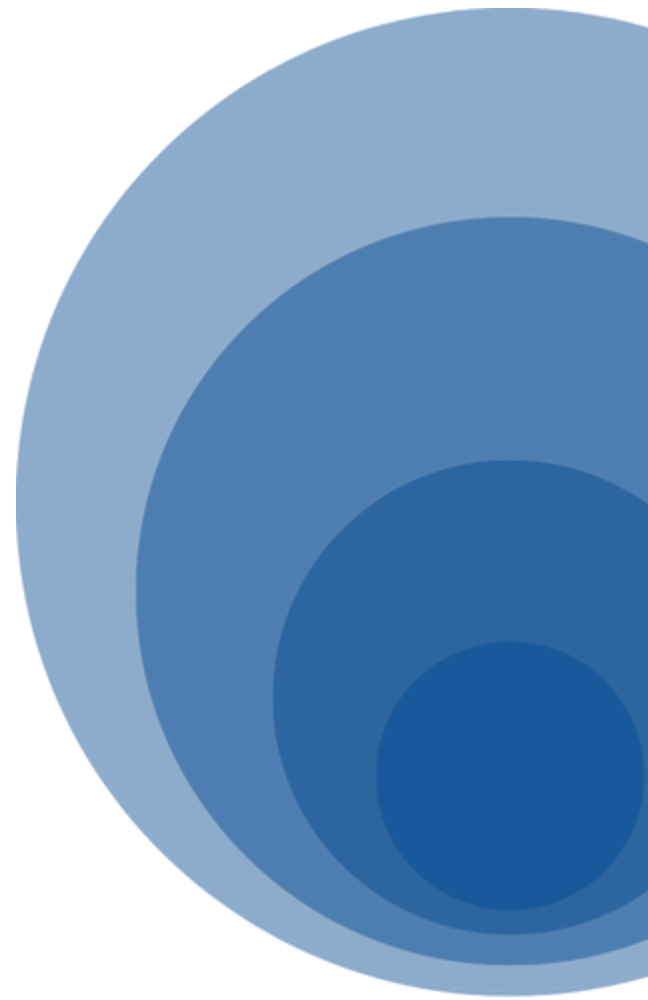# ORDER FOUR:

A BICYCLE PLATFORM FOR DIFFERENTLY ABLED USERS

Phil Caridi

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Phil Caridi is a Brooklyn-based artist, industrial designer, and educator with a specialty in both digital and traditional fabrication. Phil has a BFA in industrial design from the Savannah College of Art and Design (SCAD) and an MPS from ITP at NYU. Phil is currently the Manager at the ITP/IMA Makerspace Lab and Adjunct faculty at ITP, where he workes with faculty to introduce students to the equipment and methodology used in prototyping and fabrication. Phil worked as a contract industrial designer for over a decade. His artistic work focuses on the abstraction of time, the transformation of physical movements into digital inputs, and kinetic installations. Phil has been developing a concept he calls long-form/short-duration installation work. Phil is a cyclist, an avid action figure collector, a lover of comics, and a fan of all things musically heavy and slow.

ABSTRACT

Project Mjolnir is an open-source adaptive mountain bike (aMTB) platform designed to address critical barriers faced by differently abled users, namely, cost, customization, and repairability. Mjolnir surpasses conventional assistive devices by positioning itself not just as a bike but as a system of inclusion, empowerment, and co-design. Grounded in the C.A.R.E. framework—Customizable, Affordable, Right-to-repair, and Evolving—the platform encourages community participation in its ongoing development, allowing for rapid adaptation to individual needs such as quad grips and modular seating. Compared to commercial options costing up to $20,000 USD, Mjolnir can be built for approximately $6,500 USD using widely available parts. All design files are freely distributed, enabling global access and faster repair. Pilot programs in Ireland and New York City further explore the integration of solar-powered, roll-in/roll-out trailhead storage into urban infrastructure. Beyond physical design, Mjolnir functions as a catalyst for redefining mobility and inclusion, supporting an aging and diverse population with evolving abilities. By inviting users into the design process, Mjolnir challenges the boundaries of what a product can be, reclaiming mobility, independence, and joy for all who wish to ride.

