Landmine accidents are common in war torn countries, resulting in 26,000 new amputees each year. Prosthetic devices are monetarily out of reach for these amputees. For reference, the average cost of a prosthetic in the United States ranges from $5,000 to $15,000. Moreover, purchasing a prosthetic is not a one-time cost. On average, growing children require new prosthetics every 6 to 12 months, while adults require new prosthetics every 3 to 5 years. Therefore, there is a significant need for low-cost, durable, and functional prosthetics.

e-NABLE is a community of volunteers dedicated to serving people in need of low-cost 3D printed prosthetics. The simplicity of their designs allows the cost to remain low, ranging from $12-20 per prosthetic. Currently, all e-NABLE prosthetics for partial hand amputation operate using the same closing mechanism: wrist flexion closes the hand by tightening the flexor cables attached from the tips of the fingers to the back of the wrist. Continuous holds must be maintained using constant wrist flexion, resulting in muscle fatigue and potentially overuse injuries, such as carpal tunnel and tendonitis. This project aimed to resolve these issues by creating a locking mechanism to hold the fist of the prosthetic in a closed grip position.

The team initially considered two locking mechanisms: a pawl ratchet mechanism on the wrist joint, and a clamp for the tensor cables. Ultimately, the clamp design was chosen because it allowed the user to straighten the wrist while the clamp is enabled—a feature that would not be supported by the ratchet design. The clamp was integrated onto the back of the palm of the original device. The clamp provides the ability to maintain tension in the strings without wrist flexion and allows the user to relax their wrist while keeping the fingers closed.

Designing the clamp took place over several iterations based on the design of eNABLE's Raptor Reloaded. The first clamp was proof of concept for how much force a particular clamp geometry could apply to a single string. Different materials and geometries were tested. It was determined that a curved tooth geometry made of PLA worked best. The team then designed a proof-of-concept clamp to test clamping force. An uneven clamp force distribution was uncovered during this stage of testing; however, it was deemed acceptable for the project's design specifications. The whole clamp was then integrated on to the back of the palm and the final iteration included 3D printed pins. They are modeled after the current pins with a different shape to fit the small confines of the clamp.

Testing was also performed to validate the final design and provide feedback for future improvements to e-NABLE designs. Maximal force testing of the clamp with two different string types, a 3mm string and 0.4mm fishing line, confirmed the presence of a clamp force distribution discovered during the device's development. Additionally, the team found that 3mm string required a higher force before slippage than fishing line. Approximately 44 N can be applied to the strings before one of the fingers or thumb will begin to slip. This force testing provides optimal-use parameters for users. To evaluate the effect the clamp has on sustained grip strength, load cells were used to record the force applied to a held object over time. Multiple shaped objects were tested: a rectangle, hemisphere, and a cylinder. This variable provides e-NABLE developers with feedback on the types of objects this design can hold, providing opportunities for further device refinement. The results of force testing showed there is no significant difference between any of the shapes. This indicates that as long as the object is sized correctly to fit in the hand, the shape of the object shouldn't affect gripping performance.

This modification of the Raptor Reloaded design benefits users by allowing them to maintain continuous holds without constant forearm flexion, enhancing personal comfort. The added clamping component can be used within a range of 0- 44 N of tension and can hold objects of different shapes.