

Safely transitioning from ECLIPSE to INTERSECT

Inject QC & optimize expertise with Petrel Guru

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Total



What's Next?

SIS Global Forum 2017

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Le Palais des Congrès de Paris

Schlumberger

SUMMARY

- INTERSECT deployment in TOTAL
- Migration workflow challenges
- Guru workflow & principles - Feedback
- Application 1: QC geometry & 3D simulation properties
- Application 2: QC ECLIPSE to INTERSECT migration
- Conclusions & way forward

INTERSECT deployment in TOTAL

- 2012: Total joins Schlumberger-Chevron on INTERSECT
- 2013: Total acquires PANGEA super computer (220000 cores, 6.5 Pflops)
- 2017: INTERSECT is Total's in-house simulator
 - INTERSECT on all main assets in HQ – Majority in affiliates but ECLIPSE still used
 - Specific TOTAL-INTERSECT in-house version to support Total's Business & Operations:
 - Integrated network, Specific EOR options, ... – *Development teams in Houston/Pau/Abingdon*
- Total is using in-house and multi-vendor workflows with INTERSECT
 - In-house Modeling, Pre Post Processing Platforms (Sismage-CIG, REPLIX), Uncertainty workflows
 - Multiple vendors: in particular, [Petrel RE + Guru](#)

INTERSECT deployment in TOTAL

- Total users feedback on INTERSECT:

- Runs better & faster than ECLIPSE in vast majority of cases – 3D parallel easy to use
 - *Many operational models (big & complex models) can only run using INTERSECT*
- Very flexible & powerful Field Management
- 3D Peaceman connection factors inside INTERSECT (uncertainty workflows)
- Custom scripts give access to new workflows (partner functionality)
- Very efficient Reservoir Coupling & Integrated Surface Network (in-house) – Preferred to ECLIPSE Coupling+Network
- Flexible workflows => *INTERSECT successfully wired to Total in-house solutions for efficient use*

- Bottlenecks

- Need to learn new simulator & new workflows => Change management & training
- Bulk data format (gsg) not open => Consortium is developing RESQML input/output for INTERSECT
- File management & syntax => Total developed an in-house deck editor (Res. Eng. Platform for IX = REPLIX)
- Other challenges - See next slide

INTERSECT deployment challenges

- Migration workflow

- Many existing ECLIPSE models built outside Petrel

=> Massive migration: QC is critical & time consuming



**Behavior differences
or limitations?**

**Match quality?
Mismatch reasons?**

- Optimize and share expertise resources

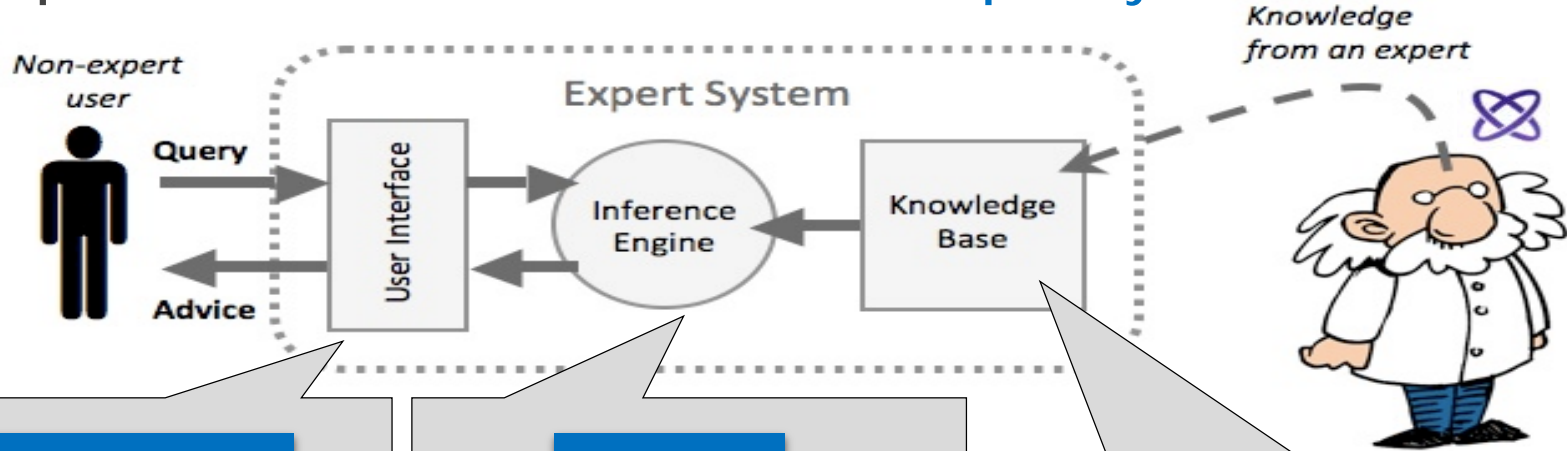
- Simulation team daily tasks: support, training, testing, methodology, deploy

**How to limit
software manipulation
in a multi-vendor workflow?**

**How to automate
complex & repetitive QC
tasks?**

**How to smooth
migration process?**

Guru provides the framework to build an expert system



Guru User interface

Guided Workflow

Simulation Case
Answer: IX_161_MODEL2

Output folder name
Answer: QC

Well diameter (for ex: 0.15)
Skin calculation
0.15

Test & report manager

Type	Name
1	Sim. case - results per well - s...
2	Sim. case - results 3D static an...
3	Sim. case - results for field - S...
4	3D grid - cell geometry and pr...
5	Sim. case - inputs QC
6	QC Migration via Line Plots
7	QC Geometry & 3D Sim Props
8	QC Migration using 3D Simula...

