SPACE EDUCATION AND OUTREACH SYMPOSIUM (E1)
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DEVELOPMENT OF COLLABORATIVE MODELING TOOL AND SYSTEM THINKING EDUCATIONAL PROGRAM FOR NANO-SATELLITE DEVELOPERS

Abstract

This research aims to support for nano-satellite developers to build mutual understanding about their own system using our self-developed web application and educational programs, in order to proceed the developing process rationally and efficiently communicated with team members and hence to improve the success rate of missions. Nano-satellites have been greatly paid attention for recent years. The number of nano-satellites on orbit and investments have rapidly increased. However, the success rate of nano-satellite missions of new entrants has been less than that of the experienced developers. According to past researches, failed projects had critical problems on the integrated tests qualitatively and quantitatively. One of the authors led the project of 1U-CubeSat "OPUSAT" that was launched in 2014 to success. In the case of "OPUSAT", the design documents updates could not often keep up with the design updates. Thus, the developers had to start from sharing information about their own components and to adjust interfaces before the integration tests. The team member actually wasted extra several weeks to prepare the tests. Although "OPUSAT" was fortunately success, these kinds of schedule overrun should have been avoided. The authors thought that the problem might be in mindset of developers. We paid attention to system-thinking and modeling. The system-thinking teaches the importance of the interaction between the conceptual level and the implemental level design to the developers. Modeling promotes sharing of the information and the interpretation in developers' brain. In the paper, we firstly explain our self-developed web application that provides collaborative modeling. Users can create relational graphs consisting of nodes and links, and add comments on the graphs. Several assist functions such as notification by email help users to utilize our tool naturally in their workflow. Users can review and manage the design of their developing system in our tool. Secondly, we introduce the effects of our tool on the educational program of the system-thinking to the graduate students. In fundamental works to

understand operational, functional, and physical view, students of this program analyze several functions of ballpoint pen and create models of them from these points of view. In advanced works, they create models of new product to address a certain problem. Teachers evaluate students' models about the completeness and consistence. We conducted this program, and found that communication on models between students and teachers brought deeper understanding about system-thinking. Finally, we provided our tool to nano-satellite project, and evaluated the effectiveness.