The ribosome as an historical relic of our ancient past

Protein synthesis is clearly an RNA-based process. During translation three different types of RNA (mRNA, tRNA and rRNA) collaborate to direct polypeptide synthesis. In contemporary organisms these RNAs are assisted by a complex array of proteins. But it is likely that in the primordial protein world RNAs directed protein synthesis without the aid of proteins. Some biologists speculate that these relatively crude primordial protein-synthesizing systems were relatively inefficient and error prone. Over time, evolution tinkered with the protein-synthesis machinery. Some of the proteins synthesized by these primitive cells were put to use in protein biosynthesis, increasing the efficiency and accuracy of the translation process. In this way the modern ribosome evolved. RNA-based catalysis is less powerful than protein-based catalysis. Ribosomes synthesize polypeptides at a rate of about 20 amino acids per second. Compare this speed with that of DNA polymerase, a protein-based catalyst, which polymerizes 500 nucleotides per second. In an essay about the evolution of biological catalysts, Bruce Alberts, a cell biologist, suggests that RNA catalysis is like vacuum tube technology, with protein catalysis being the microchip equivalent. If RNA catalysts are less efficient that protein catalysts, why do they still exist in cells today? With the aid of a large complex of proteins, ribosomal RNA works well enough to be retained as a catalyst and so was never replaced by a protein enzyme. It is the evolutionary history of the cell, and not any inherent chemical supremacy of RNA as a catalyst, that explains the structure and workings of the ribosome today. The primacy of RNA in protein synthesis today can be viewed as a hold-over from those ancient times when RNA catalysis was the norm.