Guru Engine

Workflows

- Guided workflows
 - Ask for an object
 - 123 Ask for a numeric value
 - abc Ask for a text input
 - YN Ask a Yes/No question
- Quality reporting
 - Screen capture
 - Create new window
 - Create new well section window
 - Create report
 - Get min/max of a seismic inters
 - Insert seismic intersection
 - Set camera position
 - Traffic light
 - Get simulation case input data
 - Size of reference list column
 - Select from reference list
 - Get statistics of results object

Guru Customizable Knowledge Database*

Search results

intersect

Refine Search

Reservoir Engineering
Difficulty
Page type
Author

Premium Content
Premium Content Only:

[INTERSECT hub](#)
Reservoir Engineering | Use the INTERSECT tab to control this simulator.

[Appendix_INTERSECT_support](#)
Reservoir Engineering | INTERSECT output in Patel has two different modes.

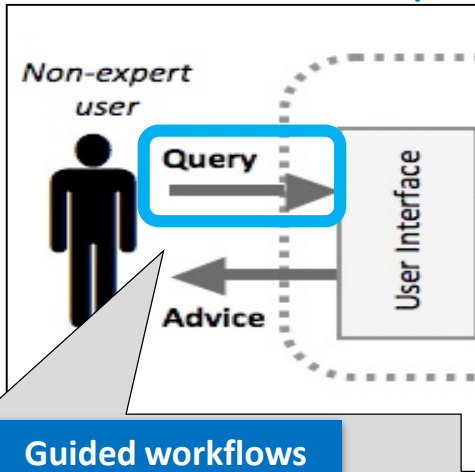
[INTERSECT viewer](#)
Reservoir Engineering | You can open the INTERSECT case viewer either by clicking Viewer on the Advanced tab in the Define simulation case dialog box, or by right-clicking on your case in the Case pane, and clicking Viewer.

[Results tab_INTERSECT](#)
Reservoir Engineering | Use the Results tab to select the outputs for an INTERSECT case.

[INTERSECT user guide](#)
Reservoir Engineering | You can create and edit an INTERSECT simulation run using the INTERSECT user guide process. You can use these edit in simulation case to extend the existing Patel simulator support.

*Not yet investigated in Total simulation department
=> Using internal knowledge sharing solutions

Guru workflows: input



Guided workflows Interactive test

Guided Workflow

Simulation Case
Answer: IX_161_MODEL2

Output folder name
Answer: QC

Well diameter (for ex: 0.15)
Skin calculation
0.15

Ok Cancel

Test templates

Monitor data quality during a project lifecycle

QC Geometry & 3D Sim Props

Information Overview **Input** Statistics

Test inputs

Enter a name for the test.
QC Geometry & 3D Sim Props

1. Simulation case
[arrow] [input field]

2. Typical well diameter (skin computation)
0.15 * Optional

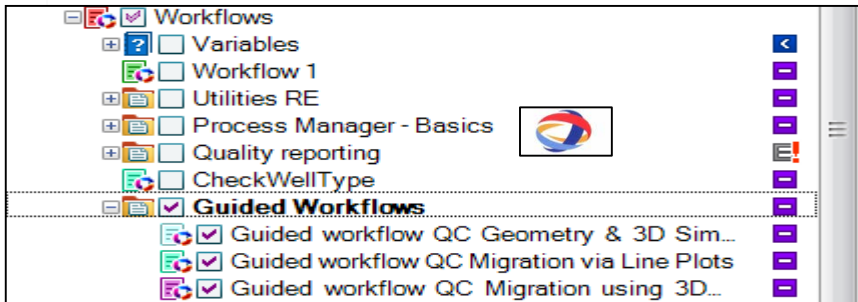
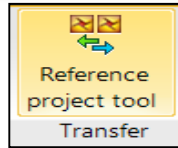
3. Name of Plot folder that will be created by the test
QC Geom & 3D Sim Props * Optional

Select test in template library → Configure test with your data → Run to get report

