

Agent-Based Modelling

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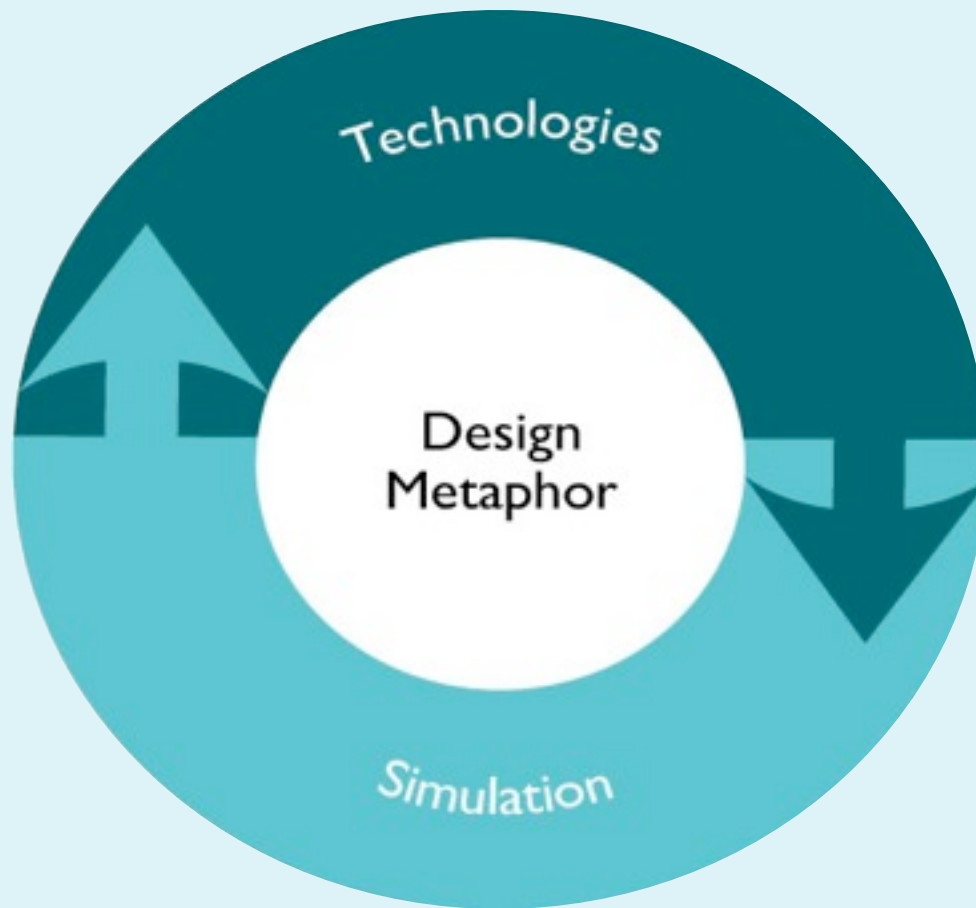
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Views of Agents: Technologies, Design & Simulation



After implementing recommendations derived from an agent-based model of a corrugated box plant developed by Eurobios, SCA Packaging was able to

**MAKE A 200%
RETURN-ON-INVESTMENT
IN THE FIRST MONTH.**

FACT

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Production scheduling optimisation

- Simulation and optimisation of processes in a corrugated box plant
- Objective: to find the production schedule that allows stock level reduction without compromising delivery times
- Plant modelling is complex (modelling relationships between customer order patterns, factory capacity, machine speeds, order batching and warehouse size, etc.)
- Combines agent technology with discrete event simulation
- Used as simulation tool – it helped choose between two customers, by determining the necessary plant capacity and the incurred costs of serving these customers
- SCA Packaging reduced inventory levels by 35% while maintaining delivery commitments

Tankers International, which operates one of the largest oil tanker pools in the world, has applied agent technology to dynamically schedule the most profitable deployment of ships-to-cargo for its **Very Large Crude Carrier fleet**. An agent-based optimiser, **Ocean i-Scheduler**, was developed by **Magenta Technology** for use in real-time planning of cargo assignment to vessels in the fleet.

