Summary

The development of new aircraft engine constructions and the fulfillment of customers' requirements and expectations regarding thin-walled components determines the application of new high-strength hard-to-form steel and iron superalloys with a high value of yield stress and high heat resistance at their working temperature. The analysis of both the nature of the work and the transmitted loads indicates that the largest dimensional tolerance requirements apply to the struts which is a heavily loaded bearing element in the aircraft engine's fuselage structure. Taking into account the difficulties in obtaining the required dimensional and shape accuracy of the strut, which is plastically formed from the hard-to-form 17-4PH steel, the Pratt & Whitney Rzeszów has been attempting to develop a new technology for forming components of the intermediate fuselage of the turbofan engine. The analysis of the current research results and production experience indicate that currently used, non-automated, forming technology with heating in a conventional chamber furnace with radiant heating does not provide adequate conditions for the production of components of the intermediate case components with quality allowing for automation of their assembly and welding.

This thesis presents the results of numerical simulations of the forming process of strut, the results of which were the basis for modification of the currently used technology of production of struts. The work-stand for forming hard-to-form sheet metals developed within the REFOR project is fully automated. The results of numerical simulations based on the finite element method, taking into account the complex thermal-mechanical phenomena, were verified experimentally using the system for photogrammetric measurement of element geometries (GOM Inspect). The developed guidelines regarding the process of plastic forming of the struts sub-assemblies elements allowed to increase the reproducibility in their final production, as well as to improve the dimensional and shape quality allowing for the final implementation of full automation of their welding and assembly processes. In the research part, this thesis contains the results of investigations of mechanical and thermal properties of 17-4PH sheet metal. The results of experimental research on the process of strut forming and the industrial process of heating a sheet metal in an induction furnace are also presented. The influence of forming temperature on the change of steel microstructure and depletion of the sheet surface in alloying elements were determined in the SEM/EDS microstructural analyses. Based on the experience gained during the development of technology for the forming of struts of turbofan engine, a modification of the existing technological process of the turbofan engine housing production was also carried out. The results of these tests are also included in this thesis.