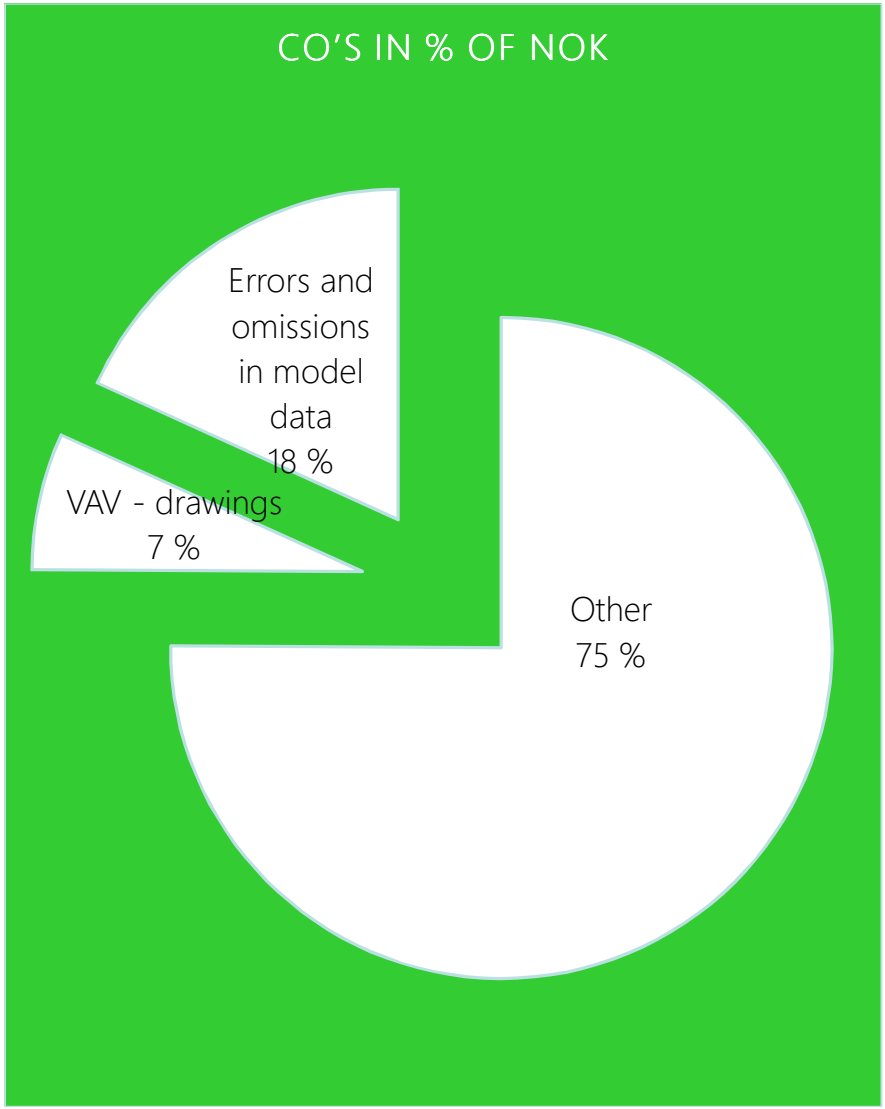
Project 2: RV 150 - E22; Ring 3 Ulven-Sinsen

Key information	
Contract type	Construction contract Unit price
Project method	Model, Manual V770 (ex: W&S and cable design)
Contract sum	532 mill NOK
Extra costs (T-Nota)	52 mill NOK
No. of Changes (CO's, T-Nota)	491
T-nota % of contract sum	9,8%
Contractor	Veidekke
Consultant	ViaNova/Aas-Jakobsen/Multiconsult

VIANOVA

Project 2: RV 150 - E22; Ring 3 Ulven-Sinsen

Key information	
Contract type	Construction contract Unit price
Project method	Model, Manual V770 (ex: W&S and cable design)
Contract sum	532 mill NOK
Extra costs (T-Nota)	52 mill NOK
No. of Changes (CO's, T-Nota)	491
T-nota % of contract sum	9,8%
Contractor	Veidekke
Consultant	Vianova/Aas-Jakobsen/Multiconsult



VIANOVA

Contractor ex. 2: RV 150, E22; Ring 3 Ulven-Sinsen

The 3D discipline models make our work day simpler and more efficient. There are almost no errors or conflicts between the disciplines in the models, from which we build the E22.

