Simulation as support for decision making in PBL negotiations

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- Operational Availability
- Resource Utilization
- Dynamic Scenario Assessment

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- Optimized Assortment
- Repair Strategy
- Supply Solutions

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- Budget & Forecasting
- Cost Driver Identification
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Thales Defence
Turbomeca
PERFORMANCE-BASED LOGISTICS (PBL).

- The DoD’s preferred support strategy for weapons systems.
- Seeks to deliver product support as an integrated, affordable performance package designed to optimize system readiness.
- A support structure based on long-term performance agreements with clear lines of authority and responsibility.
- DoD program managers are required to develop and implement performance-based life-cycle (PBL) support strategies for weapons systems.
- These strategies should optimize total system availability while minimizing cost and logistics footprint. Trade-off decisions involve cost, useful service, and effectiveness.
- The selection of the specific performance metrics should be carefully considered and supported by an operationally-oriented analysis.
WHAT IS THE SUPPLIER SCOPE?

- **Spare parts**
  - (IPC, prices, delivery times)

- **Component Repair & Overhaul**
  - (Turn around Times, task prices)

- **Component supply**
  - (Backorders, waiting times, fill rate)

- **Logistic Support**
  - (System down time)

- **System supply**
  - (Availability, Power by the hour)

- **Functional leasing**
  - (Readiness, Power by the hour)
HOW TO DEFINE BALANCED PERFORMANCE REQUIREMENTS AND REWARD MODELS?

- A complex problem
  - need for efficient analysis models

- The customer
  - Wants to secure that his operational needs will be met without risking to pay too much

- The supplier
  - Wants to assess the resources needed to fulfill the commitment and the risks and economical consequences

- You want to create a Win-Win situation!
USE MODELS AND SIMULATION?

- Simulation tools like SIMLOX
  - Evaluates the operational performance that the customer can achieve given a certain contractual performance level...
    
    ...and the probability of meeting that performance level given a certain logistics solution.

- Optimization tools like OPUS10®
  - Defines the most cost effective spares parts solution to meet the objectives
  - Calculates the logistics support cost to meet a certain performance level
Example: SIMULATION OF PBL LEVELS FOR A COMPONENT SUPPLY AGREEMENT.

Conclusion:
- 2 Backorders don’t influence operations at all
- 3 Backorders is acceptable!
- 4 Backorders limit operational capability
- 5 Backorders is not acceptable
Example: ARE THE BACKORDER LEVELS AFFORDABLE?

Conclusion:

- Spares stock needed to meet 3 backorders will cost 51 millions
- To reach 2 backorders will cost 25% more
- How much can you afford/how much are the extra flight hours worth?

3 NBO cost 25% less than 2 NBO.
Example: WHAT IS THE RISK OF NOT ACHIEVING THE BACKORDER LEVELS REQUIRED?

**Conclusion:**

- Backorder levels will differ much over time
- Even though the average backorder level meets the requirement, the risk of not reaching the monthly average is quite high
HOW TO ASSESS A REWARD MODEL.

- What type of reward function should be used?
- How does the reward distribution look like, i.e. how large reward can be expected?
- What is the probability for getting the full reward?
- What is the risk that the reward becomes less than 70%?
- Other consequences...
OUR SCENARIO.

- 3 operative locations, One at home and two abroad
- In total 12 helicopters
- Each operative location is evaluated on a yearly basis
- Scenario length: 10 years
EXAMPLE OF A REWARD FUNCTION FOR A PBL CONTRACT FOR AVAILABILITY.
SIMULATE AND EVALUATE THE REWARD FUNCTION.

1 SIMLOX replication

Availability per year

Reward outcome per year

Reward function $R(A)$

Reward distribution approximation $P(R)$
RESULT CONVERGENCE WHEN RUNNING MULTIPLE SIMULATIONS.

Reward distribution convergence $H_N(R)$

- N=1
- N=3
- N=10
- N=30
- N=100

Probability

Reward $R(A)$

0% 25% 50% 75% 85% 91% 94% 97% 100%
CONCLUSION.

• The analyses should be based on more than one replication to give enough confidence in the results

• There is a need to automate the analysis process
SORRY, NO TIME FOR A DEMO.
PLEASE VISIT US AT THE DISPLAY.
NEGOTIATING ALTERNATIVE REWARD FUNCTIONS.

![Graph showing reward functions for customer and supplier](image-url)
EVALUATING THE PROPOSALS.

Reward distribution $f(R)$

Probability

Reward $R(A)$

Customer

Supplier
The supplier’s proposal generates a greater reward more quickly compared with the reward function proposed by the customer.

The supplier’s proposal also gives a lower incentive for meeting the customer’s requirements due to a low reward decrease rate below the target availability.

surprised?
EVALUATION OF DIFFERENT MEASURING INTERVALS.

Reward distribution $f(R)$ for different evaluation intervals

- Weekly
- Monthly
- Yearly

Reward $R(A)$

Probability
CONCLUSION.

- The variance of a reward function parameter is usually greater when measured over shorter time intervals compared to a longer time interval.

- A temporary decrease in performance during a short period are evened up when measuring the performance over a longer time interval resulting in a higher reward compared to when measuring over shorter intervals.

- One could say that shorter measuring intervals are better for the customer and longer intervals are better for the supplier.
SENSITIVITY ANALYSIS.

Reward distribution $f(R)$ for cases 1-5

Case 1: Baseline (optimized stock from OPUS10 for $A=85\%$)
Case 2: Understocked (optimized OPUS10 stock for $A=70\%$)
Case 3: Overstocked (optimized OPUS10 stock for $A=90\%$)
Case 4: Baseline, but Item failure rate 30 % higher
Case 5: Baseline but, resupply times 30 % higher
CONCLUSION.

<table>
<thead>
<tr>
<th>Case</th>
<th>$P(R \geq 90%)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Baseline</td>
<td>0.85</td>
</tr>
<tr>
<td>2: Understocked</td>
<td>0.36</td>
</tr>
<tr>
<td>3: Overstocked</td>
<td>0.96</td>
</tr>
<tr>
<td>4: Failure rates +30 %</td>
<td>0.71</td>
</tr>
<tr>
<td>5: Resupply times +30 %</td>
<td>0.41</td>
</tr>
</tbody>
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- The understocked scenario gives only a 36% probability of achieving a reward above 90%.
- The result also shows that it is important to avoid long resupply time.

- If the supplier wants to have a high reward, stocking enough spares and managing the resupply times should be a priority.
- This approach makes it possible to optimize the balance between cost and reward.
REWARD OR PENALTY?

- Who should have the financial risk?
- In general Customers should favor rewards and Suppliers penalties
- A reward function creates a more positive atmosphere - You get a motivating reward for achieving your objectives rather than being driven by the negative mindset of trying to avoid a penalty
- So - the best solution might be to have both at the same time...

Does it matter since \( P(x) = 1 - R(x) \)?
SUMMARY.

- Modeling & simulation are essential in understanding the consequences of a PBL contract and in designing reward functions that gives the supplier incentives to meet the objectives.

- The proposed method provides the decision maker with an efficient decision support tool that can be used for instantaneous evaluations in a contract negotiation.

- The method makes it easy for both customers and suppliers to evaluate the probable reward in a PBL contract and assess the risks for not meeting the contract objectives.

- The same methodology can also be used by the supplier to design and optimize the logistic support solution.
REFERENCE PROJECTS.

- Nordic Standard Helicopter Program - NH90
- Saab Dynamics
- BAE Systems Hägglunds
THANK YOU FOR LISTENING.

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