In recent years, a focus of aerospace engineering design has been the development of advanced design methodologies and frameworks to account for increasingly complex and integrated vehicles. Techniques such as parametric modeling, global vehicle analyses, and interdisciplinary data sharing have been employed in an attempt to improve the design process. The purpose of this study is to introduce a new approach to integrated vehicle design known as the top-down design methodology. In a top-down design methodology, the main idea is to relate design changes on the vehicle system and sub-system level to a set of over-arching performance and customer requirements. Rather than focusing on the performance of an individual system, the system is analyzed in terms of the net effect it has on the overall vehicle and other vehicle systems. This detailed level of analysis can only be accomplished through the use of high fidelity computational tools such as Computational Fluid Dynamics (CFD) or Finite Element Analysis (FEA). The utility of the top-down design methodology is investigated through its application to the conceptual and preliminary design of a long-range hypersonic air-breathing vehicle for a hypothetical next generation hypersonic vehicle (NHRV) program. System-level design is demonstrated through the development of the nozzle section of the propulsion system. From this demonstration of the methodology, conclusions are made about the benefits, drawbacks, and cost of using the methodology.