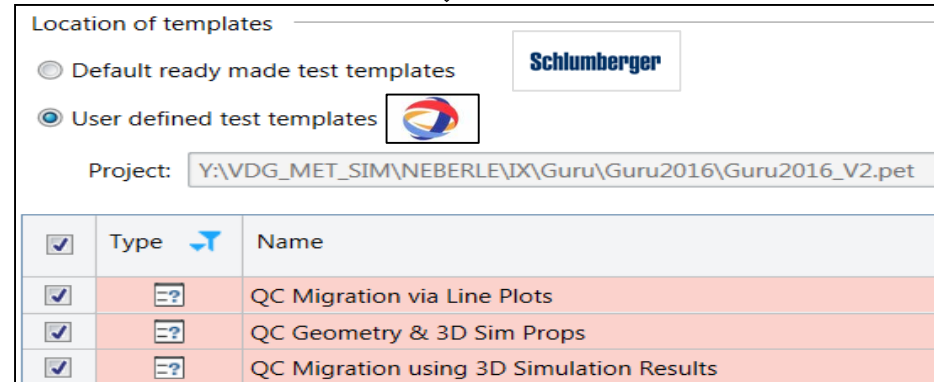
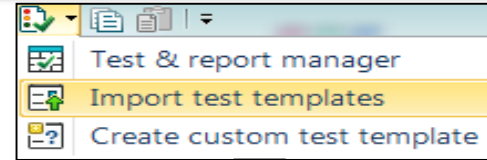
Test templates		Tests		Reports	
Name	Type	Name	Valid	Name	Result
QC Geometry & 3D Sim Props		QC Geometry & 3D Sim Props	✓	TESTGEOM 10/13/2016 14:30:50	●
				QC Geom & 3D Sim Props 10/13/2016 15:09:26	●

Guru workflows: deployment

Guided workflows
Total



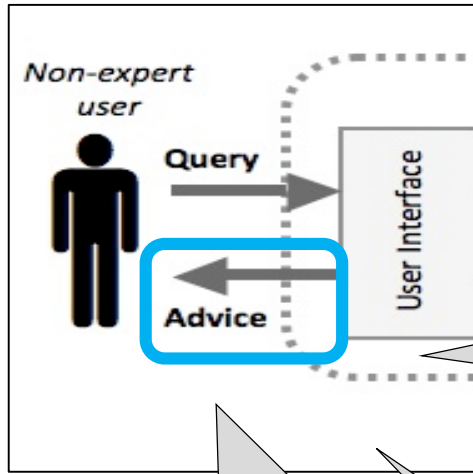
Test templates
Slb and Total



Could not customize ready made test templates

⇒ Useful feature for the future

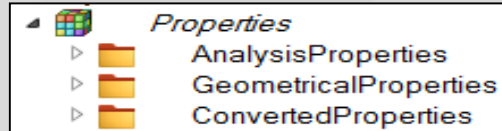
Guru workflows: output



Hide complexity:

- Computations
- Tricky/repetitive manipulation
- Plot configuration

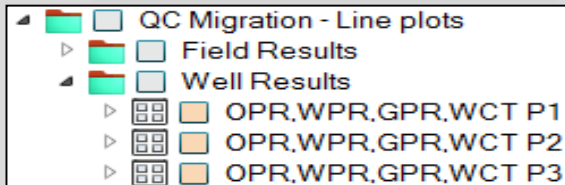
QC Properties



Reports

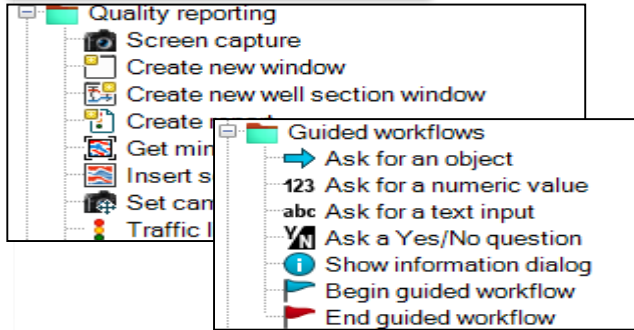
- **FAIL - Cell Angle IK**
Cells are too distorted; consider
- **CAUTION - Cell Angle JK**
Check if distorted cells are inside
- **CAUTION - Cell Angle IJ**

