Is your digital twin smarter than you

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Argon&Co

CURRENT WORLD DYNAMICS

TOO MUCH COMPLEXITY FOR US MERE HUMANS TO HANDLE

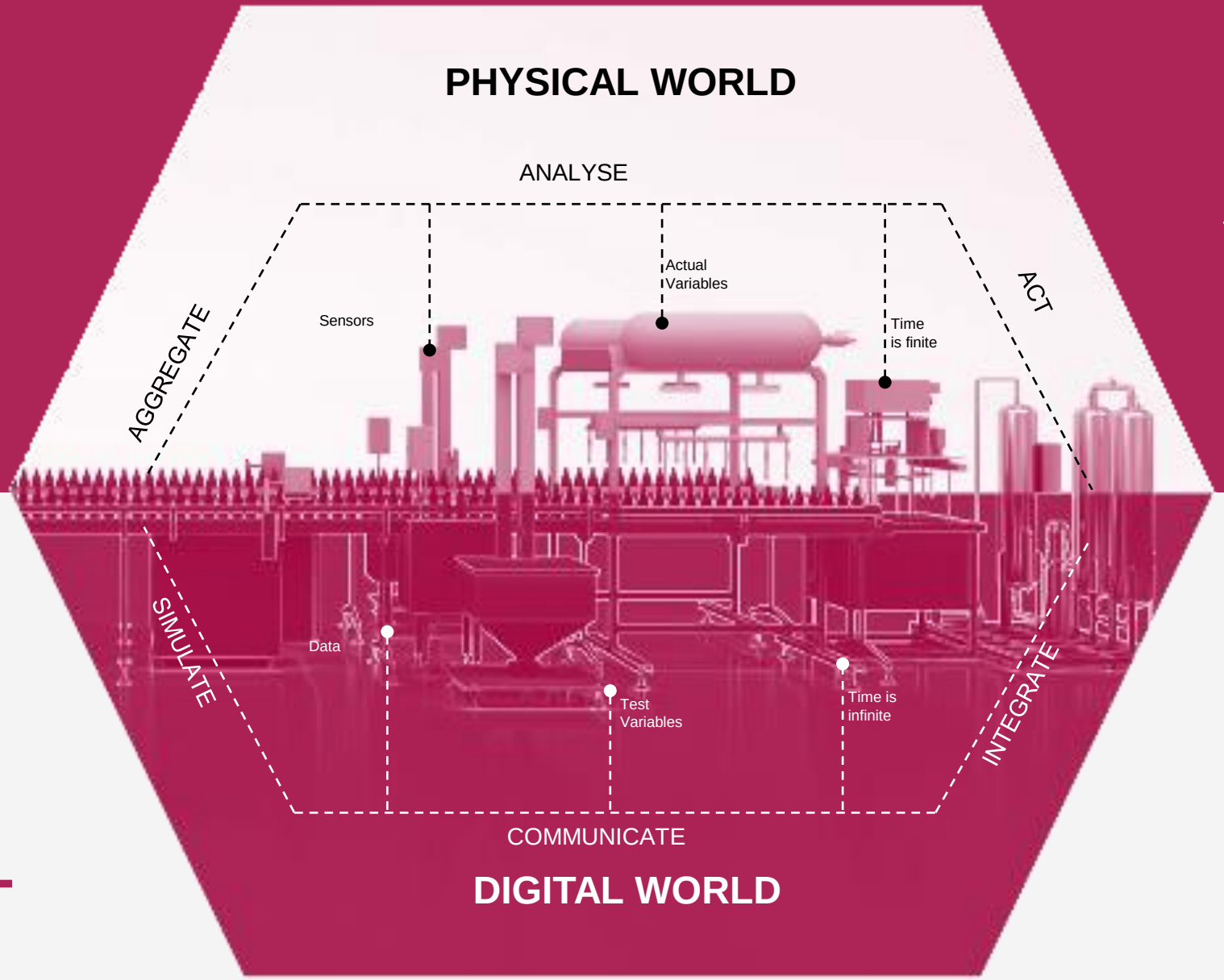
A DIGITAL TWIN

VIDEO

A VIRTUAL REPRESENTATION OF A PRODUCT, PART, SYSTEM, PROCESS OR SUPPLY CHAIN THAT ALLOWS YOU TO SEE HOW IT WILL PERFORM, SOMETIMES EVEN BEFORE IT EXISTS.

UNLOCKING TRUE REAL-WORLD REPRESENTATION IN A DIGITAL TWIN CAN DRIVE VALUE IN YOUR BUSINESS.

