



Middle Distillate Optimization with Spiro Digital Twin

UK Refinery Case Study



A simple tool to close the gap between planning and operations and drive your refinery to optimal efficiency.

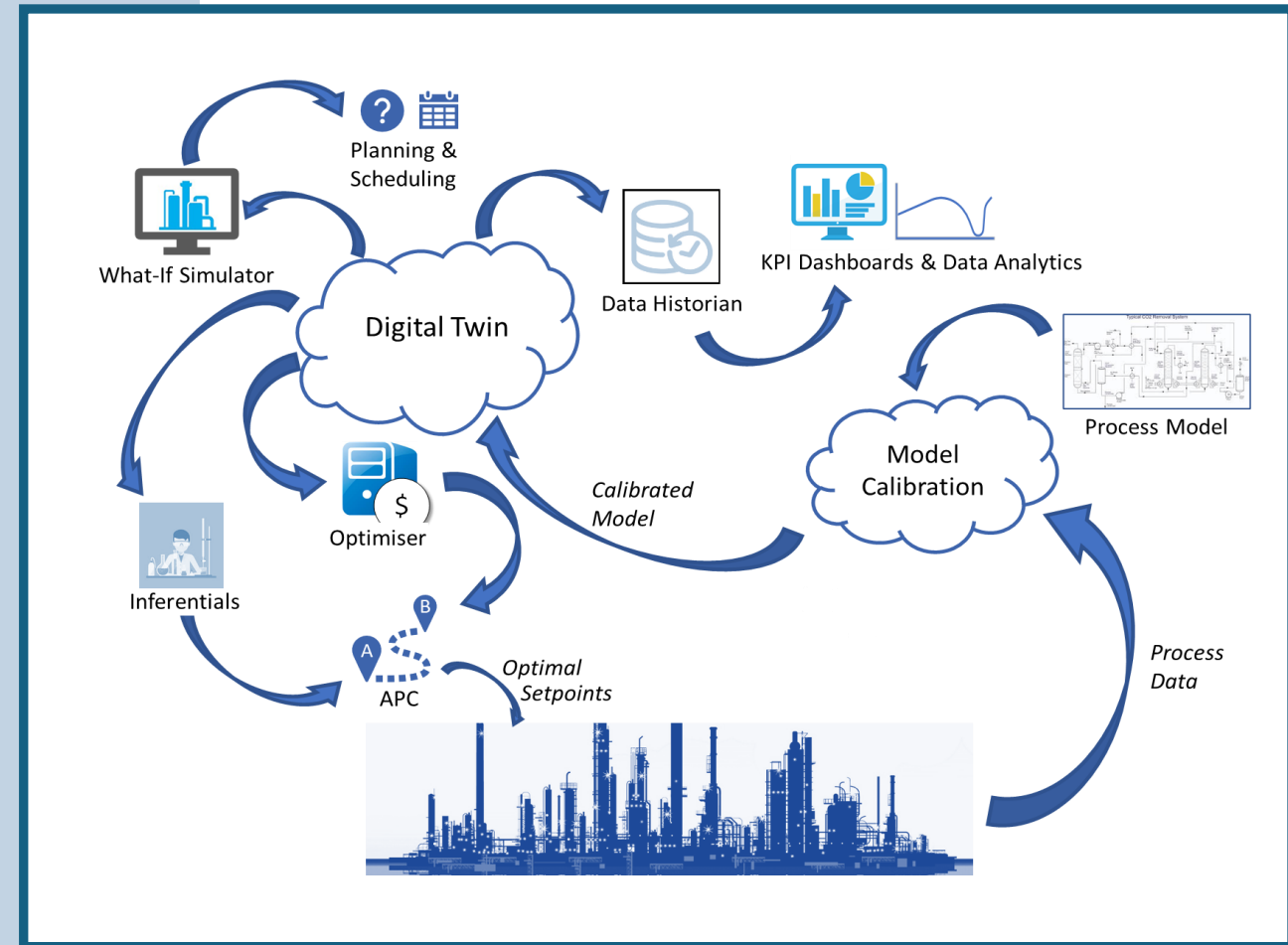
Dynamic data reconciliation ensures that the process model is aligned with the real-world process.

Deployment in the **Cloud** or **On Premises**.

