Economic Theory and the Reality Test

A comment by Lex A. van Gunsteren on the work of Jonathan Barzilai.

Leiden, October 2011.

I am neither a scientist nor a consulting engineer. I am a development engineer interested in mathematical modelling as a tool for designing objects, in particular ship propulsion devices, buildings, and urban developments.

Mathematical modelling in engineering sciences involves two steps (Fig. A):

1. We make simplifying assumptions when mapping the empirical system – the reality – into the mathematical system – the model. For instance the assumption of an ideal (incompressible, frictionless) fluid in potential theory.
2. We map back from the mathematical system, the model, into the empirical system - the reality – to check if the mathematical model reflects reality to a satisfactory degree. Let us call this step *the reality test.*

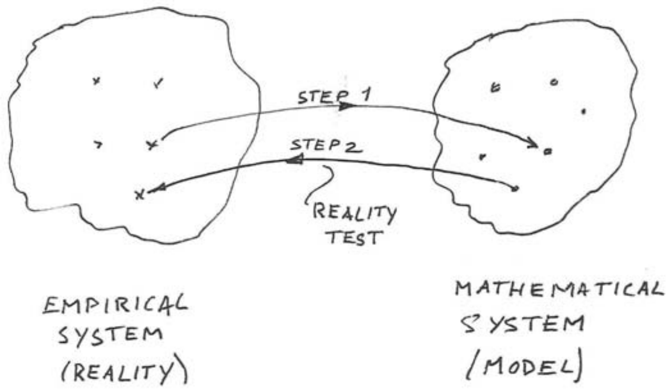

Fig. A: Two steps in the engineering sciences.

As an example, let us consider Chapter 5 of my Ph D thesis (Delft, 1973) "Performance calculation of heavily loaded ducted propellers".

The dots in Figures 43, 44, and 45 of the thesis indicate the results of mathematical calculations carried out with my non-linearized theory, in which slipstream deformation (contraction as well as downstream increase of pitch of the slipstream vortices) is taken into account. These results pertain to the mathematical system, the model.

The lines in Figures 43, 44, and 45 represent open water test results. These results pertain to the empirical system, the reality.

Open-water characteristics

The open-water characteristics of the K_a 4-70 propeller series in N.S.M.B. standard Nozzle 19A were calculated; the results are presented in Figs. 43 to 45. Both torque and thrust coefficients are somewhat underestimated by the program, the largest discrepancy being in the nozzle thrust coefficient (Fig. 44). In spite of the simplifications in the mathematical model, the agreement can be regarded as satisfactory. It should be particularly noted that the error does not appear to depend on the thrust loading to any significant extent, which constitutes a significant improvement over the results of previous methods.

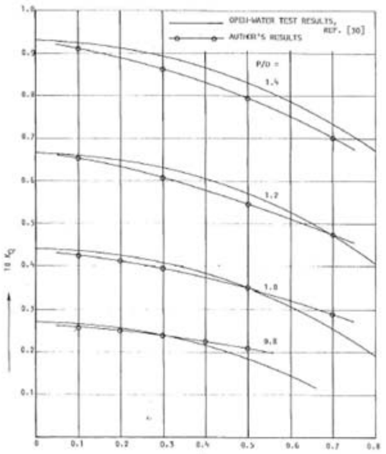

Fig. 43. Comparison of author's computed results with open-water test results of K_a 4-70 series in N.S.M.B. Nozzle 19A (torque coefficient)

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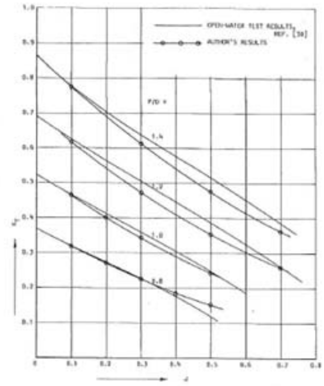

Fig. 44. Comparison of author's computed results with open-water test results of K_a 4-70 series in N.S.M.B. Nozzle 19A (thrust coefficient)

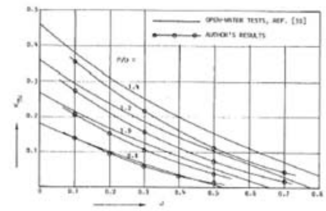

Fig. 45. Comparison of author's computed results with open-water test results of K_a 4-70 series in N.S.M.B. Nozzle 19A (nozzle thrust coefficient)

Fig. 43, 44 and 45 Ph D thesis (Delft, 1973)

In spite of the simplifications that still remain in my mathematical model, the agreement between the two can be regarded as satisfactory. The theory successfully passes *the reality test.*

If we do not account for slipstream deformation, that means we assume the diameter and the pitch of the slipstream vortices to be constant downstream, then the agreement becomes extremely poor at low advance ratios, more or less as depicted in Figure B. In the area of heavy propeller loadings (towing conditions), linearized theories, which do not account for slipstream deformation, fail *the reality test.*

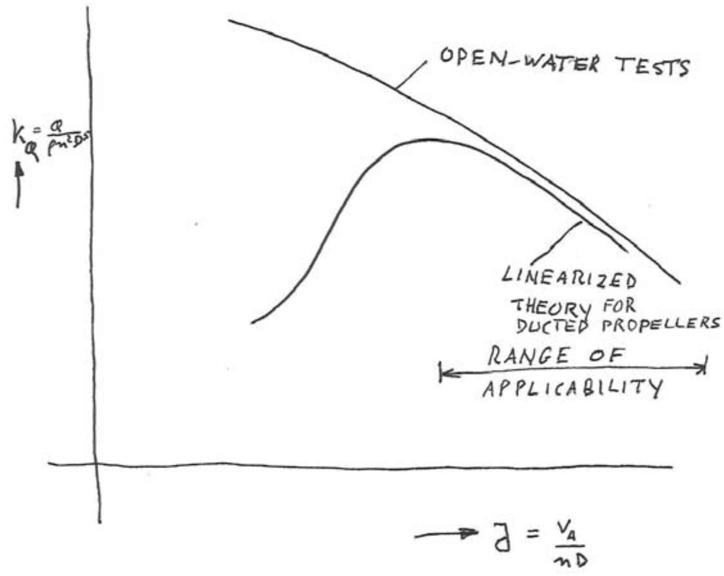

Fig. B: The reality test.

In the engineering sciences, a *reality test* is always possible. In hydrodynamics, a test in the cavitation tunnel or an open water test. In aerodynamics, a test in the wind tunnel. In construction, full scale testing.

In economics and social sciences, by contrast, such a *reality test* is not readily available. As a result, improper use of scales that are ill defined, as is commonplace in those fields, remains unpunished.

If a *reality test* is not possible in economics and social sciences, we have to resort to meticulously scrutinizing each step in the process of shaping the theory concerned. This is exactly what Jonathan Barzilai has done with a lot of zeal and persistence. Therefore, every fundamental error that he discovered has to be regarded as a step forward, as progress, not as criticism on the scientists who produced the errors.