SUMMARY

A product development was conducted upon achieving the goal of this thesis of modifying a defective folding table in order to secure a continuous operational mode of the auditorium filled with aforementioned tables in the future and upgrade the room's using experience. An aim for fixing the failing tables instead of completely remodelling the auditorium with new furniture was achieved. Development methods were particularly limited to the financially advantageous and straightforward options that can be feasibly fabricated and implemented within the university without resorting to supplementary manufacturers of bigger scale. Several conclusions can be made on the account of the analytical process conducted and the final solution proposed:

1. The whole structure of the folding table was analyzed by examining multiple broken tables presented in the university. The underlying reason of failure was determined to be the top closure of the table's column, which in result of usage was being fractured. It was identified to withstand stress from the hinges and sliding moving parts present in the hinge system within the column in the process of user applying force to the table top. Owing to the general geometry of the table two aforementioned components are pressing on the top closure from below in the instance of the table being unfolded. The force applied was also determined to be of high magnitude due to the vast difference in lengths between the points of rotation present in the hinges and at the apex of the top closure, where the table top rests but also moves in a rotative manner. Corresponding dimensions of important for further analysis components were taken.

2. A force diagram was created to determine the acting force from the user pressing on the table top marking both rotational points of the system and their lengths. The total value of the force acting on the top closure was determined to be 2060 N. For better understanding of the weakest areas of the detail a Finite Element Analysis (FEA) was conducted utilizing a 3D model of the detail created in SolidWorks software. Since the most important for analysis stress present in the detail is of bending nature, a bending moment (16,995 Nm) was then calculated. Bending stress (~3 MPa) was further calculated in the cross-section of the top closure at the placement of cracking occurring most often according to FEA results utilizing values of moment of inertia ($\mathrm{Lxx} = 60441{,}83\ mm^4$) and perpendicular distance from the neutral axis to the farthest point on the section obtained from the software.

3. It was resolved to increase the moment of inertia in order to lower the bending stress present in the section. The list of possible options of lowering the stress for considered geometry was analytically constricted to the number of three, namely adding material to the top closure, changing its material, and changing the geometry of the top closure utilizing several materials. All the methods were put to the test with provisional FEA of each option. Material addition presented itself partially helpful with stress still present in the most critical areas around screw holes. An option of 3D printing the top closure was considered for its financial appeal and did not turn out to be satisfactory due to disparity in the actual yield strength of the printed plastics and the calculated required strength.

4. Eventually, only changing both geometry and utilized material provided acceptable result. It was decided to create a two-piece geometry consisting of the 6 mm steel plate of the same shape as the inner silhouette of the column with an FDM printed from ABS addition on top covering half of the plate's upper surface to provide an apex for positioning of the table top in the unfolded state. Two pieces are screwed together with the bolt heads positioned at the bottom and subsequently screwed to the column of the table. Both of the 3D models and corresponding assembly were created using the same software with the drawings presented in the appendices' section. This solution presented itself greatly durable satisfying all requirements with the metal plate withstanding all the applied stress, which was also tested with FEA, and the plastic part securing the resting of the table top surface. An increase in the moment of inertia ($\text{Lxx} = 142619{,}23\ mm^4$) and decrease in bending stress ($1{,}749\ MPa$) was also detected upon recalculated for the proposed design, which secured the verdict. The settled option satisfied the requirements of being financially feasible, easy to produce within the premises of the university and uncomplicated to assemble. The goal of keeping original tables with fixing of the issue to avoid remodeling of the auditorium was thus achieved.

Results of conducted product development has shown to be pleasing with the proposed alternative design being easily implementable, functional, and modest. Further additional work of creating route sheets and calculating production times and costs can be done in the future accompanying the conceivable manufacturing of the suggested detail.