LIVE DECISION ANALYTICS



DIGITAL TWINS

FOR THE FUTURE AND THE PRESENT

Machine Digital Twins

Digital replica's of equipment and events

- From designing and testing Formula one Cars to supporting Asset maintenance
- Predictive maintenance

Manufacturing Lines

Designing and testing from capacity to Cost

- Line optimisation: Running the digital twin in parallel with the real machine can provide valuable insight into where a problem might arise and ensuring bottlenecks are understood
- Capacity modelling: Scenario modelling provides the ability to model unforeseeable impacts to complex production and understand the true cost of failure (processing vs. pack)
- Product costing, NPD & budgeting: Accurately modelling the true cost of products within the supply chain. Rapidly identify not only new product costs but the impact on existing products. Rapid budgeting process to allow focus on value-add activity rather than modelling

Factories & WH

Designing the future, optimising the current

- Site/warehouse design: Leverage the simulation model to challenge current processes and ways of working to optimise design of critical supply chain assets
- Scheduling: Ability to instantaneously adapt plan to variables that exist in the real world driving optimised performance against key metrics. Ability to plan disparate but dependent resources using stochastic performance

Supply Chains

Cadence and Pragmatists

- Network & logistics design: Complex models become simple objects allowing full end-to-end modelling, optimisation and simulation of entire network using stochastic probability both inside and outside the factory

- Continually rethinking your network and the optimal solutions that exist each day

Business

Accept planning complexity to enable process simplification

- Capital investment: Digital twins can be used to model new capital investments, diagnose financial performance and map detailed financials prior, to any money being spent

- Smarter decision logic can identify future risks based on live data-sets

LIKE DOGS DIGITAL TWINS ARE NOT JUST FOR CHRISTMAS.

IMPORTANT DESIGN PRINCIPLES

Start with the data you have

Select the right technology

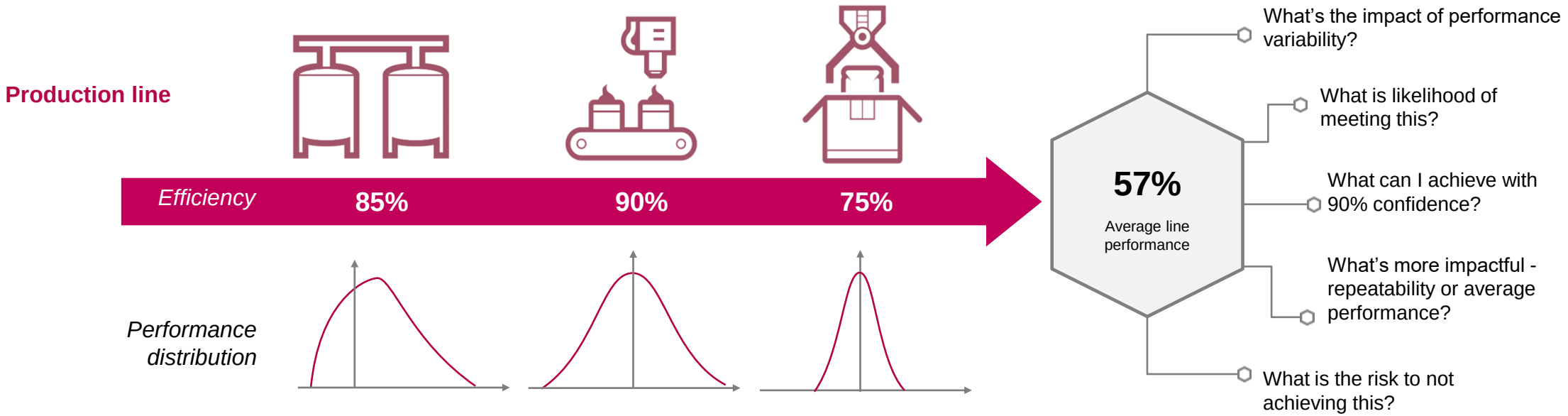
Utilise variability

Risk based models

A model needs to be maintained

Using real world variability

We don’t plan using global averages, we plan using real world variables and create risk based models based on probable outcomes



Risk based outcomes

How is it different?