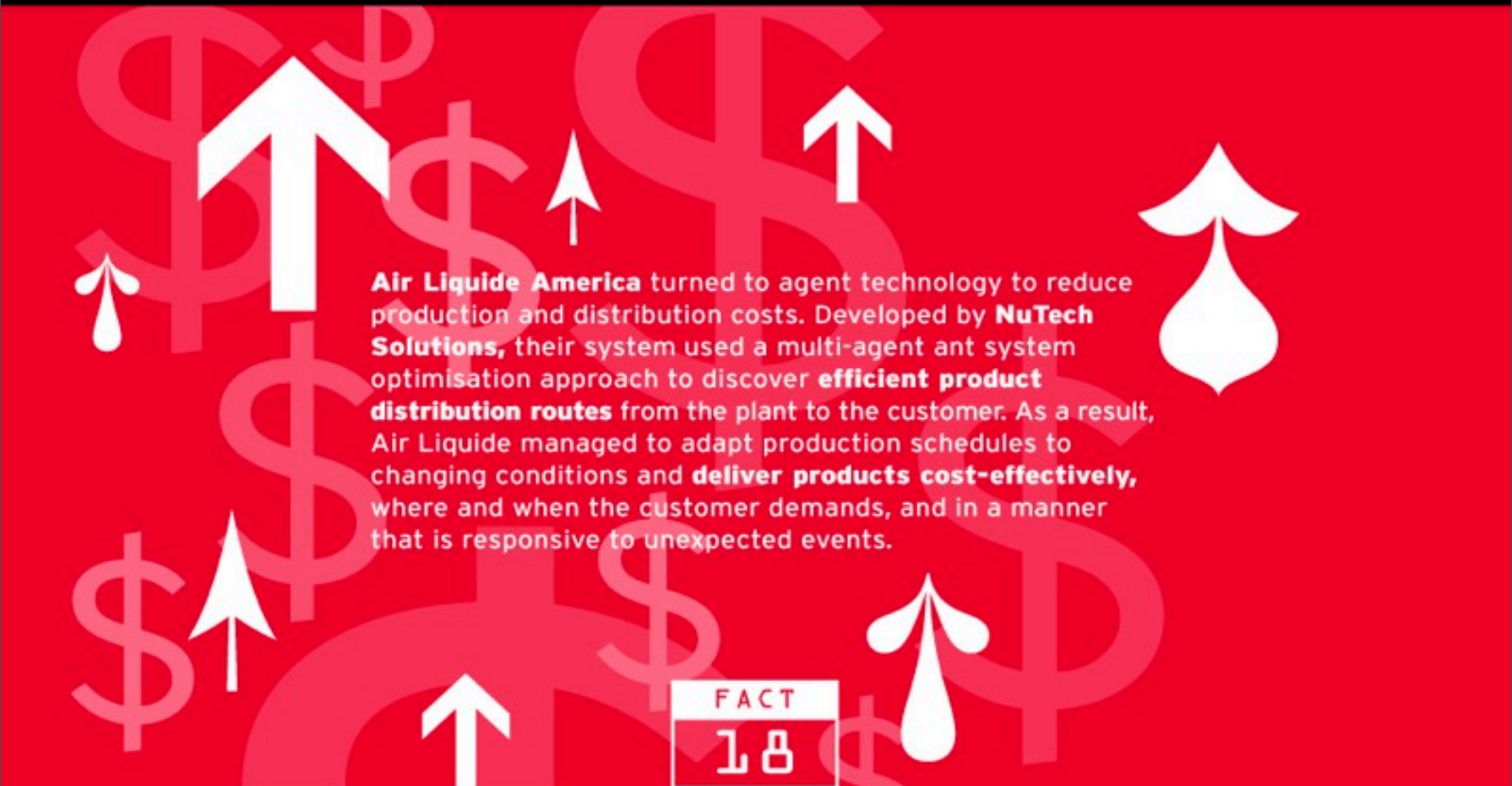
The system can **dynamically adapt plans** in response to unexpected changes, such as transportation cost fluctuations or changes to vessels, ports or cargo. Agent-based optimisation techniques not only provided improved responsiveness, but also **reduced the human effort necessary** to deal with the vast amounts of information required, thus **reducing costly mistakes**, and preserving the knowledge developed in the process of scheduling.

