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SYSTEMS ENGINEERING STUDIES OF ON-ORBIT ASSEMBLY OPERATION

George W. Morgenthaler

While the practice of construction has a long history, the underlying theory of construction is relatively young. Very little has been documented as to techniques of logistic support, construction planning, construction scheduling, construction testing and inspection. The lack of "systems approaches" to construction processes is certainly one of the most serious roadblocks to the construction of space structures. System engineering research efforts at CSC are aimed at developing concepts and tools which contribute to a systems theory of space construction. The research is also aimed at providing means for trade-offs of design parameters for other research areas in CSC.

Systems engineering activity at CSC has divided space construction into the areas of orbital assembly, lunar base construction, interplanetary transport vehicle construction, and Mars base construction. A brief summary of recent results is given here.

Several models for "launch-on-time" have been developed. Launch-on-time is a critical concept to the assembly of such Earth-orbiting structures as the Space Station Freedom, and to planetary orbiters such as the Mars transfer vehicle. CSC has developed a launch vehicle selection model which uses linear programming to find optimal combinations of launch vehicles of various sizes (Atlas, Titan, Shuttles, HLLVs) to support SEI missions. Recently, the Center developed a cost trade-off model for studying on-orbit assembly logistics. With this model it was determined that the most effective size of the HLLV would be in the range of 120 to 200 metric tons to LEO, which is consistent with the choices of General Stafford's Synthesis Group Report.

A second-generation Dynamic Construction Activities Model ("DYCAM") process model has been under development, based on our past results in interruptability and our initial DYCAM model. This second-generation model is built on the paradigm of knowledge-based expert systems. It is aimed at providing answers to two questions: (1) What are some necessary or sufficient conditions for judging conceptual designs of spacecraft?, and (2) Can a methodology be formulated such that these conditions may be used to provide computer-aided tools for evaluating conceptual designs and planning for space assembly sequences? Early simulation results indicate that the DYCAM model has a clear ability to emulate and simulate human orbital construction processes.