Keywords: *Bicycle, inclusive, open source, mobility*

A BICYCLE PLATFORM FOR DIFFERENTLY ABLED USERS

I want to ride my bicycle

Do you remember when you first learned to ride a bike? Do you remember that first taste of freedom and independence while riding? Now, picture that taken away from you. How does that make you feel? For more than 15 million people globally [1] with spinal cord injuries (SCI), this is their reality. If we expand the pool of differing ability levels to include both physical and cognitive abilities, that number balloons exponentially.

One of those fifteen million is Noel Joyce, who suffered a T8 injury in 2006 that left him paralyzed from the mid-torso down. In 2021, he purchased an adaptive mountain bike for approximately $15,000 USD, which broke easily and frequently. Replacement parts came at both a monetary and time premium, with wait times often reaching six months.

Richard Buchanan's Four Orders of Design can be summed up in one sentence: "The future is accessible." Inspired and invigorated by the challenges he and thousands of others face, Noel and I set out to change the way adaptive mountain bikes are designed, used, and viewed by the public.

Enter Project Mjolnir (Mjolnir), a first-of-its-kind open-source adaptive mountain bike (aMTB). Mjolnir is a platform for imagining creative solutions for varying ability levels. Buchanan says, "a chair is not a thing, but a place of activity" [3]. This would clearly define Mjolnir as being in the Third order of Design, "Actions", but I challenge that notion and believe Mjolnir sits in the Fourth order of Design, "Thoughts"

Figure 1: Noel Joyce riding Mjolnir FS V18

It's a platform

Returning to the idea that this bike serves as a platform, we utilize a system we call C.A.R.E:customizable, affordable, right-to-repair, evolving. This aligns well with the Design for All ethos, as all people should have access to everything society offers. Realizing Mjolnir as a platform that embraces input from all is one way it leans towards the Fourth Order of Design.

Customizable: Mjolnir is customizable, allowing each user to control how they interact with the bike. One of Mjolnir's greatest strengths is that it is open source, meaning anyone can contribute. Feedback from the adaptive mountain bike community is incorporated into future iterations to help it evolve and grow. Some users contribute designs that are integrated into the next official version. Others provide valuable insights into specific needs, such as the quad-grip for riders with limited mobility in their fingers and hands, or the requirement for fenders on both the front and rear to protect the rider and their co-pilot. Adaptive rides typically use a co-pilot, another able-bodied rider, to assist with reading the trail from a different angle, overcoming trail obstacles, and providing emergency help in the event of mechanical failure.

Affordable: One of the most significant barriers to entry to adaptive mountain biking is the cost. A typical aMTB can cost upwards of $20,000 USD for a stock, off-the-shelf bike. This is at least double, if not triple, the price of an upright bicycle. By making Mjolnir open-source and self-built, we have reduced the cost to roughly $6,500 USD. While this is still a significant amount, it maintains parity with the current market pricing of an upright bike. We pay close attention to the design and fabrication methods used to produce Mjolnir, ensuring the cost remains competitive.

Right to Repair: The next barrier to entry for the aMTB segment is the cost of repair, in terms of both time and money. Since many of the companies that produce aMTBs are small, their production timeline can be measured in months. So, breaking a model or brand-specific part can mean the customer can't ride their bike for half a year. Replacement parts are costly, which, when paired with long lead times, means some riders would rather do without the upkeep than invest in a bike. To combat this, all fabrication files for Mjolnir are free to download, which means users can take them to a local machine shop or an online service bureau and have the part made to order, generally delivered to their door within two weeks.