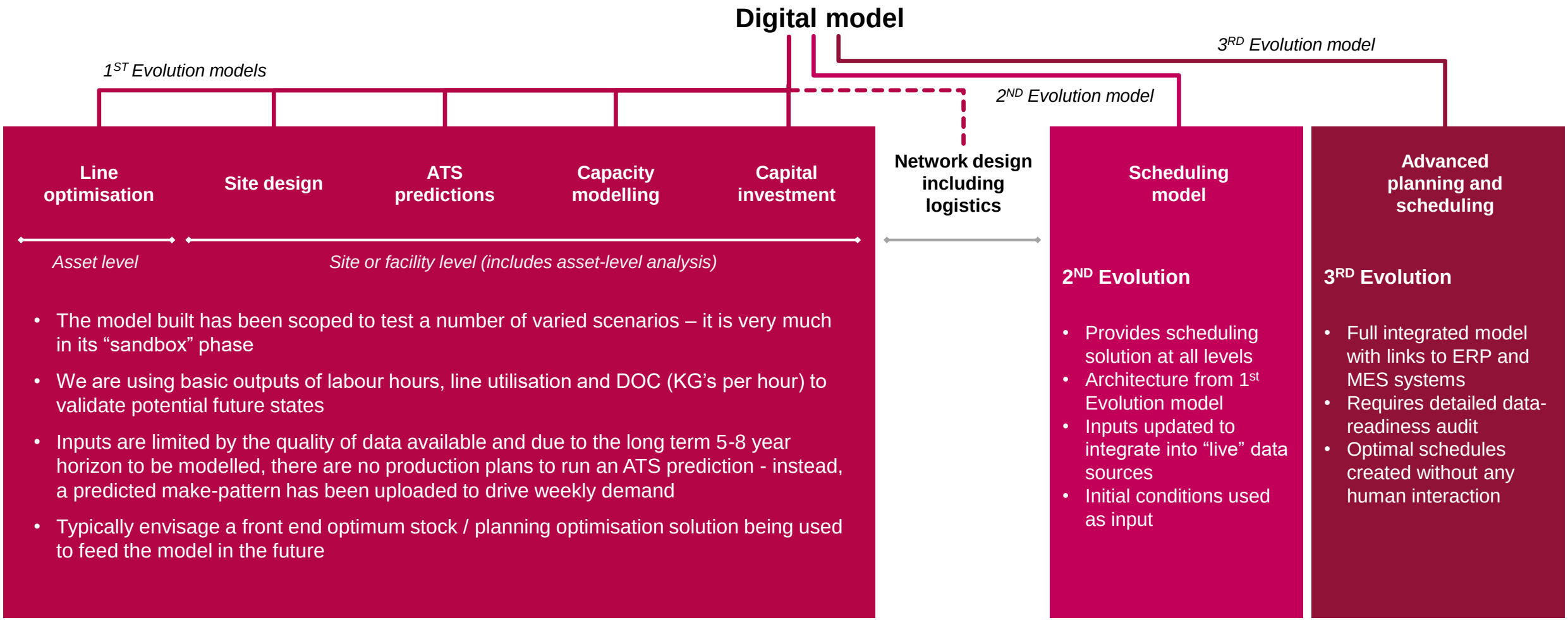
- Accurately captures **real world complexity** including resources etc.
- **Iterative modelling with stochastic performance** of each asset
  - Every iteration uses random performance within distribution
  - Set variation any or all elements of model
- Define required level of confidence
- Model thousands of iterations instantly or watch in simulated environment

What impact will this have?

- Replicate the current state of the value chain in a simulation model, and project future states based on current real time information, and real time operational constraints
- Iteratively determines accurate real world overall performance and plan according to likely outcome
- Statistically validated risk analysis to assess feasibility of predicted future states to meet performance
- Highlights performance bandwidth and expected range

Evolving a solution to solve the problem

A correctly generated digital model can be used to dynamically calibrate the environment in order to positively impact every phase of the product lifecycle; through design, building and operation.



- The model built has been scoped to test a number of varied scenarios – it is very much in its “sandbox” phase
- We are using basic outputs of labour hours, line utilisation and DOC (KG’s per hour) to validate potential future states
- Inputs are limited by the quality of data available and due to the long term 5-8 year horizon to be modelled, there are no production plans to run an ATS prediction - instead, a predicted make-pattern has been uploaded to drive weekly demand
- Typically envisage a front end optimum stock / planning optimisation solution being used to feed the model in the future

- Provides scheduling solution at all levels
- Architecture from 1st Evolution model
- Inputs updated to integrate into “live” data sources
- Initial conditions used as input

- Full integrated model with links to ERP and MES systems
- Requires detailed data-readiness audit
- Optimal schedules created without any human interaction

Line Design

Context: **A vertically integrated agricultural business** had an ageing packing hall that had become the bottleneck of the entire process and was at end of life. The cost of replacement was significant and initial insights showed limited operational cost savings.

