In cooperation with the Delft University of Technology (TUD), MARIN has developed ECOTRANS, a computer model that simulates container transport on the River Rhine between Rotterdam, The Netherlands, and Mainz, Germany. The model, which was developed at the behest of The Netherlands Institute of Maritime Research (NIM), is intended to quantify the economic merits of container transport by water in order to compare them with other transport modalities, such as trains and trucks. ECOTRANS covers naval, architectural, operational and economic aspects, and is being used to compare vessel concepts and analyze transport schedules.

Martin van Hees

TUD's contribution began with a computer program developed by them, VARMOD, from which the following parametric models were extracted and adapted:

- General arrangement on the basis of 'blocks' of containers;
- Structure on the basis of German Lloyd Rules;
- Weight and center of gravity;
- Simple hydrostatics and initial stability;
- Resistance and powering;
- Shallow water speed loss;
- Building cost;
- Capital outlays and operational costs: fuel, personnel, insurance, stores, harbor costs, and overhead.

Special attention was paid to actual waterway conditions, which were assumed to be fixed and constant in VARMOD. Statistical data about real water levels, which are constantly changing, and

bridge passage heights - which are, obviously also changing with the water levels - on the 8 stages of the trip from Rotterdam to Mainz helped to more accurately predict the sailing time per stage. This resulted in an improved foundation for analyzing departures and arrivals. Since restrictions in keel clearance and/or bridge passage heights impose upper limits on cargo carried, the transport capacity of a conceptual vessel is also more accurately predicted.

QUAESTOR

QUAESTOR KBS (Knowledge Based System), which has been developed by MARIN, deals with storage, management and application of a knowledge base of parametric model fragments and data. Acquiring and storing these models and data is the task of the knowledge engineer. Up until now, its focus has been on the conceptual design of a variety of naval ships, such as submarines, frigates, swaths. But it has also been applied in such other fields as propulsor design, ship performance monitoring, and even aircraft concept design.

Any application of a knowledge based system starts with the user indicating one or more parameters as 'top goals'. In the case of ECOTRANS, one top goal - the TEU (twenty foot equivalent units) cost per kilometer - can suffice to get virtually all approximately 300 model fragments or relations and 400 parameters into a model. A parametric model or 'template' is assembled through an interactive process of system proposed model and user input and decisions.

If a model fragment is used outside its defined bounds, the inference engine dynamically adapts the model. A QUAESTOR KBS model is fully transparent. If desired, the user can trace any result back to the applied model fragment, and is thus able to change expressions and data at run time. Models are simply modified or extended by modifying expressions in, or adding expressions to, the knowledge base. The ECOTRANS project is also intended to demonstrate some of the capacities of QUAESTOR KBS.

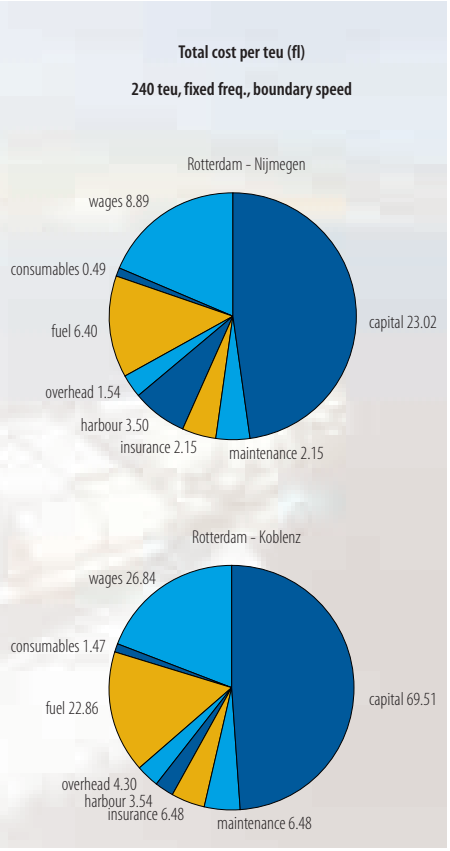
Themes and Variations

Within the scope of a validation study of the ECOTRANS knowledge base, TUD performed a large number of variations of three point designs, 90 TEU, 208 and 240, respectively.

The variations were:

- Schedule based on an integer number of round trips per week, fixed weekly departure and arrival times (as in the current actual practice), and operation at economic speed (minimum waiting time) or at constant power (with boundary speed as an upper limit);
- Schedule based on a real number of round trips per week with variable departure and arrival times;
- Routes: Rotterdam to Nijmegen, Koblenz or Mainz;
- Cargo handling times per container: 1, 2, 3 and 4 minutes, respectively;
- Capital costs: building costs ranging between + 20% and - 20% of today's costs. Interest rates between 5 and 10%;
- Ship aspects: Length + 1 container;
- Technology: Weight of structure +20% and -20%. Propulsive efficiency + 15% and + 30%.

The figures below present the result of an example variation. In this case, 3 round trips per week, fixed schedule, and economic speed.



Conclusions

In comparison with data provided by ship yards and operators, the variations performed with QUAESTOR KBS produces realistic results. The absolute accuracy of the predicted cost is limited because small changes in the operational profile can have large impacts on the TEU costs per kilometer. This was to be expected. This is particularly obvious if the number of round trips per week is between 1 and 2. The value of the ECOTRANS model is in its ability to classify solutions rather than to provide exact figures.

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