Evolving: Mjolnir is designed as a system that can evolve with input from the community. We don't have all the design solutions, and we don't even know all the problems that need to be addressed. However, by leveraging the community and individual users, we can continue to develop the design of Mjolnir to ensure that everyone who wants to ride a bike can do so. We look to new manufacturing techniques and companies to further reduce costs.

THE BASICS OF
PROJECT MJOLNIR

Mjolnir consists of three main modular sub-assemblies. The front assembly is shown in magenta, the seat assembly is shown in CYAN, and the rear assembly is shown in green (Fig. 2). All parts shown in grey are standard off-the-shelf bicycle components. This was paramount to the design; we wanted to reduce the number of custom parts on the bike to allow for faster repairs, lower costs, and the ability to make repairs at any local bike shop. The main frame members are 50mm aluminium tubes, which are ubiquitous worldwide. All of the choices of materials, standard parts, and manufacturing processes were chosen to ensure availability and cost reduction. Digital part files, Bill of Materials, and manufacturing resources are all available on our website, and users can download and self-build any of the parts.
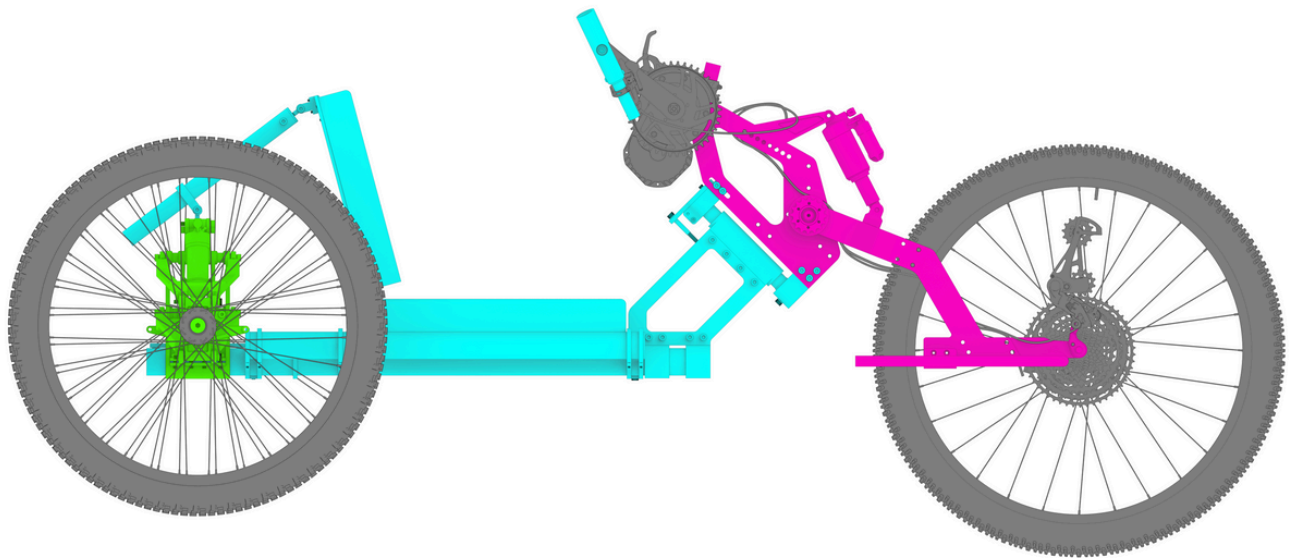

Figure 2: Orthographic view of Mjolnir FS V18, showing the sub-assemblies by color

Triangle of Doom

In Greek mythology, Mjolnir, Thor's hammer, was created to break down barriers. Mjolnir, the bike, achieves this customizability, reducing costs and time spent waiting for repairs.

In his lecture at IxD 2011, Buchanan spoke of the "Triangle of Doom" [3]. The three points of the triangle define what a product is:

- It must be useful or, as Buchanan puts it, have intellectual content.
- It must be usable, physically or otherwise.
- It must be desirable, put in other terms, can we identify with it?