FACT

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Vessel transportation scheduling

- Ocean i-Scheduler, developed by Magenta Technology for Tankers International
- Finds the most profitable allocation of cargoes to vessels (oil carriers) for a fleet
- Agents model vessels and cooperate with each other to find the optimal schedule for the entire fleet
- Schedules are adapted in real-time in response to changes in the environment, e.g.:
 - cargoes change constantly,
 - tankers can fail unexpectedly,
 - oil transportation costs change daily



Air Liquide America turned to agent technology to reduce production and distribution costs. Developed by **NuTech Solutions**, their system used a multi-agent ant system optimisation approach to discover **efficient product distribution routes** from the plant to the customer. As a result, Air Liquide managed to adapt production schedules to changing conditions and **deliver products cost-effectively**, where and when the customer demands, and in a manner that is responsive to unexpected events.

FACT

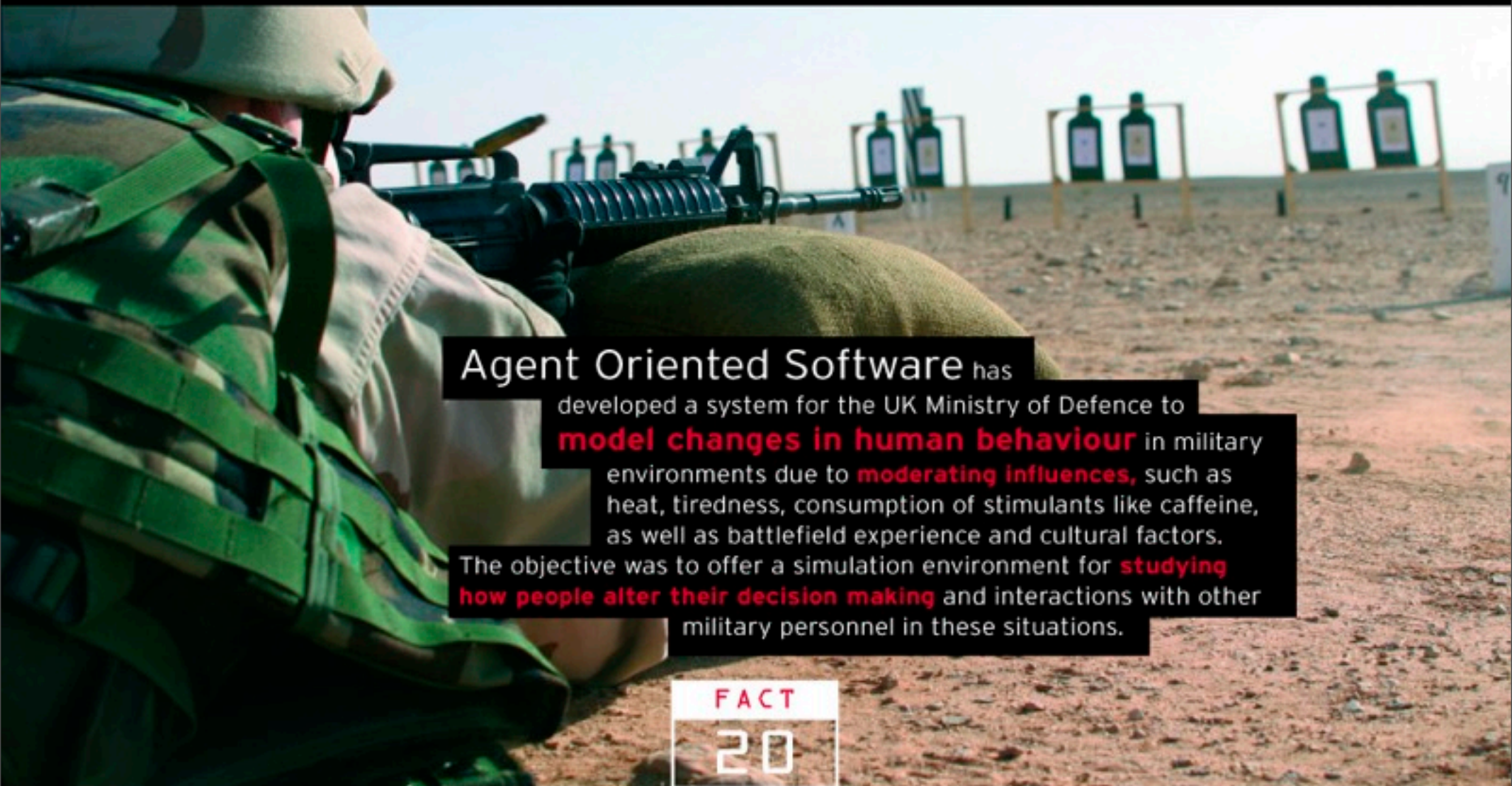
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Supply Chain Production Optimiser