QC plots/windows



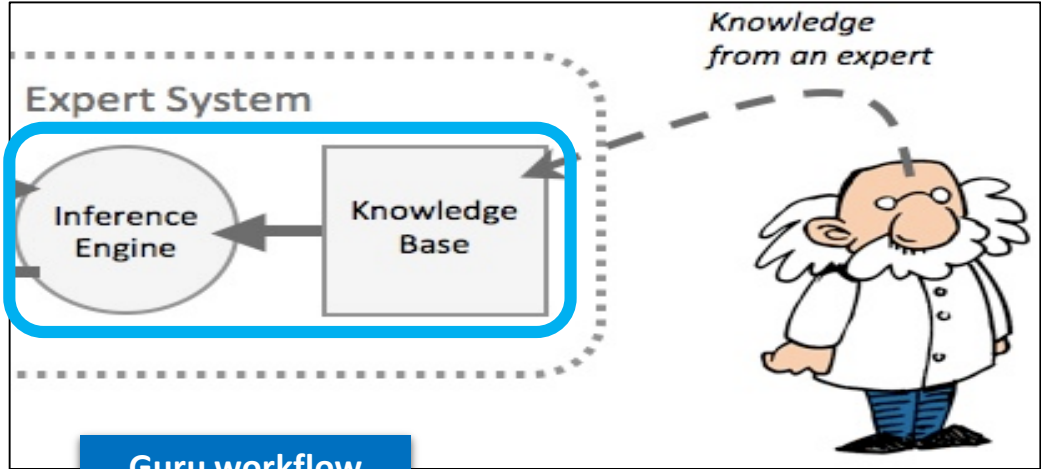
Guru workflows: behind the scene

Guru Engine Toolbox

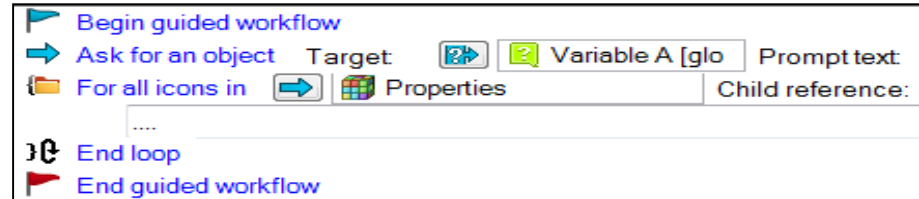


Let the experts do the programming ...

- Very powerful
 - Tricky manipulations going on in the background
- ⇒ can work-around most limitations in Petrel workflow tools




Guru workflow




Application 1: QC Geometry & 3D Simulation Properties

- Quality reporting
 - Test templates
 - Custom test templates
 - QC Geometry & 3D Sim Props**
 - QC Migration via Line Plots
 - QC Migration using 3D Simulation Results

Analyze geometry, static & recurrent 3D properties of a single simulation case



Simulation Support
QC Geom & 3D Sim Initial Props workflow
Report
 Author: j0030765
 Report created on: 10/13/2016
 Report ran by: j0030765



REPORT RESULT - PASS - Report Concern Level
 OK Check report summary section

Project
 Project name: Guru2016_V2.pet
 Project location: Y:\VDG_MET_SIM\NEB... (Guru\Guru2016\)

[Geometrical Properties Statistics table](#)
[Simulation Properties Statistics table](#)
[Analysis Properties Statistics table](#)
[Analysis Plots](#)

Simulation Case/Grid information

CaseName	GridName	Dimensions	Cells	%Active	...
ECL_161_MODEL2	ECL_161_MODEL2.EGRID	60 x 39 x 3	7020	87	

Grid	Min	Max	Delta	...
X	807540.38	814608.25	7067.88	
Y	9436084	9443115	7031	
Z	-3522.13	-3269.87	252.26	

Bookmarks to different report sections

Compute relevant reservoir engineering parameters

Links to Petrel objects

Quality flags

Geometrical Properties Statistics

Property	Min	Mean	Max	N	QC	Note
CellAngle_IK	0.09	14.02	76.76	6075	●	Sum RFIP inside distorted cells
CellAngle_JK	0.01	2.25	60.87	6075	●	Sum RFIP inside distorted cells
CellAngle_IJ	0.01	2.39	67.86	6075	●	Sum RFIP inside distorted cells
CellInsideOut	0	0	0	6075	●	

QC tips & recommendations

Simulation Properties (@t=0) Statistics

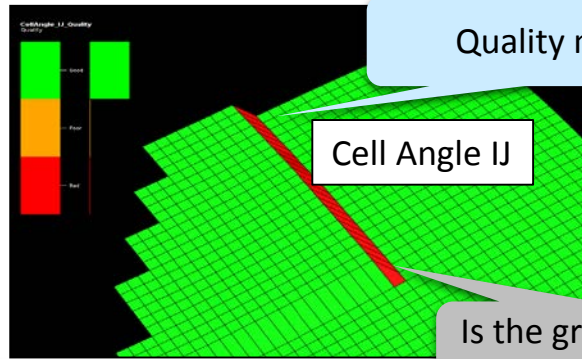
ConvertedProp	Min	Mean	Max	N	QC	Note
RPORV	860	8743	35256	6075		Compare PoreV vs RPORV
RPORV	858	8719	35159	6075		Use Store option
Φ_PORO	0.0587	0.1168	0.2292	6075		
%NTG	0.1173	0.4273	0.6905	6075		
k _i _PERMX	79.3564	130.1017	281.6443	6075		Kh_effective=Kh_total/NTG
k _i _PERMY	79.3564	130.1017	281.6443	6075		Kh_effective=Kh_total/NTG
k _i _PERMZ	3.2659	5.5921	9.7098	6075		Kv_effective=Kv_total
TRANX	0	7.07	18.52	6075		Analyze presence of barriers
TRANX	0	7.01	17.78	6075		Analyze presence of barriers
TRANZ	0	18.2	49.82	6075		Analyze presence of barriers
SWAT	0.22	0.65911	1	6075		Consistent with GOC/WOC?
SOIL	0	0.24089	0.78	6075		Consistent with GOC/WOC?
SGAS						Consistent with GOC/WOC?

Customizable QC property lists (API Tracking, Brine, Tracers, ...)