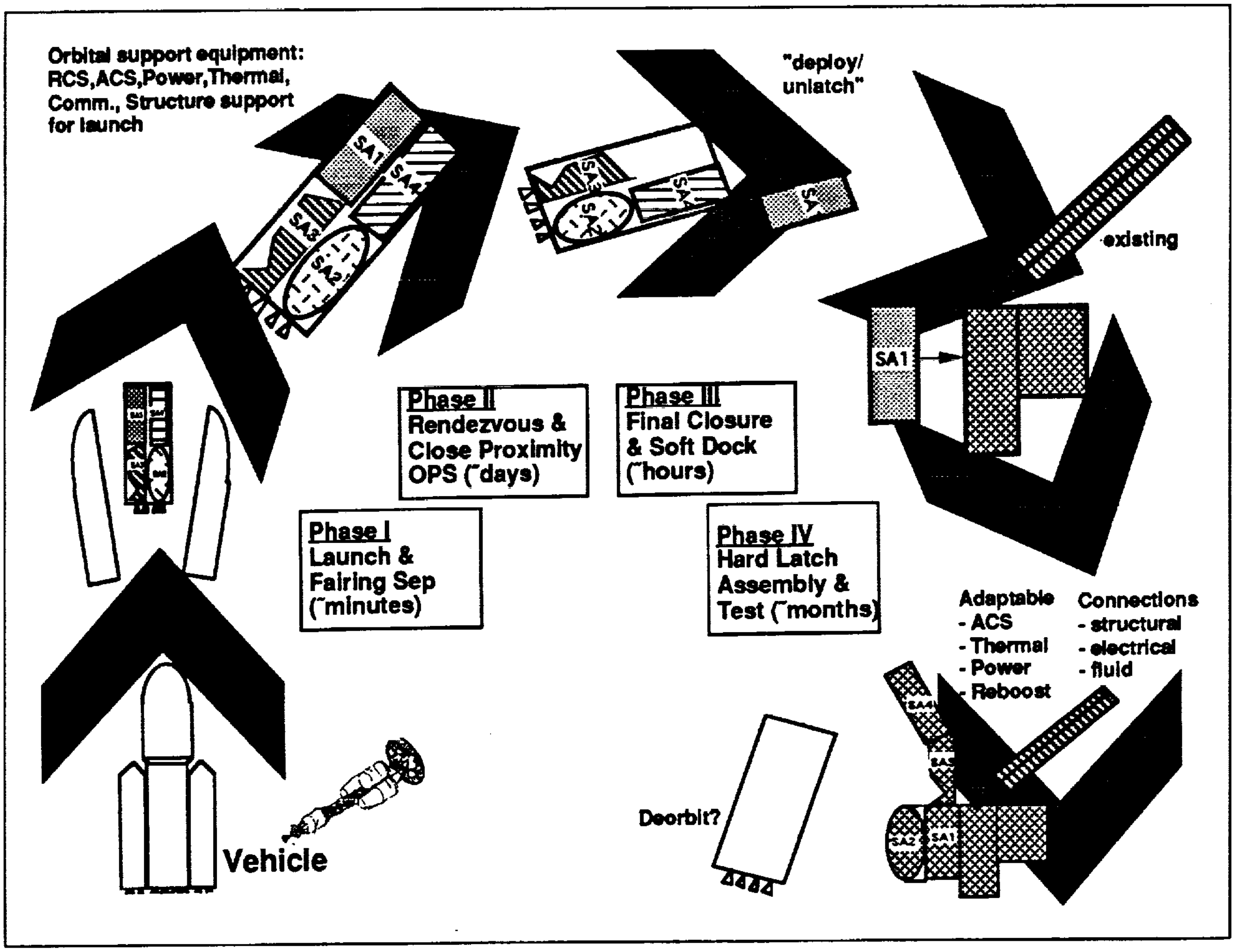

Fig 6.1 An orbital assembly scenario

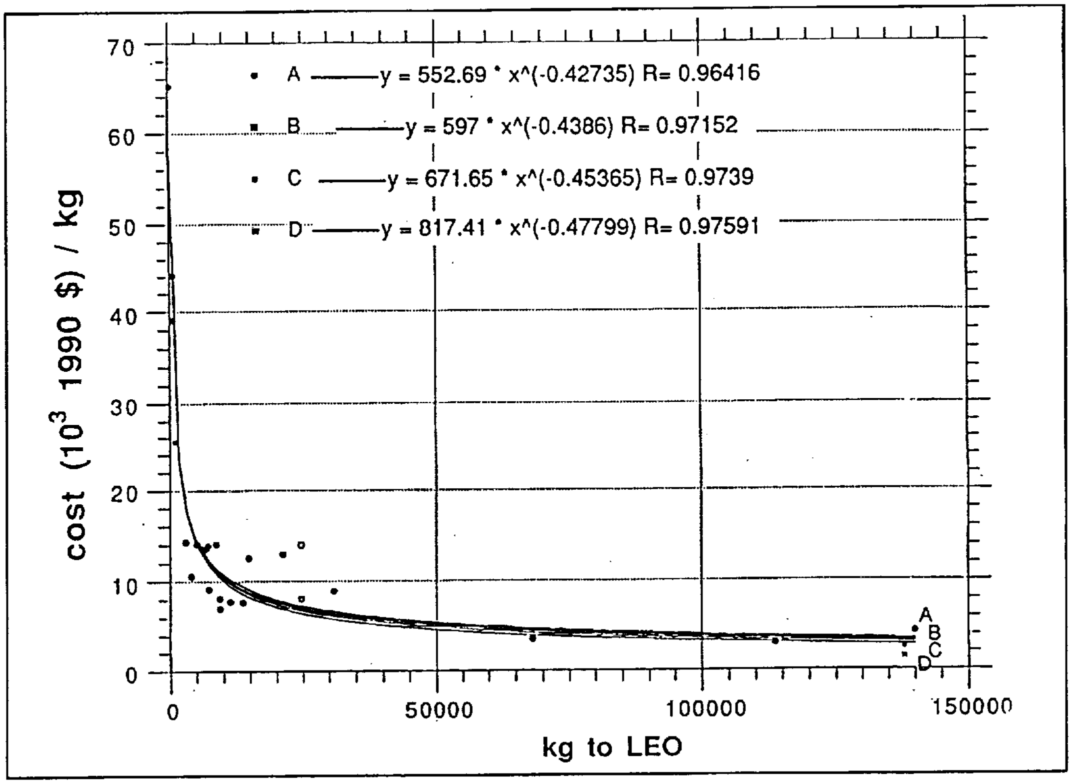

Fig 6.2 Cost/kg vs. kg to LEO