- NuTech; Client: Air Liquide America
- Optimisation of production and distribution of liquefied gases
- Combines domain dependent heuristics, with genetic algorithms and ant based optimisation:
 - the genetic algorithm optimises the production schedule at each plant
 - the ant algorithm optimises energy distribution routes from plant to customer
- Solutions are adapted dynamically to take into account fluctuations in energy prices, weather changes, client demand and desired inventory levels
- Information is fed back into the control systems that operate the power plant



Agent Oriented Software has developed a system for the UK Ministry of Defence to **model changes in human behaviour** in military environments due to **moderating influences**, such as heat, tiredness, consumption of stimulants like caffeine, as well as battlefield experience and cultural factors. The objective was to offer a simulation environment for **studying how people alter their decision making** and interactions with other military personnel in these situations.

FACT

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Human Variability in Computer Generated Forces

- Agent Oriented Software for the UK MoD
- Simulation of combat situations for military training
- Models the influence of moderating factors (e.g. fatigue, caffeine intake) on soldiers' behaviour, both at individual and team levels
- Built on Jack Intelligent Agents toolkit, makes use of the BDI reasoning model
- Integrated with other simulation environments (CGF systems) used by the MoD



OVERVIEW	AFTERMARKET OPPORTUNITY	ABOUT LOST WAX
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WHAT IS AEROGILITY?



Working with Rolls Royce, Lost Wax has developed Aerogility, a multi-agent system to help business managers better understand the complexities of the aerospace aftermarket.

www.aerogility.com

What is Aerogility?

How it works

Implementing Aerogility

Benefits

FACT

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Aerogility

- Software agents represent the Aftermarket resources - people, assets and processes.
- For each resource we capture their purpose, business goals and objectives.
- The interactions between the agents - Aftermarket resources - are determined by easily changed parameters covering overall strategies, management policies and organisation configurations, as well as business processes and rules.
- The overall Aftermarket model yields SLA, KPI and operating metrics.

Metrics for contract analysis

- Contract monitoring software can be integrated with existing Aerogility to provide additional simulation metrics regarding contract clause violations through contract-based monitoring.
- Enables number and level of violations incurred to be determined through static analysis of results
 - identifying conditions under which higher penalties may arise.
- To inform revisions of the terms and conditions of any potential future contracts.

Policy, Process & Explanation

- Coupling of software to use Aerogility events as input to global monitoring to
 - provide focused, contract-relevant explanations of events leading to undesirable behaviour.
- Focus attention on processes and policies with potential weaknesses

Contract-enhanced Aerogility

- Future enhancement of Aerogility, or similar future products, enabling explicit modelling of the processes of
 - contract establishment
 - renewal
 - termination
- Simulation of long-term effects of contract fulfilment or violation
 - providing engine manufacturers with, for example, a basis for prioritising resource allocation to different customers where there is risk of future contract violation.

Issues

- Granularity of modelling
 - cognitive approaches
 - explicit decision-making
 - agents as cognitive elements (neurons, beliefs, goals)
 - agents as teams, organisations, etc
- Closing the loop with the real world
 - integrating simulation with real architectures
 - feedback to refine simulations
 - modelling as part of design process

Issues

- Process modelling and implementation
 - Taking results of ABM not just to inform thinking, but for design of systems
- Techniques to be adopted
 - ant colonies
 - genetic algorithms
 - learning mechanisms
 - swarms
 - etc

Issues

- Methodological issues
 - How to design a model to demonstrate particular kinds of behaviour
- Emergent normative behaviour
 - distinguishing explicit norms for use in regulating behaviour from implicit cooperative behaviour in studies of norm emergence
 - correspondence of ABM to higher-level systems