Excavation & Conveying for Lunar Missions

System developments for the two fundamental steps of the ISRU chain

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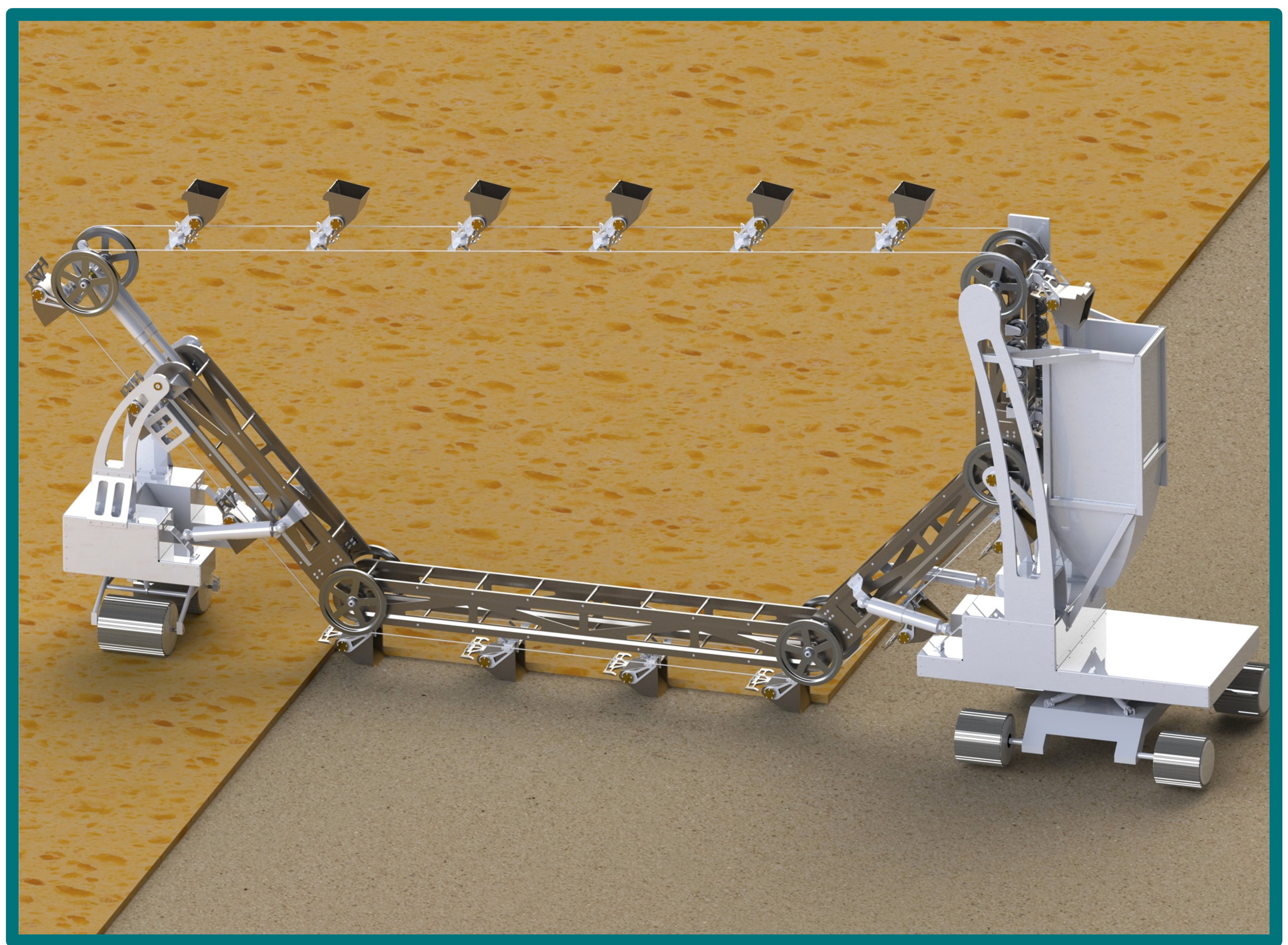
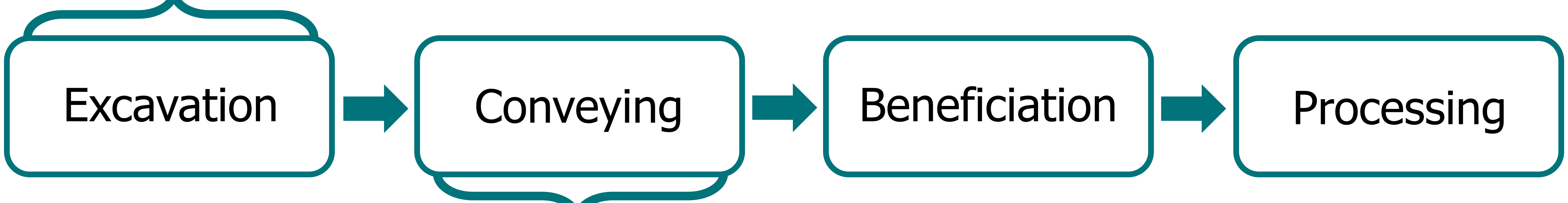
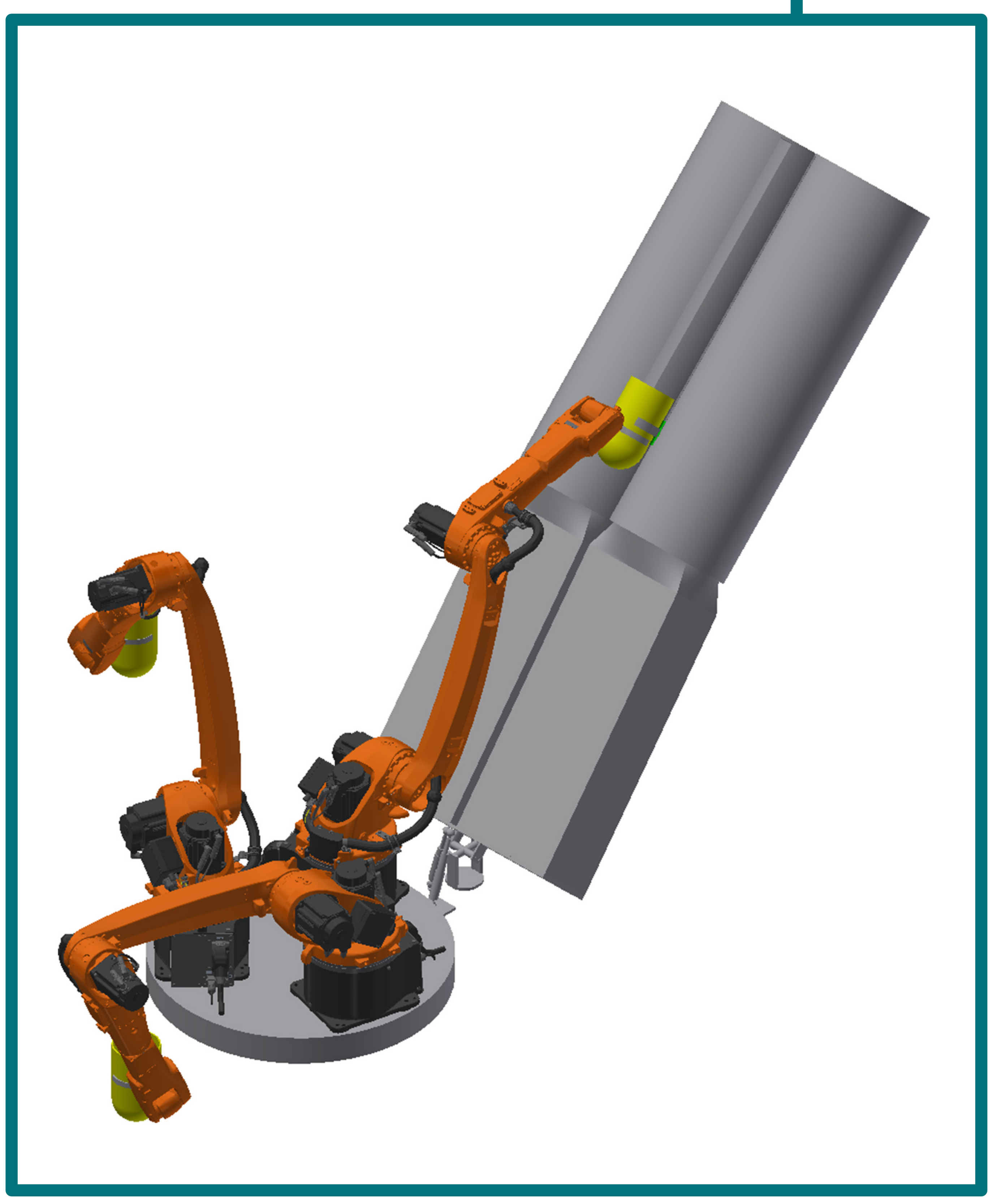


