If the development of the Stephensonian steam locomotive had kept pace with the expansion of engineering knowledge what ultimate level of performance would it have reached? I was asked the same question, specifically directed at thermal efficiency, by a representative of the Chinese Bureau of Energy Conservation in *1987.* *My* reply gave the following figures for the efficiency factors listed in Table *78:*

- Boiler combustion efficiency : *95%*
- Boiler absorption efficiency : *90%*
- Auxiliary efficiency factor : *96%*
- Cylinder efficiency : 22%
- Transmission efficiency : *94%*
- Drawbar efficiency : *96%*
- Overall drawbar thermal efficiency : 16,3%

These were in my estimation the maximum values which could be expected from a conventional non-condensing coal-fired reciprocating steam locomotive incorporating all the features necessary for optimum performance such as a high efficiency combustion system (micronised coal firing, which would inter alia have solved the pollution problem), very high boiler pressure and steam temperature, a compound expansion engine unit, and high power : weight ratio with a high fraction of the total weight available for adhesion. It follows from the second law of thermodynamics that the fundamental factor limiting the steam locomotive's thermal efficiency was the loss of useful energy due to the degradation of heat energy during its transfer from the temperature of the flame in the firebox to that of the water in the boiler, even if that heat transfer could be accomplished with 100% efficiency. This phenomenon could not be avoided in any steam locomotive design, however sophisticated it may have been, and higher efficiency could only be obtained by expanding the steam to sub-atmospheric pressure and low temperature by means of condensing to counter the negative effect on the cycle efficiency of the restricted inlet steam temperature, as done in stationary steam plant. Thus higher efficiencies were possible on paper - where almost anything is - and several engineers claimed them in (to me) more-or-less incredible proposals, but there is one hell of a difference between putting down on paper what a locomotive ought to be able to do and actually getting it to do it reliably in everyday service. Academic knowledge of thermodynamic theory, essential though it is, is not enough - knowledge of the 'nuts and bolts' of the steam locomotive, not to mention the psychology of railwaymen, is of no less importance in order to be able to assess the extent to which theory can be translated into practice in the railway environment, and in my professional opinion the detrimental effect on capital cost and reliability resulting from the complexity of these proposals would have far outweighed the thermal advantages being sought in any sober judgement based on the overall effectiveness and economy of a locomotive as an operating tool.