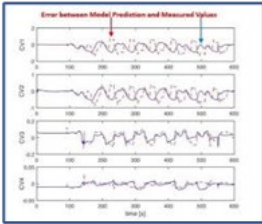
Full integration with local APC including process dynamics

One model provides multiple functionalities

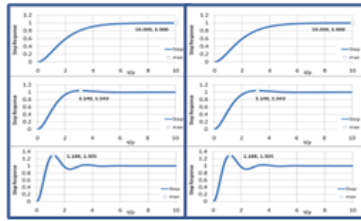
What-if Simulator	Inferentials
Online optimization	KPI Dashboards



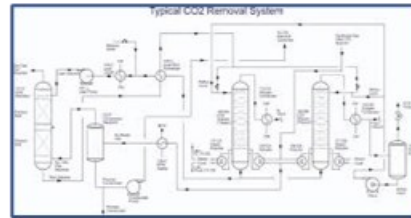
Plant Data + ML



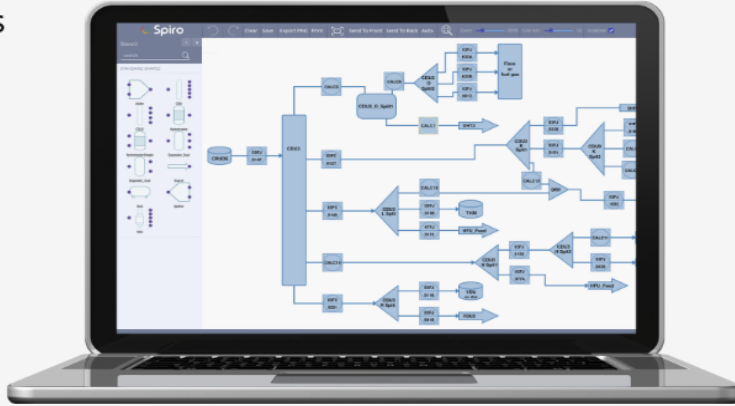
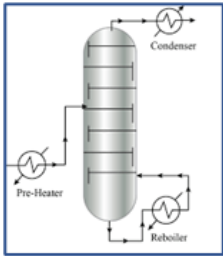
APC Dynamics



Rigorous Simulation + ML



Unit Operation Models



Easy to use **graphic editor** to build process model with a complete **library** of predefined standard refinery units

All models are **easily customizable** to adapt to different unit configurations

APC gain matrix and dynamics are **easy to import** and integrate with model

Degrees of freedom analysis and full offline initialization of the model

Agile modeling approach. Model is easily scalable from unit model to full process.

Hybrid models which include both data-driven and first principles components **significantly reduce the deployment and maintenance effort**