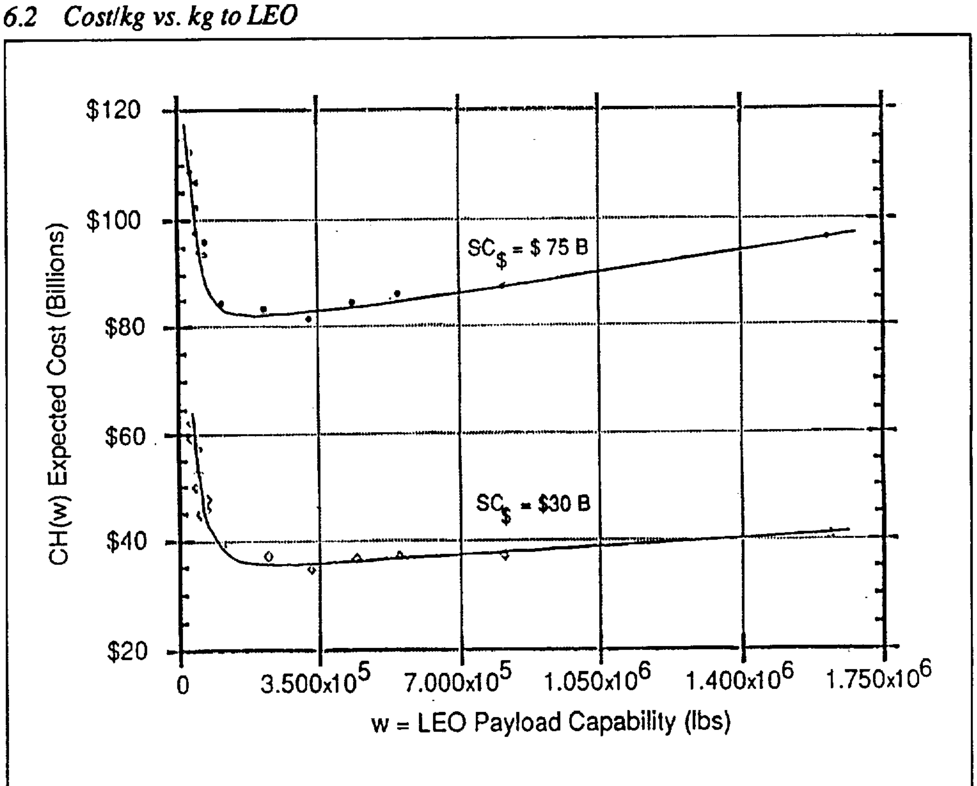

Fig 6.3 Total expected cost vs. LEO payload capability

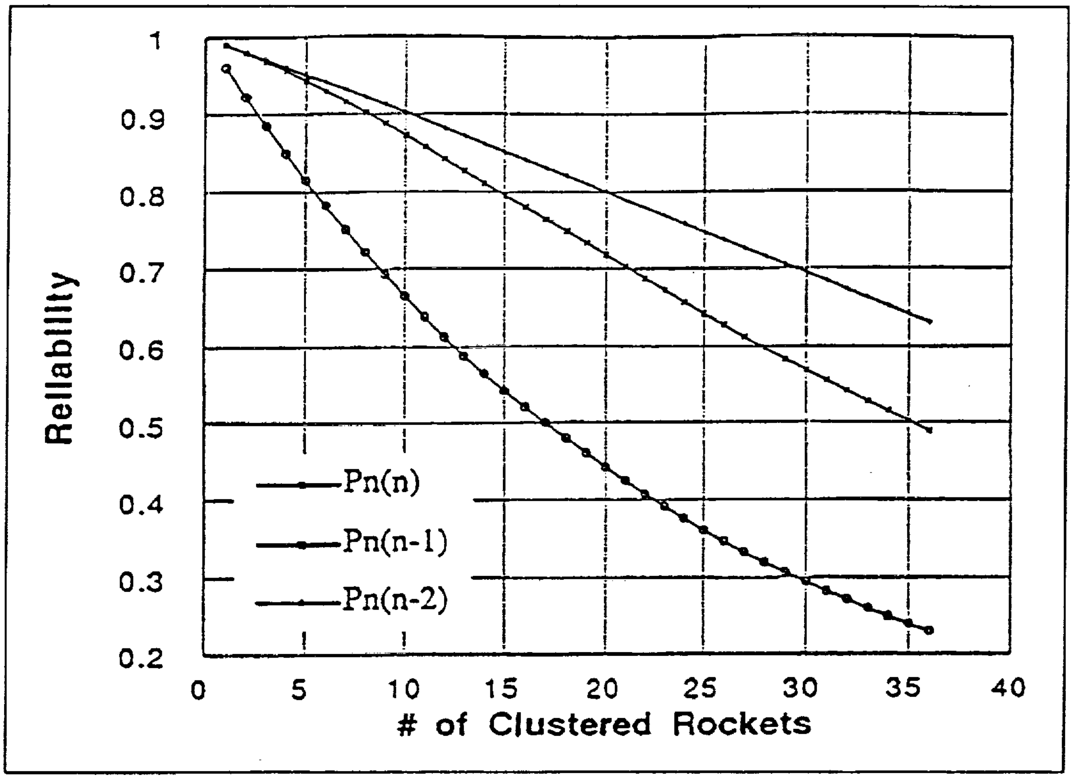

Fig 6.4 Launch vehicle reliability as a function