Case: The current design principles had shared product flows and assets, lines were constrained to formats and sizes.

We firstly developed design concepts and hypothesis, working with the commercial team to overlay future packaging trends and required capabilities.

With these design principles and hypothesis we built a number of models of the future state and were able to pressure test each investment option in detail, considering best case and worst case scenario's across volume, line performance, SKU count and labour costs.

Outcomes: An optimised capital cost, reduced by 20% from original design briefs. A risk based decision where the optimal solution was the one that carried the least risk in totall against probably outcomes.

Machine driven scheduling

Utilise algorithms to drive reactive decisions. Look forwards to create proactive decisions.

Intelligent planning software

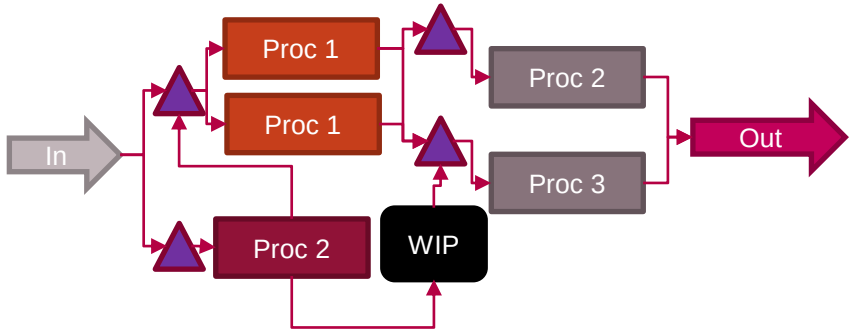
The Simio Digital Twin platform has a planning and scheduling Gantt view, integration to ERP and data exports to ERP of BI software.

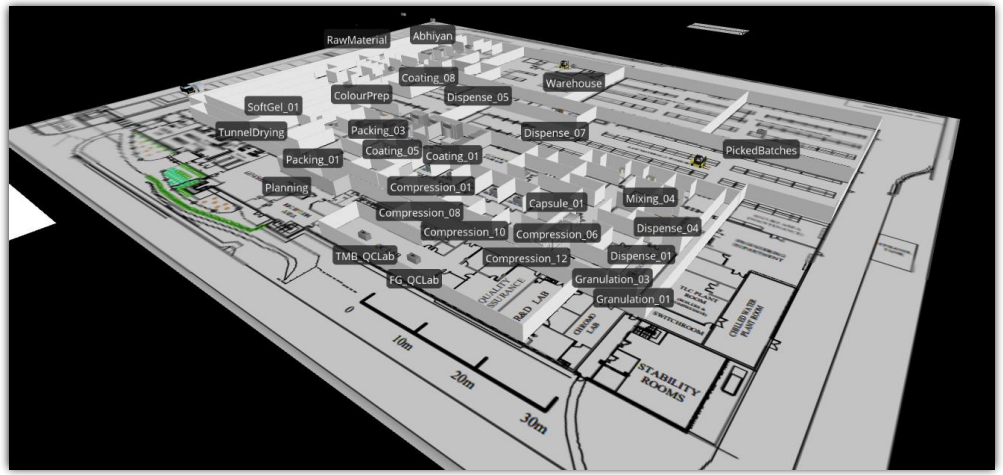
Utilising planning constraints, known production variables and site level interaction, An optimum schedule for today, out to the foreseeable demand can be created.

Inputs:
- Planning constraints and current system design
- Asset performance data
- Demand profiles and SKU data

Outputs:
- Planning Gantt view and production schedule
- Capacity analysis
- Weekly production outputs and times

Every manufacturing process can be broken down into a discrete, simplified map. Whilst processes can be complex with multiple SKUs, this can be deconstructed into simple, interconnected process blocks, separated by destination decisions





Every manufacturing system, from a single manufacturing line up to entire network of sites, is trying to navigate a number of orders through a process map. The level of detail of that map, is infinitely scalable.

Any logical process, defined by a process map can be developed into a digital twin, optimised and utilised as a planning solution including complex processes such as:

- WIP productions
- Make to stock and inventory management
- Loopback and rework
- Tiered BOMs and production
- Multi-routed products
- Parallel processes
- Dynamic asset selection
- Variable failure profiles
- SKU specific changeovers and minimisation
- Schedule driven batching
- Self-regulated WIP consumption and inventory
- Multi-site inventory and demand

Planning solution

Context: A contract manufacturing site manages 900+ active products, across 70 assets and 4 product streams. The onsite planning process relied on key resources and manual inputs. The planning process was in its infancy, with no long-term capacity planning, or schedules beyond 24 hours

Case: The site was looking to make a step change in finding efficiencies in production, whilst creating predictability in its performance and end of month customer satisfaction

The complexity of the process lay both in the variety of SKUs, but also the unpredictability of production demand. Each weekly plan has a completely unique SKU mix of over 80+ SKUs, 110+ heads of labour, 2,500 raw materials and 70 assets to schedule and manage.