Case study

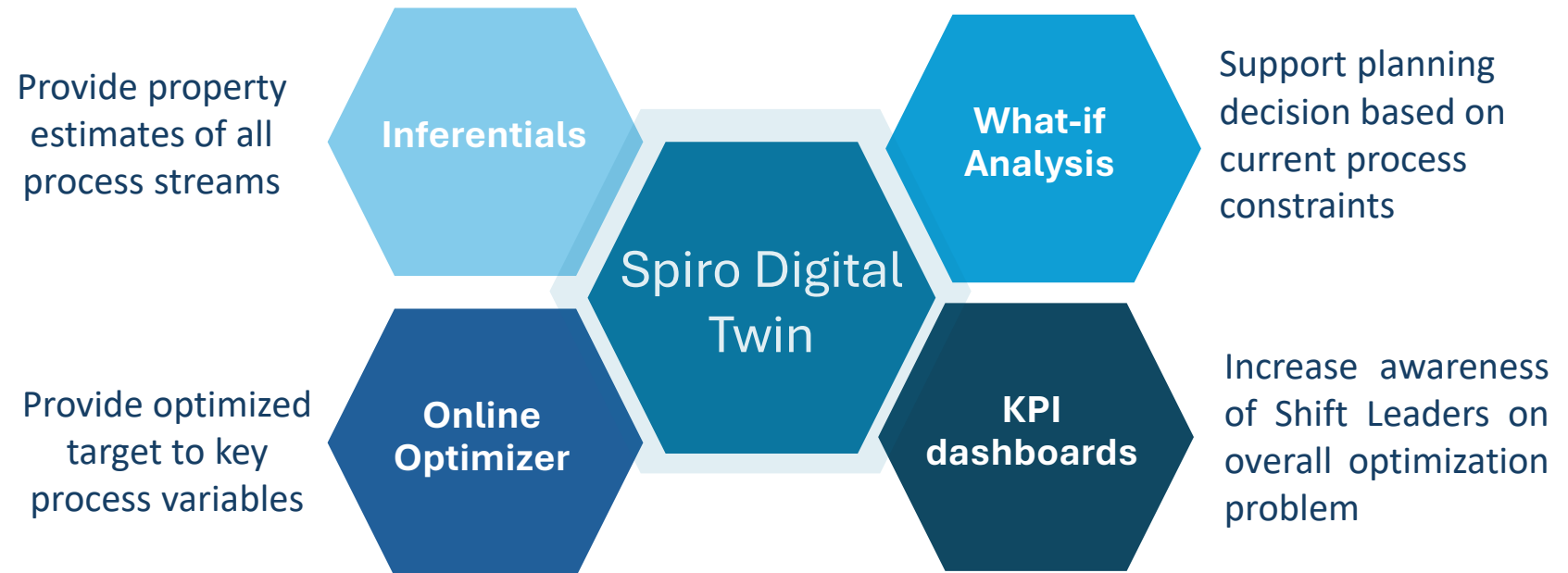
UK Refinery, 140.000 b/d capacity

Target to increase production of middle distillate products (Jet Fuel, ULSD)

Project Scope

- 2 Crude Units
- 2 Naphtha Hydrotreaters
- 1 Diesel Hydrotreater
- 1 Vacuum Unit
- 1 Hydrocracker

Project Deliverables



Delivered solution

- Spiro Team worked in **close interaction** with refinery process team to capture all the requirements during the functional design phase
- Model was **built and fully simulated in Spiro Office based on historical data** and delivered onsite ready for open-loop commissioning. What-if analysis tool allowed to **test the model on different scenarios** with limited effort
- Digital Twin provides a **new solution every two minutes** solving the **full non-linear problem**
- **Flows properties** are **estimated by digital twin** based on process values and **updated with analysers and lab samples** where available.
- Connection with the DCS is managed through **OPC-UA**. All Digital Twin parameters are stored in a **dedicated Influx database**.
- Each unit is configured in separated flowsheet which could be **easily switched OFF if the unit is not in service** without affecting overall solution
- **Flow routing is updated in real time** from DCS using valve positions and flow readings
- A **dedicated DCS display** has been configured to set targets and limits which are not included in APC. From same display is possible to **update economic values** of the three main products (Naphtha/Kero/Diesel).

Challenges

- Complex process flow routings
- Highly variable crude slate
- Changing economics
- Multiple turnarounds and units out of service
- APC available only on some units
- Covid restrictions

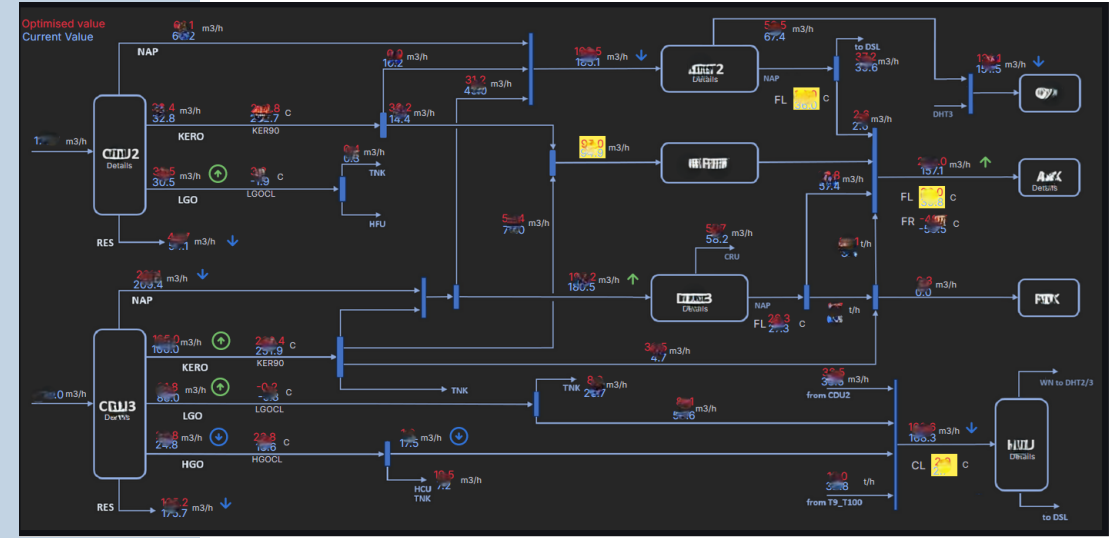


Delivered results

- New process dashboard for Shift Leaders with major constraints and optimization opportunities clearly highlighted
- Increased awareness of process limits by scheduling team leading to a more accurate daily plan
- Giveaway reduction on final products currently under investigation