Application 1: QC Geometry & 3D Simulation Properties

Properties

- AnalysisProperties
 - PORV_CONTRAST_I
 - PORV_CONTRAST_J
 - PORV_CONTRAST_K
 - TRANX_CONTRAST
 - TRANX_CONTRAST
 - TRANZ_CONTRAST
 - CellActivity
 - KvKh
 - KxKy
 - KxNet
 - KyNet
 - SkinMinVerticalWells
 - SkinMinHorizWells
- GeometricalProperties
 - CellAngle_IJ
 - CellAngle_JK
 - CellAngle_JK
 - CellInsideOut
 - DX
 - DY
 - DZ
 - Depth
 - BulkV
 - Layer
 - WellIndex
 - REGULARITY_X
 - REGULARITY_Y
 - ELONGATION

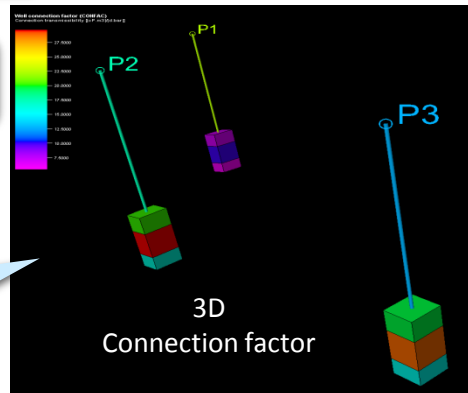


Is the grid suitable for flow simulation?

Analysis properties

Geometrical QC properties

Fit-to-purpose 3D views



Any issue with well connection factor?

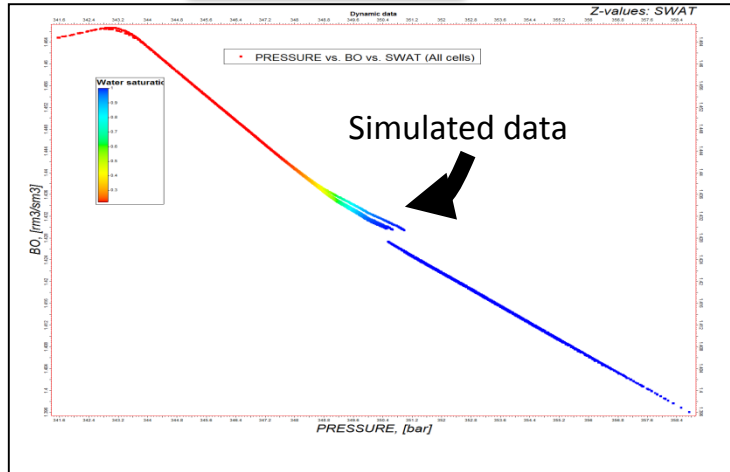
QC Geom & 3D

- 3D
 - CellActivity
 - PORV [Any]
 - PERMX [Any]
 - PORO [Any]
 - NTG [Any]
 - TRANX [Any]
 - TRANX [Any]
 - TRANZ [Any]
 - CellAngle_IJ [Any]
 - CellAngle_JK [Any]
 - CellAngle_JK [Any]
 - REGULARITY_X [Any]
 - REGULARITY_Y [Any]
 - ELONGATION [Any]
 - CONFAC [Any]
- Histogram
 - PERMX vs PERMY
 - PERMZ
 - CellAngle_IJ vs CellAngle_JK
 - REGULARITY_X vs ELONGATION
 - SkinMinVerticalWells vs SkinMinHorizWells
 - PORO vs NTG
 - SWAT vs SGAS
 - OIL_DEN
 - OIL_VISC
 - RFIPOIL vs RFIPWAT
- CrossPlot
 - PERMX vs PERMY vs PORV
 - PORO vs NTG
 - KvKh vs NTG
 - PRESSURE vs Depth vs SWAT
 - RS vs Depth vs OIL_DEN
 - RPORV vs Depth vs SWAT
 - PRESSURE vs BO vs SWAT
 - PRESSURE vs OIL_VISC vs SWAT

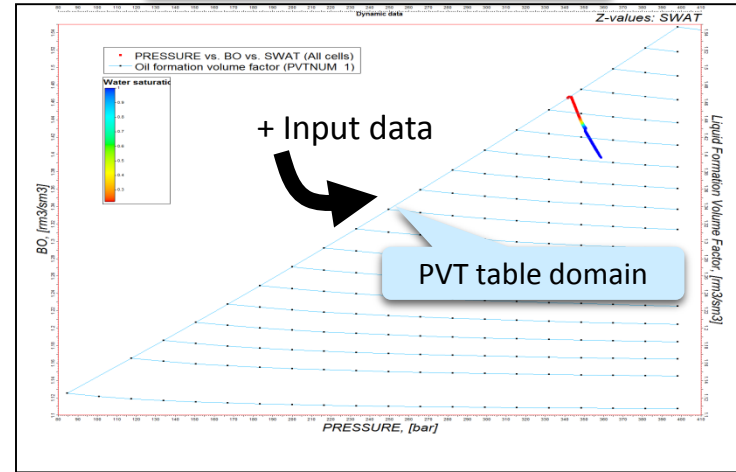
Pre-configured plots

Application 1: QC Geometry & 3D Simulation Properties

Guru output



Manually Customized plot



Not all tools are available (yet) in scripts to configure/customize plots

⇒ Ex: cannot impose min/max range on plots or overlay plots to QC input vs output

