Grand Challenges for Discrete Event Logistics Systems

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With the experience of dealing with systems as complex as wafer fabrication plants as well as aerospace spare parts logistics networks, I would consider the following four factors as the greatest contemporary challenges for Discrete Event Logistics Systems:

(i) Domain-specific characteristics of Discrete Event Logistic Systems,

(ii) Cycle time for model generation and model maintenance,

(iii) Involvement of humans in operating such systems,

(iv) The difficulty of quantifying the value generated by decision-support software for managing and optimising such systems.

How to tackle the first challenge can be illustrated by how D-SIMSPAIR, D-SIMLAB's flagship product for planning and optimisation of spare parts logistics networks in the aviation industry, evolved: The original intention was to develop this system using a Commercial-Off-The-Shelf (COTS) simulation package as the backbone. However, it turned out that such a simulation software comprises a lot of modelling gadgets and graphical features that are actually not required when it comes to *regularly* carrying out domain-specific decision support tasks but only make the simulation execution very slow. More importantly, the associated optimisation tasks turned out to be too complex to be handled by such a generic tool. With this experience, and knowing that spare parts logistics optimisation is a critical business process with sufficient potential across the entire aerospace domain, we decided to (re-)develop D-SIMSPAIR from scratch as a *domain-specific* decision support tool: The respective business processes were modelled with high-fidelity by gradually incorporating all relevant decision support rules (never mind, if the fidelity is too high here and there, at least we do not always have to challenge the model's validity), and we also developed a new optimisation module, thereby making use of a considerable amount of domain-specific heuristics. The result was an ERP-kind of decision support tool – where simulations and optimisations only require model configuration but no model set-up – and which can be regularly run without the need for continuous model re-verification and re-validation. Only such a decision support tool is able to generate *maintainable* benefit over a long period of time. High configurability is in fact indispensable, otherwise the software would always be subject to targeted buyers' typical reaction "Nice software, but our processes are different, therefore it is not relevant for us...". Naturally, when developing such a system it is essential that (i) all functionality is taken over into one master version of the software, and (ii) the system is developed with input from several customers to make sure that it is not "customised to death" to the needs of one single customer.

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The second challenge has to do with the fact that modelling of Discrete Event Logistics Systems is a human effort that always takes a considerable amount of time. However, decisions typically need to be made fast. So the enabling decision-support tool needs to be equally fast, not only with regard to the execution of planning and optimisation runs but more importantly – in the light of the speed of *change* in today's production and transportation logistics networks – with regard to keeping the underlying models up to date. Ultimately, this can be done only if the entire model generation and model maintenance process is automated with a degree as high as possible. This process must be of such high quality that the verification and validation process can eventually be skipped. That is what we are currently pursuing with our lead customer in the semiconductor manufacturing domain.

The third challenge arises from the involvement of people in managing Discrete Event Logistics Systems: In a highly-automated wafer fab, the effect of human decision-making on the shopfloor might be negligible to some extent, although data inaccuracies and inconsistencies caused by the human involvement in the data maintenance process are also a limiting factor even in such automated fabs. However, the larger the (geographical) scope of contemporary DELS to be managed, the greater the role of human decision making for managing and operating such systems, not to mention that such supply chains are typically driven by a large range of very inhomogeneous external factors. And by nature it is simply impossible to model human decisions because the underlying "intelligence" cannot be portrayed. So this becomes an inherent limitation for the generation of a high-fidelity model. Not to mention that lack of fidelity again increases the validation effort, i.e. the effort to find out whether the model is actually useful for the intended purpose.

The fourth challenge arises from the difficulty to quantify the value generated by decision support systems. In fact, contemporary systems do not have features that would automatically determine such value. This has also to do with the fact that value determination involves a comparison against a baseline. But the question now arises how to determine such a baseline? Is the baseline represented by "doing nothing"? Or is it represented by a scenario associated with a decision enabled by a simpler, "lower quality" decision support tool? In D-SIMLAB we are currently undertaking an effort to incorporate the determination of the value of the decisions supported and/or optimisations carried out into both D-SIMSPAIR, the domain-specific spare parts planning and optimisation system for aviation, and D-SIMCON, the domain-specific toolset for shopfloor optimisation in semiconductor (wafer) fabrication.