Mjolnir fundamentally rests on these three points:

1. Is it Useful?

Mjolnir provides differently abled users with the ability to regain freedom of movement and independence by offering them a new method of mobility. Previously, being away from the built environment was challenging due to high barriers to entry in terms of cost and access. It also increases the opportunity to remain active despite physical or cognitive limitations, and could potentially help boost self-confidence and happiness.

2. Is it Usable?

We have designed Mjolnir to act as a platform for each individual user, with the focus on usability. Components can be adjusted, redesigned, and adapted to all needs. One area we focused on this year was a quad grip. Designed for users with limited dexterity in their hands and arms, the quad grip allows for breaking with the lateral movement of the forearm. Seat position, foot placement, and body position are all easily adjustable in the core platform configuration. We view usability on an individual basis.

3. Is it desirable? Can we identify with it?

Mjolnir takes the familiar look and feel of an adaptive bike and enhances it by reflecting the true user base—a community of members with diverse individual needs. It fits in our mind like a bike does. The placement of the wheels and tires, the use of pedals, and the visual weight suggest that it is indeed a bike. The bicycle holds a special place for many, memories of childhood freedom and self-reliance.

Add a Voice

The Triangle of Doom is a method for determining what the product is saying, where it fits in our lives, and its unique voice. The mission of Mjolnir clearly states that it belongs to all of us, regardless of our ability level and individual needs. A good friend once told me, "One day we will all be disabled," which profoundly affected me. We don't generally think that way, but it is the truth, as we age, our bodies and minds change. Mjolnir, among other differently abled users, can help an aging society stay active and healthy. Mjolnir's voice is one of inclusion and honesty, of collective effort and partnership.

A Bike, Accessible for All

I met Noel while I was a research resident at NYU's Interactive Telecommunications Program, an interdisciplinary master's degree program that interrogates the use of emerging technology through the lens of art. New York City, and the challenges it can pose, were integral to our design process. Apartments in NYC can be small and cramped, often lack access to elevators, and rarely meet ADA compliance standards. This poses a non-unique problem for riders of aMTBs: how does one store a large bike in a small apartment? And secondly, how does one transport it to the trail?

Maybe the answer to those questions is not to store the bike in individual apartments? Or to eliminate the need to travel with and transport the bike? Perhaps the solution is to make them publicly available through the infrastructure of government departments, NGOs, and public spaces. This is where we are headed with Project Mjolnir.

We are currently working on a pilot program that utilizes the urban park network of NYC to make these bikes available at the trailhead, exploring the use of half-land/sea containers to create a secure roll-in/roll-out storage unit. We launched a similar program in Ireland in the summer of 2024, with the assistance of Cycle Ireland, which funded the construction of five bikes and deployed them to five localities in Ireland, making them available for riders to use. Here again, we aim to reduce the barrier to entry for users to get back on the bike.

We are working with Fresh Kills Park to identify a permanent location for testing the roll-in/roll-out unit. The unit will be self-sustaining, featuring solar panels to charge the pedal-assist system on the aMTBs, and security cables for users to lock their valuables and wheelchairs while riding in the park. This system addresses one of the most significant issues with getting differently abled users on the trails: cost and access.

Return to the Fourth Order

Mjolnir surpasses the definition and category of the Third Order of Design, "Activities, Services, and Processes." It is truly a system that creates broad access for a group of users who have traditionally been marginalized. Mjolnir relies heavily on a system design that incorporates the user into the design process and reduces the barriers of entry. The complexity, strategy, and impact are on a scale much larger than that of an individual. Utilizing large entities, such as government organizations and diverse user groups with multifaceted needs, the spiderweb of Project Mjolnir continues to grow and expand.

Buchanan asks, "How can the orders of design align to do the most good, for the most people"? [3] The answer is clear: as designers, we must embrace the decentralization of knowledge by inviting users, organizations, and all people to the design process, using a shared common vocabulary, giving a voice to each individual user.

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