Petter Bakke, Project Manager – Veidekke ASA

VEIDEKKE

VIANOVA

Project 4: Fv. 456 Vågsbygdveien, Auglandsbukta-Flødemelka

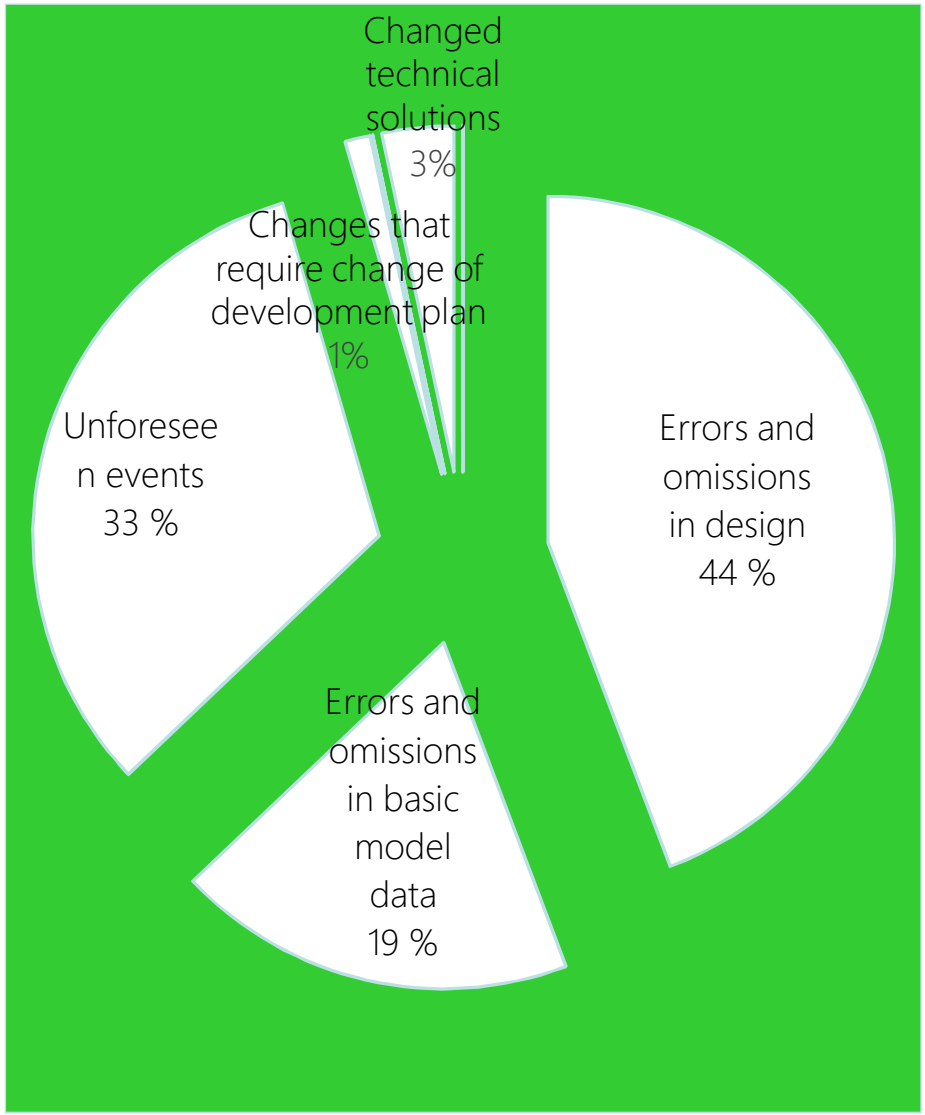
Key information	
Contract type	Construction contract Unit price
Project method	Model, Manual V770
Contract sum	43,7 mill NOK
Extra costs (T-Nota)	1,8 mill NOK
No. of Changes (CO's, T-Nota)	86
T-nota % of contract sum	4,2%
Contractor	Veidekke Entreprenør Tidl. Trafikk & Anlegg
Consultant	ViaNova Kristiansand

