Aalto University

TU Delft

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SPOT

SOCIETAL PERSPECTIVES TO INNOVATION OPPORTUNITIES IN TECHNOLOGY

EXPLORING MEGAMORPH ‘HOW MIGHT WE?’

ATTRACT

Report:

Exploring opportunities with 'How Might We' questions:
A student perspective

Prepared for:

MEGAMORPH

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Student contributors:

This compilation of student perceptions was collated from the submissions of 34 students. Students who wanted to be acknowledged as contributors by name are Masood Afaq, Johannes Kallio and Tuomas Mannonen. All other students contributed anonymously.

Nature of student assignment:

Students were introduced to the MEGAMORPH technology card and project description. They were tasked to consider opportunities for development or additional use cases by exploring different frames of reference. The exploration leveraged the generation of 'How Might We' questions, which are a technique to identify various opportunities.

Student responses we collated into categories:

- Communicating and demonstrating the technology's potential.
- Inspire and raise awareness among possible future users.
- Reduce cost to increase interest.
- Exploring possible domains of application (education, health care, wearables, the built environment, and transportation).

How Might We

Introducing the technique.

"How Might We" (HMW) questions are a strategic and constructive tool employed in the design thinking and innovation processes. They're used to reframe problems as opportunities for creative solutions.

The structure of an HMW question is intentional. It starts with "How," implying possibility and action, followed by "Might," allowing for diverse potential solutions, and ends with "We," emphasising collaboration and a collective approach to problem-solving.

HMW questions encourage us to look at challenges from different angles, helping to redefine issues in a way that opens up possibilities rather than limiting solutions. By posing more open-ended questions, HMW prompts stimulate creative thinking and generate a wide range of potential solutions. This fosters innovative ideas that might not have been considered otherwise.

Overall, HMW questions serve as a catalyst for creativity, collaboration, and innovative problem-solving within development processes, enabling teams to generate fresh ideas and find effective solutions to complex problems.

In this compilation, a number of HMW questions were crafted with potential next steps or opportunities for early prototyping activities. All questions are presented exactly as students constructed them, some with additional considerations and prototyping ideas.

Communication and Demonstration of the Technology Potential

How might we develop a "sales pitch" for large area screening evaluation kits so that private companies can understand the technology and possible applications?

"This is a promising angle for exploration, because often a good, simple sales pitch goes a long way when you want to sell your skills, services, or products. Private companies may not understand all selling techniques, so by keeping the sales pitch simple enough for private company representatives to understand it, they may start to support it."

- *Anonymous student*

How might we market this technology so that different commercial partners feel confident to heavily invest into the project?

"The more people who are aware of this technology, and its advantages and challenges, the more individuals can research and develop, for example, cheaper manufacturing methods… The use of surveys and customer testing can reveal how the product will be perceived by the end users and commercial partners. This would be helpful in making business plans and also predicting the estimated market need which they can incorporate in their production plans in the future as well."

- *Masood Afaq*

How might we develop a still picture frame using GMOD so that the design team could have a real prototype that displays the potential benefits of GMOD in display technology?

"Starting with the replacement of an LED display directly is difficult task, instead what should be focused on in early prototyping stages should be simple and effectively demonstrations the use of this technology. A still image can be a good example of this. Generating a simple static image with high resolution compared to its counterpart would be a good mile-stone I believe. Once a still image has been created, it can be use to see how the resolution of the generated image is different from already existing images."

- *Anonymous student*

How might we build a range of interesting prototypes so that we could attract more funding and expertise to work on our projects?

"This is a promising angle for exploration, because showing the producat in action is always more interesting and demonstrative than a slide shows or website. The more prototypes there are, the more opportunities one have to get people interested in a product."

- *Anonymous student*

How might we improve the durability of GMOD displays so that customers could justify paying a higher price for products with these displays?

"I think that if the durability could be proved to be better than other smartphone displays for example, a lot of people would be more interested in it."

- *Anonymous student*

How might we create affordable GMOD-based large-scale display

evaluation kits so that potential commercial partners in the tech industry could assess the technology's feasibility and potential, thereby encouraging support from the private sector support?

"By offering cost-effective evaluation kits, Megamorph can attract the interest of tech industry partners, promoting collaboration and private sector investment. It is essential to gather insights into usability and effectiveness from commercial partners. One can select a diverse group of potential commercial partners from the tech industry who represent various interests and perspectives. This may include companies involved in display technology, electronics, or related sector."