But Guru can prepare plot basis

⇒ adv. users can customize further

Application 2: QC ECLIPSE vs INTERSECT migration

Compare 2 cases using **line plots** or **3D simulation results** or **PRT**

- Quality reporting
 - Custom templates
 - QC ECL vs IX - Line Plot Results
 - QC ECL vs IX - 3D Results
 - QC ECL vs IX - Reports**

ECLIPSE to INTERSECT Migration QC using 3D Output
 Report Name: Original Case
 Author: j0030765

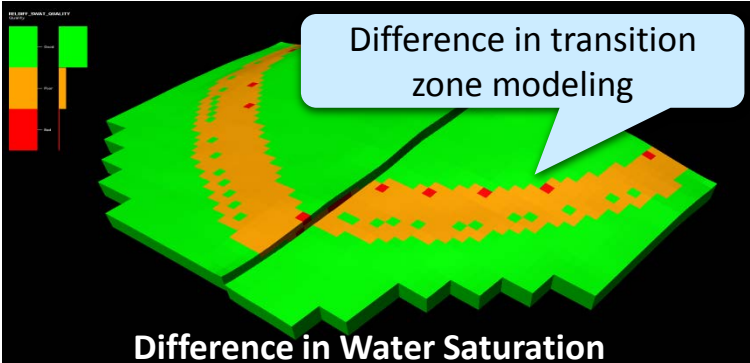
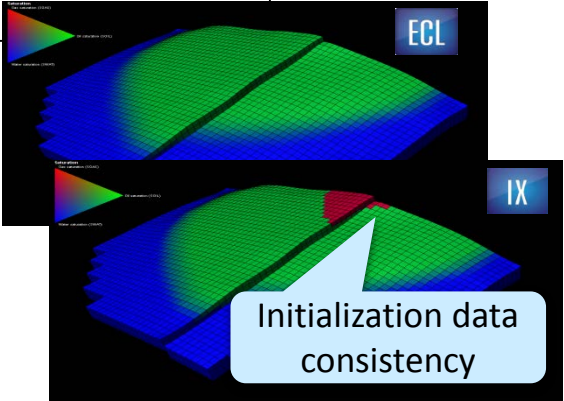
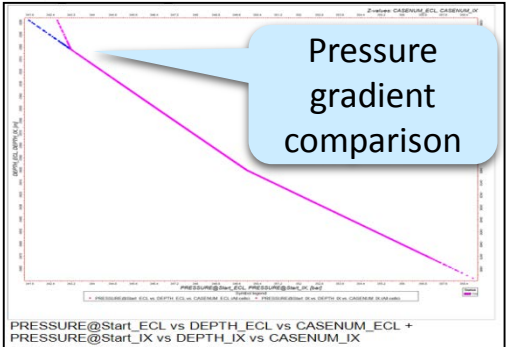
Project
 Project name: Guru2016_V2.pet
 Project location: Y:\VDG_MET_SIM\NEBERLE\IX\Guru\Guru2016\

- Bookmarks**
- [ECLIPSE Simulation Case General Information](#)
 - [INTERSECT Simulation Case General Information](#)
 - [ECLIPSE Simulation Case Statistics](#)
 - [INTERSECT Simulation Case Statistics](#)
 - [ECLIPSE vs INTERSECT - Difference Statistics](#)
 - [ECLIPSE vs INTERSECT - Relative Difference Statistics](#)
 - [ECLIPSE vs INTERSECT - Plots](#)

- Useful links**
- [IXWorld Community](#)
 - [REPLIX Community](#)
 - [Petrel4U Community](#)

ECLIPSE vs INTERSECT - Relative difference Statistics

Absolute Relative Difference	Min	Mean	Max	N	QC	-	QCPropsList
%RELDIFF_DEPTH	0	0	0	16			●
%RELDIFF_TRANX	0.05	0.32	2.22	4614			●
%RELDIFF_TRANY	0.06	0.31	2.08	4529			●
%RELDIFF_TRANZ	0.02	0.26	0.73	3836			●
%RELDIFF_SWAT@Start	0	4.55	15.96	1979			●
%RELDIFF_SWAT@End	0	5.83	99.37	3763			●
%RELDIFF_PRESSURE@Start	0	0	0.32	5792			●
%RELDIFF_PRESSURE@End	0.31	2.98	12.83	6075			●