BIM modell: Statens vegvesen

VIANOVA

Project 4: Fv. 456 Vågsbygdveien, Auglandsbukta-Flødemelka

Key information	
Contract type	Construction contract Unit price
Project method	Model, Manual V770
Contract sum	43,7 mill NOK
Extra costs (T-Nota)	1,8 mill NOK
No. of Changes (CO's, T-Nota)	86
T-nota % of contract sum	4,2%
Contractor	Veidekke Entreprenør Tidl. Trafikk & Anlegg
Consultant	ViaNova Kristiansand



The collaboration model provides a true understanding of the objects. This improves communication and provides a neat and accurate picture that everyone understands. We eliminate misunderstandings. This includes communication with the public, as well as with the participants of the project.

Erling Guttormsen, Byggeleder Fv. 456 Auglandsbukta-Flødemelka
Statens vegvesen Region Sør

Norwegian Public Roads Administration

VIANOVA

Project 5: E6 Skaberud - Kolomoen

4-lane motorway, 12,7 km

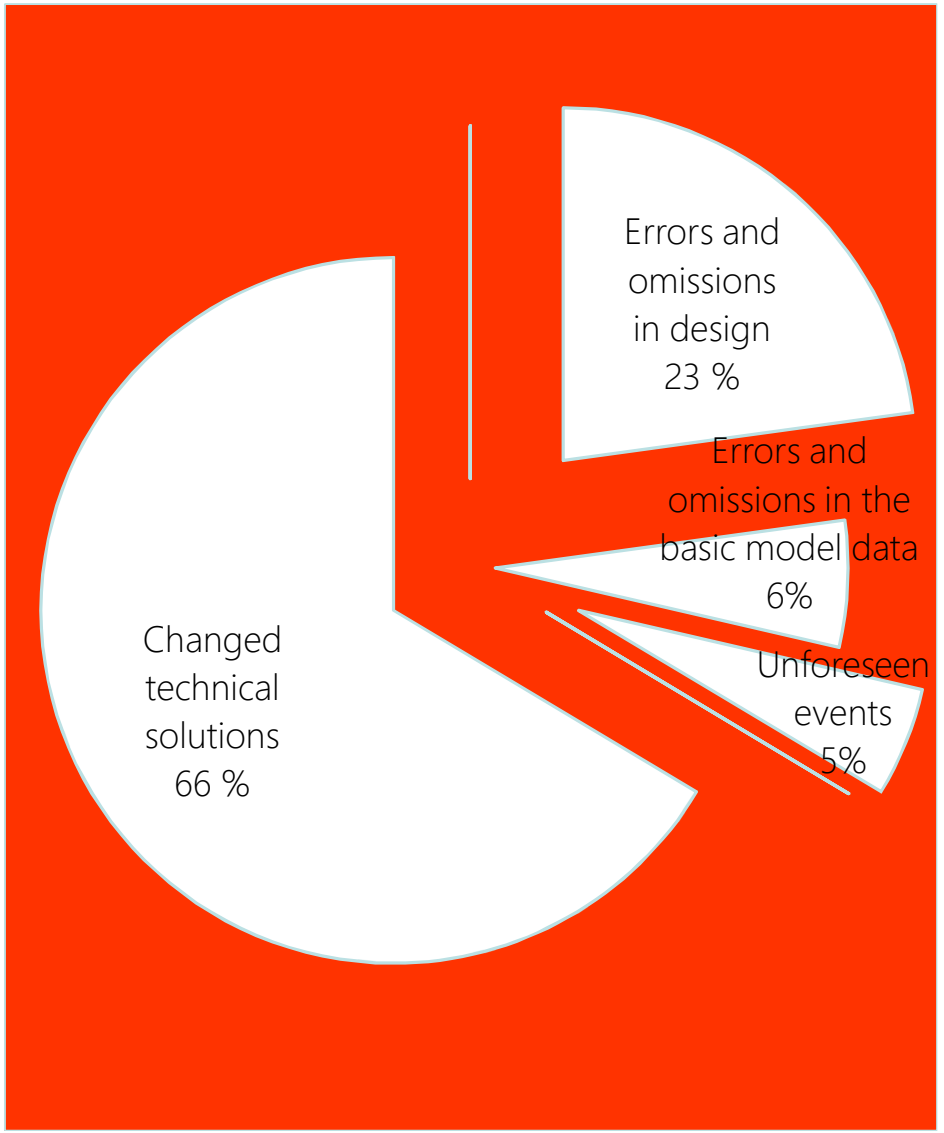
Key information	
Contract type	Construction contract Unit price
Project method	Traditional
Contract sum	470 mill NOK
Extra costs (T-Nota)	85 mill NOK
No. of Changes (CO's, T-Nota)	385
T-nota % of contract sum	18,1%
Contractor	Hæhre Entreprenør
Consultant	Multiconsult