of clustered rockets (p=0.96, r=0.25)

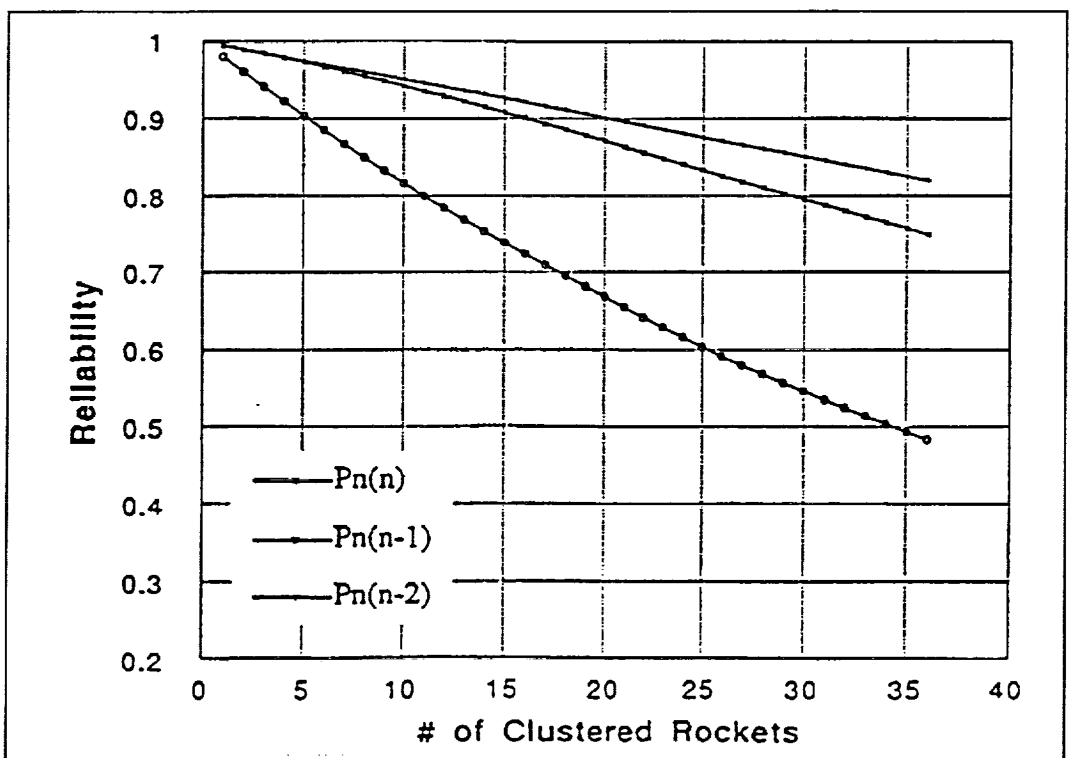

Fig 6.5 Launch vehicle reliability as a function of clustered rockets (p=0.98, r=0.25)