"The new MDO helps us to get out of our comfort zone and grab optimization opportunities we would miss,,

-- Refinery Shift Leader



NAME	CONTEXT	DESCRIPTION	LOW LIMIT	CURRENT	OPTIMUM	HIGH LIMIT	MOVE	STATUS	UNITS
LGO SPLIT Outlet 2 Volume Flow	CV	to HDT2	50,000	79,978	129,97	150,00	1.49,992	ON	m ³ /h
CDU2 Naphtha Draw Volume Flow	CV	Naphtha Flow	100,00	135,02	134,23	250,00	-0.79,220	ON	m ³ /h
CDU2 Naphtha Draw Astm 95	CV	Naphtha ASTM 95%	140,000	150,79	149,90	165,00	-0.889,43	ON	°C
CDU2 Residue Volume Flow	CV	Residue Flow	85,000	100,44	103,37	400,00	1.2,9285	ON	m ³ /h
CDU2 Lgo Draw Astm 95	CV	LGO Flow	330,00	376,35	372,85	390,00	-3.5045	ON	°C
CDU2 Kero Draw Flash Point	CV	Kero Cloud Point	39,000	41,393	40,765	55,000	-0.62886	ON	°C
CDU2 Lgo Draw Cloud Point	CV	LGO Cloud Point	-10,000	4,5212	-0.64496	5,0000	-5.1661	ON	°C
CDU2 Kero Draw Astm 95	CV	Kero ASTM 95%	220,00	249,48	222,29	245,00	-1.27187	ON	°C
CDU2 Kero Draw Astm 5	CV	Feed Mass Flow	120,000	146,86	145,97	200,00	-0.88943	ON	°C
CDU2 Lgo Draw Volume Flow	MV	LGO Flow	80,000	114,01	135,00	135,00	1.20,992	ON	m ³ /h
CDU2 Kero Draw Volume Flow	MV	Kero Flow	55,000	86,900	63,773	110,50	-1.23,127	ON	m ³ /h
CDU2 Top Tc	MV	Top Temperature	135,00	142,00	141,31	145,00	-0.68418	ON	°C
LGO SPLIT Outlet 1 Volume Flow	MV	to HDT1	34,000	34,000	5,0000	100,00	-1.29,000	ON	m ³ /h
CDU2 Top Pressure	Disturbance	Top Pressure	180,13	180,13				ON	kPa
FEED Outlet Volume Flow	Disturbance		405,06	405,06				ON	m ³ /h
FEED Outlet Astm 5	Disturbance		50,000	50,000				ON	°C
FEED Outlet Pressure	Disturbance		100,000	100,000				ON	kPa
FEED Outlet Flash Point	Disturbance		80,000	80,000				ON	°C
FEED Outlet Astm 95	Disturbance		520,00	520,00				ON	°C
FEED Outlet Bot	Disturbance		265,00	265,00				ON	°C
FEED Outlet Cloud Point	Disturbance		5,0000	5,0000				ON	°C
FEED Outlet Density	Disturbance		930,00	930,00				ON	kg/m ³
FEED Outlet Sulphur	Disturbance		3000,0	3000,0				ON	ppm
CDU2 Top Slope	Fixed		4,8567	4,8567				ON	
CDU2 Sp To Dens Coeff C	Fixed		0,62343	0,62343				ON	
CDU2 Top Offset	Fixed		17,554	17,554				ON	
CDU2 Cp Coeff A	Fixed		-165,25	-165,25				ON	
CDU2 Top Offset	Fixed		-266,57	-266,57				ON	°C
CDU2 Resid Tail	Fixed		-273,15	-273,15				ON	°C
CDU2 Residue Density	StateOut		6614,5	6539,0				ON	ppm
CDU2 Residue Density	StateOut		946,54	946,01				ON	kg/m ³
CDU2 Naphtha Draw Sulphur	StateOut		399,93	393,97				ON	ppm
CDU2 Lgo Draw Sulphur	StateOut	LGO Sulphur	3308,2	3112,3				ON	ppm
CDU2 Top Flash Point	StateOut	Top Flash Point	107,86	88,664				ON	°C