- *Anonymous student*

How might we apply the technology to other fields than optics so that those fields could be disrupted?

"Based on the technical information available, the micro-membrane technology could find a use in other applications too, such as haptics, fluid dynamics, or audio, which all currently use membrane designs for various purposes."

- *Anonymous student*

How might we develop a low power, sunlight-readable display so that workers could access information easily in bright conditions?

"With current display technologies, the readability of screens is often bad in very bright conditions such as outdoors. This can lead to workers missing crucial information regarding their safety on their devices. Demonstrating the performance of the displays in these settings will help consumers see that the product makes sense to develop, that it brings benefits, and that the safety and ease of work is increased."

- *Anonymous student*

How might we develop augmented vision so that industries that need in-eye optics could be revolutionized?

"Current solutions for in/on-eye optics (e.g. vision loss fixing implants, discreet augmented reality options) are mainly limited by the possible resolution of existing technologies due to their low PPI (pixels per inch). MegaMorph's PPI is promised to be multiple orders of magnitudes higher than existing solutions, which could revolutionize the solutions. How thin the panels can be made, can they be made see-through, and can they be made bendable? All three of these criteria are important for the use in implants and AR applications"

- *Anonymous student*

How might we form alliances with environmentally aware companies in the consumer electronics sector so that we could cooperate to mitigate the electronics industry's impact on the environment with GMOD technologies?

"GMOD's commitment to environmental sustainability partnership with environmentally conscientious electronics companies, help to lessen the detrimental effects of electronics on environment. The partnership might tackle the increasing need for green technology and assist in achieving sustainability goals by incorporating GMOD technology into a range of gadgets, promoting a cleaner and more ecologically friendly electronics sector."

- *Anonymous student*

Inspire and Raise Awareness Among Possible Future Users

How might we educate and train the future workforce in GMOD technology and its applications in order to ensure a skilled and knowledgeable workforce could drive innovation and industry growth?

"GMOD technology's success depends on a skilled workforce that can develop and implement it effectively. This question addresses the need for education and training programs that can equip future professionals with the knowledge and skills required to work with GMOD technology, thus contributing to innovation and industry growth."

- *Anonymous student*

How might we establish collaborative research and development partnerships with educational institutions and startups, so that so that the next generation of professionals in Europe could gain hands-on experience with GMOD technology, promoting talent development and ensuring a skilled workforce for the future?

"This is a promising angle for exploration, because it focuses on the development of human capital, enriching the pool of skilled professionals and fostering the next generation of experts, which aligns with Megamorph's long-term societal impact goals. The consortium can prototype an educational partnership program that collaborates with selected educational institutions and startups to provide hands-on training and experience with GMOD technology to students and aspiring professionals. This prototype is essential to determine the effectiveness of the proposed program in cultivating a skilled workforce for GMOD technology. It ensures that educational institutions and startups can successfully impart the necessary knowledge and expertise to the next generation of professionals."

- *Anonymous student*

How might we provide GMOD display assessment kits for academic institutions as well as research groups so that researchers and students could work directly with this advanced technology and encouraging creativity and knowledge in the next generation of scientists and engineers?

"Creating GMOD display assessment kits, especially for academic institutions and research centres can aid in introducing cutting-edge technology to researchers and students. It can motivate and prepare the next generation of workers for deep tech innovation by giving them an accessible and beneficial means of experimenting and learning about GMOD technology. Creating a prototype GMOD display assessment kit that consists of a reduced-sized GMOD display, instructional materials, and software tools for GMOD performance simulation. To evaluate the kit's efficacy in instructing students about GMOD technology, it can be tested in a regulated educational institution, such as a university or technical institution."

- *Anonymous student*

Reduce Cost in Order to Increase Interest

How might we optimize the production process for GMOD-based large-area display evaluation kits to ensure scalability and cost-effectiveness in order to accelerate the reduction in the price of CVD graphene?
"The integration of CVD graphene into products is hindered by its high cost and highlights the importance of large area display evaluation kits. This question focuses on streamlining the production processes to make these kits more cost-effective and scalable. By making the production of large-area display evaluation kits more efficient and cost-effective, Megamorph can attract private sector partners. These partnerships can lead to increased demand for CVD graphene and, in turn, reduce its price, making the technology more accessible"

- *Anonymous student*

How might we develop cost-effective graphene production methods so that small and medium-sized enterprises in the electronics industry could access and integrate GMOD technology?
"Developing cost-effective graphene production methods would make GMOD technology more accessible, not just to large corporations but also to small and medium-sized enterprises."