Outcomes:

An initial DIFOT of 54% to averaging 95%, a large step change in the business has seen targeted improvements, identified through simulation

A 40% improvement in throughput was realised through identified capacity constraints, labour planning and consistent production scheduling by simulating new running methodologies.

Rebuild and cleansing of all master data required was central to the transformation. Alongside the practical elements of the planning processes, from daily meetings, shop floor visuals, S&OP cycles and procurement processes.

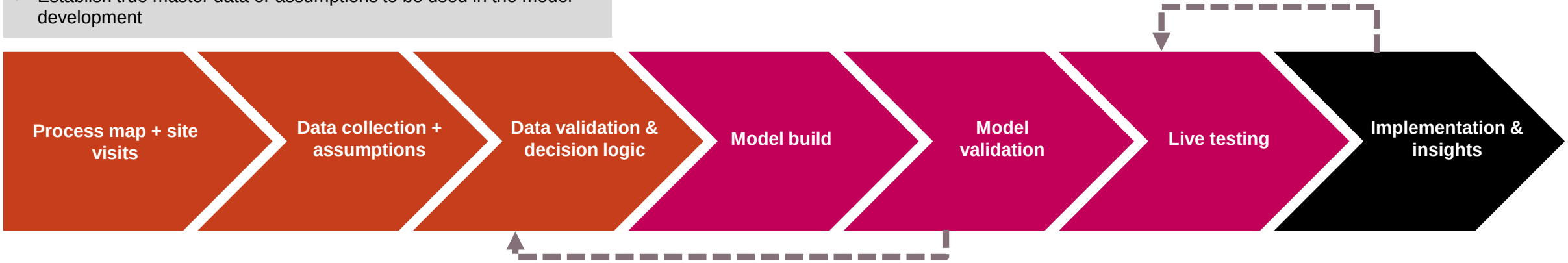
Deployment

For each model we build, we have refined a repeatable process aligned to an agile development approach

Process mapping workshops	Validate and interpret data	Model development	Develop and test hypothesis	Conclusions and model handover
Onsite workshop to develop a common understanding of the base conditions for each line; • Workshop completed for process flow logic • Collate all data sources • Establish theoretical capabilities by asset, alongside known setpoints • Consider WIP and storage capacities • Include accumulation and buffers • Capture planned constraints – cleaning, changeover and shift patterns • Live data and machine outputs where available	Overlay the input and control parameters and cleanse the data. • Current and future volume by SKU • Planning constraints and dependencies • Observations and analysis to validate live data or capture where currently does not exist.	Development of the digital twin on the Simio platform. • Align on high level potential changes and where possible build the flexibility into the model • We use an agile model development • Validate outputs with the operations and engineering as we progress to accelerate the timelines. • Site Schematics (CAD) can be inputted as the base to visualise the factory.	Once the model is established and the project team is aligned on base conditions, we can test future scenarios and run experiments to debottleneck the business on current and future volumes. • Planning optimisation – can we run for effectively by changing the decision logic • Operational Improvements – either the planned or unplanned performance loss by asset can be used to unlock the site • Capital investments, where can we upgrade speed, reduce downtime or an flexibility into the process through capital investments *(Engineering insights on available equipment from local team*)	The optimal outcome is typically one that combines & sequences elements from each hypothesis, prioritised in return on investment and simplicity. Argon & Co will work with the business to put together a prototype of what this might look like
1	2	3	4	5

Developing a digital twin

- First phase generally a “consulting” engagement to understand and map processes
- Engage teams to understand the key decision logic and optimisation options that may exist
- Develop & test decision logic offline and consider future hypothesis questions
- Establish true master data or assumptions to be used in the model development



- Following robust completion of phase 1, build logic can be completed relatively quickly
- To validate the model, we use historic data to replicate current conditions, noting the model will often likely make better decisions than were actually made
- Once confident, all data errors cleansed and decision logic aligned, live testing is completed by running the process in parallel to the real life and comparing decision points
- Go-live involves handing over the interface to the business and maintaining presence to support
- A key element that needs to be defined is the change management and how to operate.
  For example, transitioning away from daily rescheduling as we allow for natural process variations

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Transforming business.

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