In situ resource utilisation (ISRU) is seen as the basis to enable oxygen production in space exploration, whether as the vital basis, as O2 is essential for basically all life forms, or further, also for rocket refuelling purposes. In this context, specifically concerning the handling of Regolith, the ISRU chain can be seen as consisting of four major steps: excavation, conveying, beneficiation, and processing. Furthermore, on the lunar surface, these steps have to work and interact completely autonomous and are additionally also exposed to extreme environmental influences. To get an ISRU system running at all, the first two and thus initial steps (excavation and conveying) are of crucial importance. Therefore, focus was set on the development of suitable excavation and conveying system concepts for lunar application, specifically from the perspective of mechanical system principles. As illustrated in the figures, two concepts, each evaluated with high potential for the respective purpose, are proposed.





A excavation system concept (top figure), similar to the principles of a bucket chain excavator, is used to scrape material from the lunar surface. By adjusting the bridge/carrier system, different positions of the main beam can be set, and also the excavation depth can be regulated. This system shows several advantages, such as also including terrain levelling.

For subsequent conveying of gathered Regolith, a ballistic conveying system concept (bottom figure) was chosen as basic approach. Ballistic conveyance reveals advantages, especially when considering the lunar environment: low gravity, lack of air resistance, cohesive material characteristics. Moreover, this concept allows a low ratio of dead weight in relation to the conveying distance; and a mobile and flexible version is feasible. In addition, this concept makes it relatively easy to overcome obstacles in the topology between the excavation site and the processing site.

Both concepts are combined into one total system: The ballistic conveying unit is therefore attached to the platform of the excavator. Additionally, a transfer system, such as indicated in the figure consisting of robot arms, loads the accelerator of the ballistic system with material gathered from the excavator. This unified excavation-conveying system results as a promising concept to enable excavation and conveying for running an ISRU system on the Moon.

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