Optimizing Ships Propeller Shaft Alignment

We were not satisfied with standard yard design practice in determining the alignment of the main driving shaft of our recent newbuildings. And while some of the classification societies go through cycles of improvement (usually driven by the last set of failure) the overall aim is often to find the cheapest alignment often to the point of justifying the simplistic alignment chosen by the yard's standard practice.

Hellespont knew that finite element modeling would require both detailed models of the shaft and of the ship itself or at least the aft end. Since alignments tolerances must be better than 0.1mm and hull finite element models with that kind of accuracy would demand millions of elements it would be impossible to put the shaft alignment optimization in a exhaustive search for the best. In addition there were many uncertainties with propeller lifting forces, hull deflections.

Since there were so many uncertainties it seemed best to find that design that was in the center of the requirements, determine the forces and moments for extreme cases using what data could be gleaned from the engine makers, propeller towing tank results, etc, calculate the forces and other large scale deflections and forces for all extreme cases and then find the alignment that satisfied as many as possible in the most consistent way possible and which had the most room for error in shipyard production.

It was also our view we had to construct several related simple static finite element models of the shafting for the cases of: hot loaded, hot ballast, cold loaded, and cold ballast conditions. Towing tank data gave the relevant propeller lifting forces for the loaded and ballast conditions and these were used to construct the propeller force and moment extremes. The output from these eight related models' were then put into an objective function to determine the merit value of the model. Engine coupling shear and moment force constraints had to be met along with stern tube bush(s)
and intermediate bearing load constraints. If these must- satisfy constraints were not satisfied then merit of the design set to be worthless.

Each of the 8 related models had the same physical parameters that determined the shaft's specific alignment. A set of search ranges for all the parameters was determined and the computer iterated through millions of parameter combinations to find the top 100 alignments. After discussion with the yard, the engine makers, bearing makers and classification a final search was made and the final configuration submitted to classification.