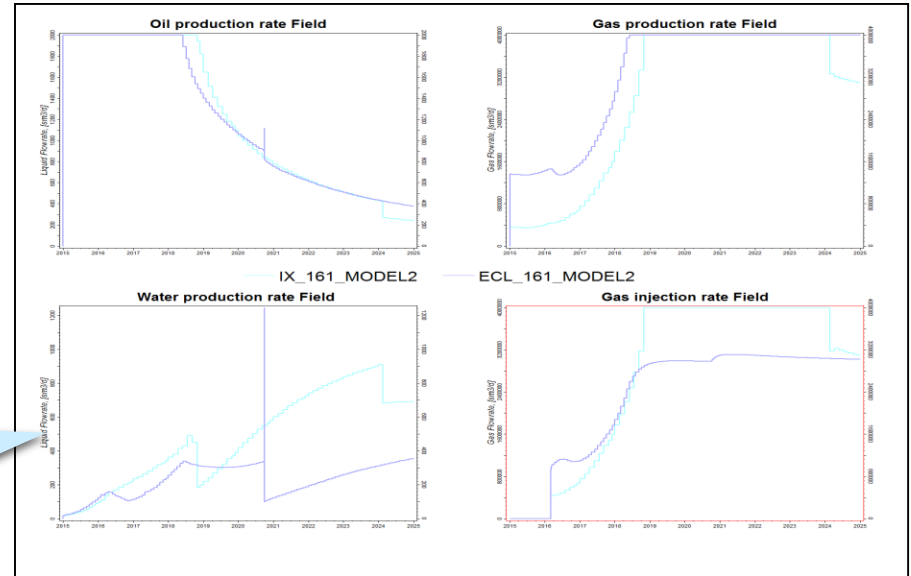


Application 2: QC ECLIPSE vs INTERSECT migration

Statistics							
Identifier	Vector	Date	Case1	Case2	Delta	Delta%	ConcernLevel
Field	Pore volume at reservoir conditions	"01-Jan-2015"	52970652	52970232	420	0.000792891882848639	●
Field	Oil in place	"01-Jan-2015"	14987345	14998141	10796	0.0720341061075194	●
Field	Gas in place	"01-Jan-2015"	2757210112	2750270720	6939392	0.251681653487277	●
Field	Water in place	"01-Jan-2015"	31134582	31140072	5490	0.0176331257634999	●

Statistics on line plot data at t

Detect & highlight mismatch in time



Application 2: QC ECLIPSE vs INTERSECT migration

QC of 3D Simulation Results

Summary

● **REPORT RESULT - FAIL - Migration message criticality**

Fail - Found 1 message with a severe criticality GSATPROD not migrated

Migration QC Report

Migration report important messages

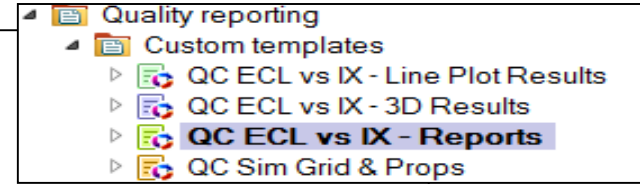
Out of 23 NOT_MIGRATED messages found 5 important messages
NSTACK is a TUNING related keywords => safely ignore, not migrated because IX has a different behavior
WBP9 => must use WBPC equivalent in IX
WBP5 => must use WBPC equivalent in IX
TUNING => safely ignore, not migrated because IX has a different behavior
GSATPROD => not migrated so must implement it manually in ixf

Active Cells Comparison

ECL	IX
6075	6075

IX Report important warnings

INFO A gas oil contact has been found in the equilibrium model 'EQLNUM_1_PVTNUM_1' at a depth of 3301.95 m with an oil bubble point pressure of 343.196 bar.



Pick & highlight important messages/information from migration and/ or simulator PRTs

```

IFO      Successfully loaded the grid.
:PORT    Grid statistics:
          +-----+
          | Total |
          +-----+
          | Number of Cells | 6075 |
          | Number of Connections (including NNCs) | 15904 |
          | Number of NNCs | 116 |
          +-----+
    
```

IX Report

```

IFO      Writing NNC report: IX_161_MODEL2.NNC
IFO      OverrideDataTypeAndFluidType is set to TRUE. Equilibrium DataType and FluidType will be recalculated.
IFO      Equilibration mode for 'EQLNUM 1 PVTNUM 1' with top=3269.87 m, bottom=3497.01 m, datum=3400 m,
    
```

Migration Report

```

IX_161_MODEL2.DATA | 193 | ECHO | SCHEDULE | NOT_MIGRATED
-----
IX_161_MODEL2.DATA | 255 | GSATPROD | SCHEDULE | NOT_MIGRATED
    
```