Statens vegvesen: E6, Firefelts motorvei med midtdeler, 12,7 km lang

Project 5: E6 Skaberud - Kolomoen

4-lane motorway, 12,7 km

Key information	
Contract type	Construction contract Unit price
Project method	Traditional
Contract sum	470 mill NOK
Extra costs (T-Nota)	85 mill NOK
No. of Changes (CO's, T-Nota)	385
T-nota % of contract sum	18,1%
Consultant	Hæhre Entreprenør
Consultant	Multiconsult



VIANOVA

Project 6: Joint Project E6-Dovrebanen

4-lane E6/double track railway Strandlykkja- Kleverud/Labbdalen – FP3

Key information	
Contract type	Construction contract Unit price
Project method	Model, Manual V770
Contract sum	1,8 bill NOK
Extra costs (T-Nota)	149,5 mill NOK
No. of Changes (CO's, T-Nota)	178
T-nota % of contract sum	8,3%
Contractor	Hæhre Entreprenør
Consultant	Cowi

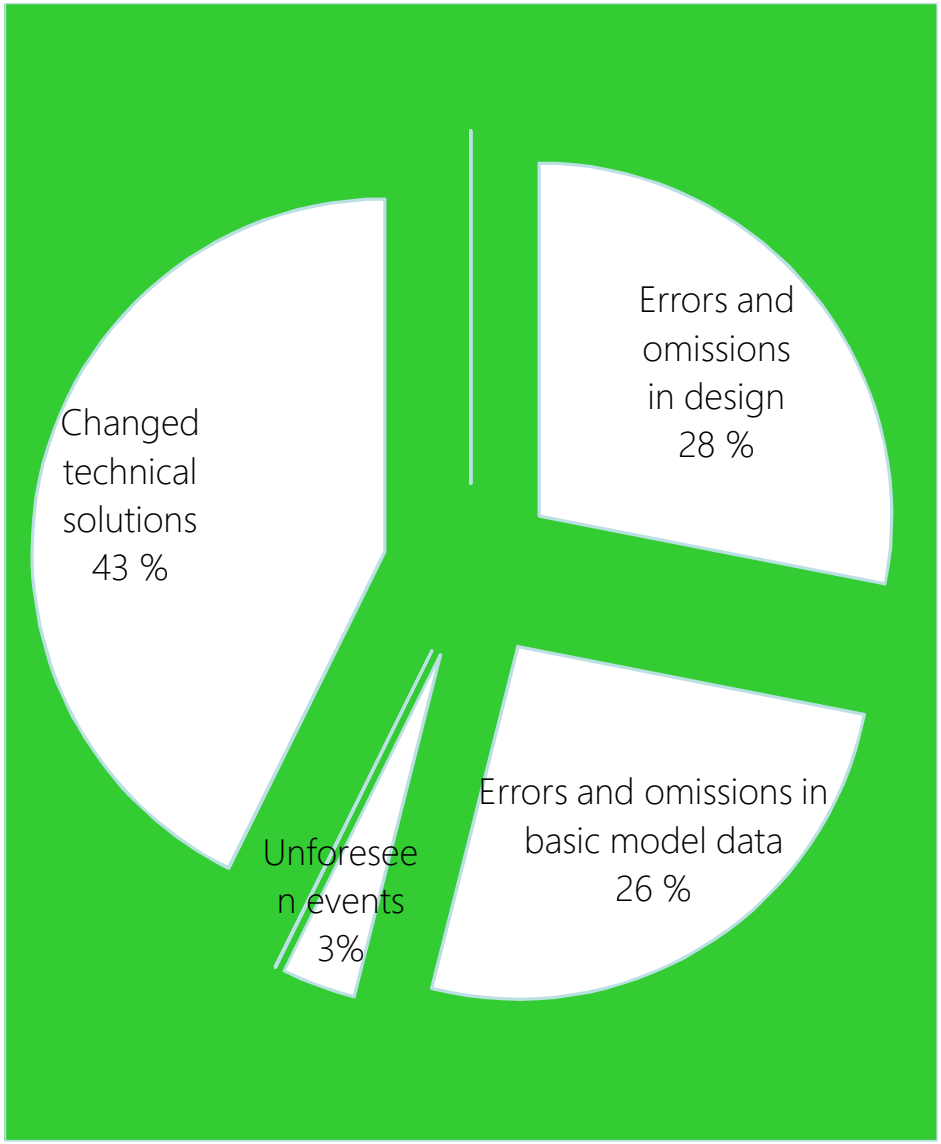
BIM-modell: Statens vegvesen/Jernbaneverket

VIANOVA

Project 6: Joint Project E6-Dovrebanen

4-lane E6/double track railway Strandlykkja- Kleverud/Labbdalen – FP3

Key information	
Contract type	Construction contract Unit price
Project method	Model, Manual V770
Contract sum	1,8 bill NOK
Extra costs (T-Nota)	149,5 mill NOK
No. of Changes (CO's, T-Nota)	178
T-nota % of contract sum	8,3%
Contractor	Hæhre Entreprenør
Consultant	Cowi



VIANOVA

Project 6: Joint Project E6-Dovrebanen

4-lane E6/double track railway Strandlykkja- Kleverud/Labbdalen – FP3

The quality of the setting-out data using a collaboration model is the greatest benefit of model use. The data flow to machine control prevents manual errors.

Jarle Kristian Tangen, Division Manager NPRA Region East
Joint Project E6-Dovrebanen & E6 Gardermoen-Biri

Statens vegvesen

VIANOVA

Project 6: Joint Project E6-Dovrebanen

4-lane E6/double track railway Strandlykkja- Kleverud/Labbdalen – FP3

BIM models no doubt contribute to reducing the contractor's risk. One feels safer both about price and project implementation when handing over the tender.

Arve Krogseth, Project Manager
Joint Project E6-Dovrebanen FP3

HÆHRE

VIANOVA

Effects by using Manual V770 Model Data

Economic benefits

- We can deduce that model-based projects reduces errors and deficiencies in the design material. This means faster construction and lower cost.
- We can also deduce that more focus on basic model data quality will reduce the "unforeseen" proportion of CO´s.
- The change orders are reduced significantly. The analysis shows an 11% decrease in change orders using the model design method vs traditional.

VIANOVA

Model server – the future step in collaboration…and it's here

Drawing	Transfer	Geometry	2D	Sequential
Model	Share	Object	3D/VR	Integrated

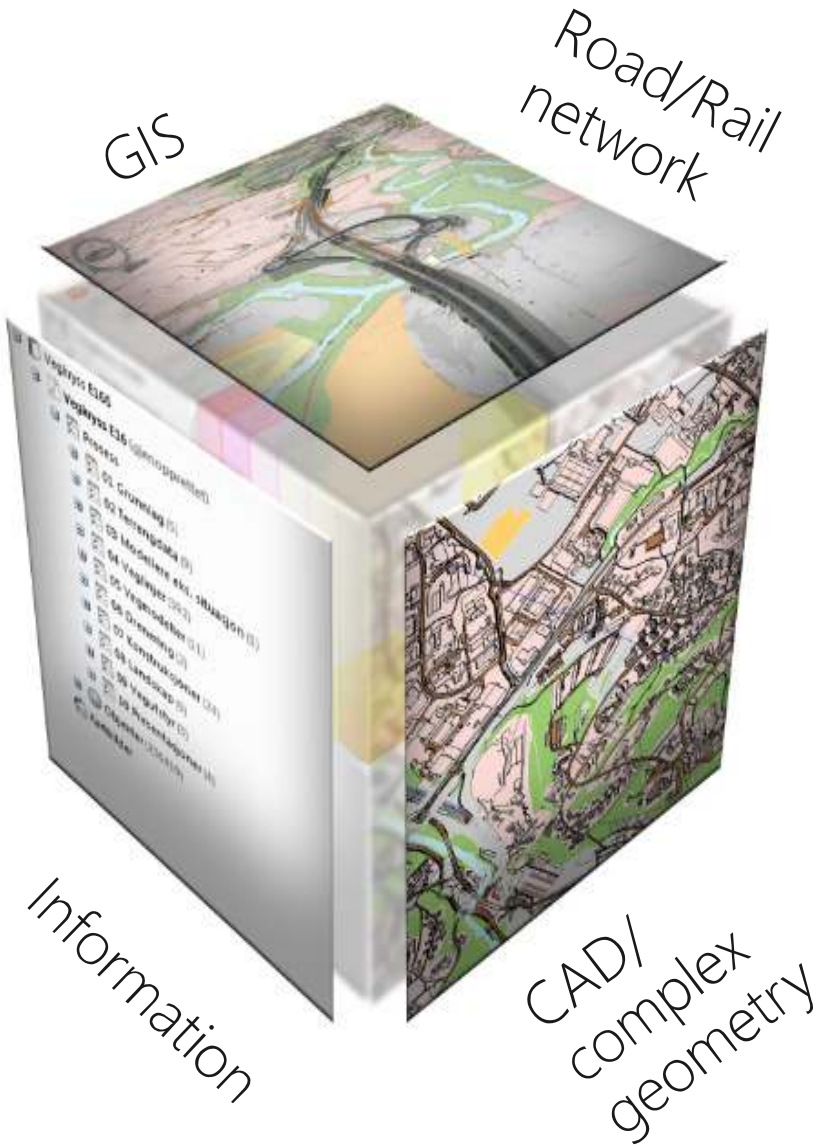
RECIEVE

SHARE

Collaboration-model, Gjønnes Subway Station Planners: Aas Jakobsen & Vianova PT Owner: KTP AS

VIANOVA

Object models will be shared through the whole life-cycle



Object model based on

- ISO 19100 series of standards
  - ISO 19107 Geometry, ISO 19109 Feature Catalogue, ISO 19111 Coord. Reference System, ISO 19148 Linear Reference System
- OGC's WMS and CityGML
- Inspire Directive

Further harmonizing:

- CityGML tunnel model and IFC tunnel model
- CityGML bridge model and IFC bridge model
  http://www.citygmlwiki.org/upload/0/02/CityGML_Tunnel.pdf
  http://www.citygmlwiki.org/upload/a/a0/CityGML_Bridge.pdf
- Extende LandXML format (InfraModel Finland)

VIANOVA

VIANOVA

Takes You There

Pioneering BIM for Infrastructure