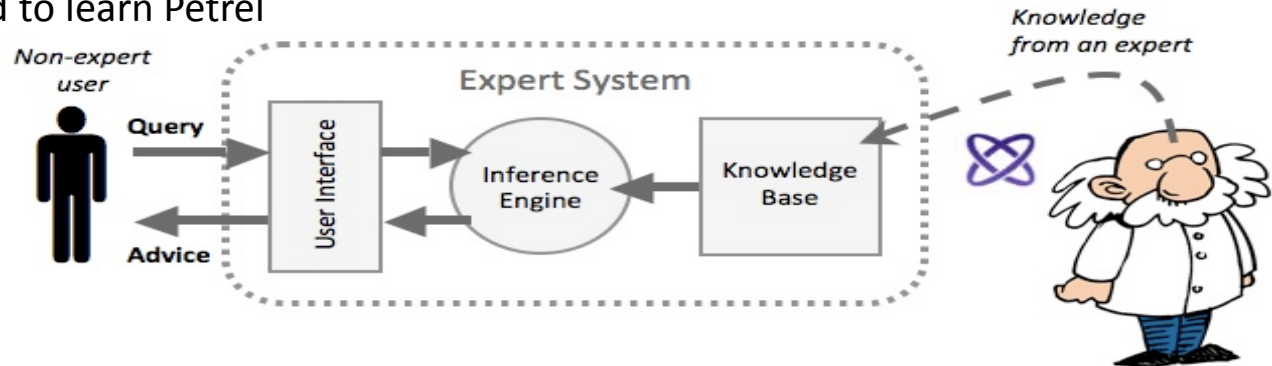
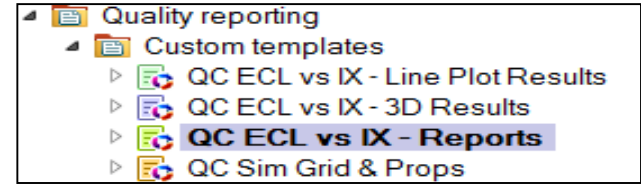
ECLIPSE Report

```

                                0.0 DAYS ( 1-JAN-2015):
NUMBER OF ACTIVE CELLS IS 6075
--MESSAGE AT TIME 0.0 DAYS ( 1-JAN-2015):
THE MEMORY REQUIRED TO PROCESS THE SOLUTION SECTION IS
13330 BYTES
    
```


Conclusions

- **Feasibility phase – Success**
- **QC workflows available for RE users with Guru**
 - Extract & compile relevant QC information
 - Inject expertise & guide users towards problems & solutions
 - Release pressure on support team & improve migration/simulation quality
- **Hide complexity – Manage frustration**
 - Simple input, no software manipulation for users
 - Users not even required to learn Petrel



Way forward

- **Deployment of Guru QC workflows:**
 - ***Upgrading workflows to Petrel 2017 – On-going***
 - Petrel users => access Guru / RE workflows with Reference Project tool
 - ***Dynamic link from within in-house INTERSECT platform (REPLIX) – On-going***
 - Launch Petrel Guru from batch file – Used in background to generate a QC report
 - Reach Petrel & non-Petrel users, no configuration or any Petrel knowledge required
- **Other potential applications**
 - Automation of analysis of regression tests for INTERSECT developments & new versions
 - In-house INTERSECT training:
 - knowledge of Petrel for pre- & post- processing no longer a pre-requisite
 - guided exercises without software manipulation

BACKUP

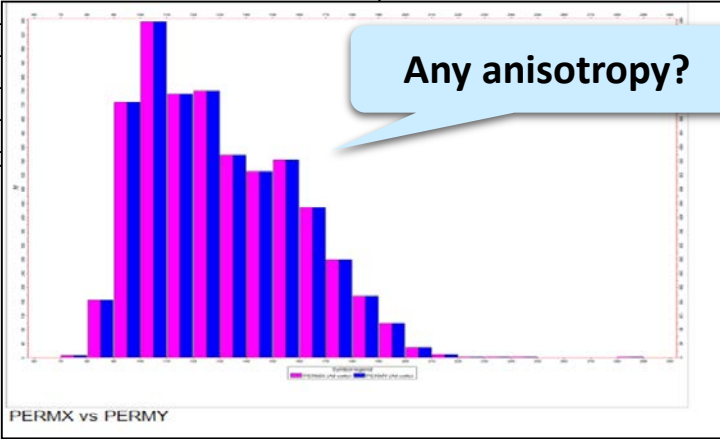
Application – QC workflows for simulation

3D	Histogram	CrossPlot
3D_CellActivity [Any]	PERMX vs PERMY	<input checked="" type="checkbox"/> PERMX vs PERMY vs PORV
3D_PORV [Any]	PERMZ	<input checked="" type="checkbox"/> PORO vs NTG
3D_PERMX [Any]	CellAngle_IJ vs CellAngle_JK	<input checked="" type="checkbox"/> KvKh vs NTG
3D_PORO [Any]	REGULARITY_X vs ELONGATION	<input checked="" type="checkbox"/> PRESSURE vs Depth vs SWAT
3D_NTG [Any]	SkinMinVerticalWells vs SkinMinHorizWells	<input checked="" type="checkbox"/> RS vs Depth vs OIL_DEN
3D_TRANX [Any]	PORO vs NTG	<input checked="" type="checkbox"/> RPORV vs Depth vs SWAT
3D_TRANY [Any]	SWAT vs SGAS	<input checked="" type="checkbox"/> PRESSURE vs BO vs SWAT
3D_TRANZ [Any]	OIL_DEN	<input checked="" type="checkbox"/> PRESSURE vs OIL_VISC vs SWAT
3D_CellAngle_IJ [Any]	OIL_VISC	
3D_CellAngle_IK [Any]	RFIPOIL vs RFIPWAT	
3D_CellAngle_JK [Any]		
3D_REGULARITY_X [Any]		
3D_REGULARITY_Y [Any]		
3D_ELONGATION [Any]		
3D_CONFAC [Any]		

Links to Petrel objects

Customizable lists to adapt to different studies

	Set reference list		3DPlotConfig
	Set reference list		HistoPlotConf
	Set reference list		CrossPlotConf



3D plots

Histograms

Cross plots