- *Anonymous student*

How might we develop GMOD technology so that it would be accessible to smaller companies allowing them to experiment with it and find its potentials in various unordinary applications?
"If the technology only falls to the hands of larger companies, we might see it only used in applications that are the most profitable. If, however, smaller companies and independent inventors get access to it, we might see how it can be used in unordinary applications. Usually, small companies need to develop something really special to success, as they don't have a customer base and attention from the public. It is common that smaller companies make many inventions that fail, until they finally come up with something that works and that the bigger companies didn't even think about. The main factor making GMOD technology expensive is the price of CVD. To reduce the price, the manufacturing process of CVD needs to be scaled and streamlined. This could, for example, include testing new production methods and ways to improve the existing processes. The supply chain also need to be optimized, and as mentioned in the report, gaining support from the private sector is also important in reducing the price."

- *Tuomas Mannonen*

How might we develop a cost-effective GMOD manufacturing process so that SMEs in emerging markets could could create affordable VR/AR devices?
"Cost-effective GMOD manufacturing process would significantly lower barriers to entry for SMEs. These SMEs could then produce affordable teaching methods with VR/AR devices. In education, for example, these methods would be a fundamental need so it would be more effective."

- *Anonymous student*

Exploring Applications: *Education*

How might we develop an early stage GMOD products so that universities could get access to high-end future technology?

"Universities are full of talented creative young people as well as individuals who have seen the world and new technologies. Launching fast some kind of rough starting prototype for universities would boost up the research of technology. This way affordable solutions would come up fast. They could perhaps give a specific thesis (bachelor, master, doc.) in subjects related to technology to students across the world. Students put a lot of effort into thesis work and with good support it may provides new diverse creative perspectives that weren't previously noticed."

- *Anonymous student*

How might we design GMOD-based display solutions for the education sector so that students and educators could benefit from enhanced interactive learning experiences?

"The adoption of GMOD technology in education can have long-term benefits by having students who are comfortable with and have a deeper understanding of advanced technology. Prototype GMOD-based display solutions designed for classrooms, including hardware and Software, addresses the growing demand for innovative educational tools and aims to improve the quality of education, student engagement, and technology adoption in classrooms."

- *Anonymous student*

How might we adopt GMOD technology into university studies so that the graduates could already be familiar with the technology and become experts in companies that utilize the technology?

One problem with new and promising technologies is, that it takes time for people to become specialists with them, and this hinders the development of products utilizing the tech. If GMOD technology were already taught in some university programs, there would have more experts with understanding about it much faster. If these new technologies aren't included in university studies, people will have to learn about them themselves or at companies using the technology. As expensive it might be, developing small scale GMOD "kits" for universities is essential in ensuring that we have enough experts who can design devices utilizing GMOD tech in the future. For example, when transistors became an essential part in electrical engineering, Teknillinen Korkeakoulu was still only teaching about their predecessor, electronic tubes. It took time till the university adopted this new technology into their teaching. Meanwhile, the graduates moved to working life with insufficient skills and many had to learn about this new tech by themselves. (source: my grandfather)

- *Anonymous student*

Exploring Applications: *Healthcare*

How might we integrate GMOD technology into medical imaging displays so that healthcare professionals could provide more accurate diagnoses and treatment, addressing the need for high- resolution and energy-efficient medical displays that support improved patient care outcomes?

This question addresses the healthcare sector, where accurate medical imaging is crucial for patient care. GMOD technology's high resolution and low power consumption can significantly enhance the quality of medical imaging displays, enabling healthcare professionals to make more precise diagnoses and improve patient outcomes. Creating a prototype of GMOD-based medical imaging display for healthcare applications allows Megamorph to validate the feasibility and performance of GMOD technology in a real healthcare setting. The process should engage radiologists and healthcare professionals in the testing process to gather feedback on the accuracy, usability, and overall performance of the GMOD-based medical imaging display.

- *Anonymous student*

How might we develop GMOD-based assistive technology solutions so that individuals with visual impairments could gain enhanced access to digital content?

By creating devices that convert digital content into tactile or auditory experience using GMOD technology, Megamorph could empower visually impaired individuals to access information and educational content. This would then help in education as individuals could use it for different needs. Developing a prototype GMOD-based assistive device that converts digital content into tactile or auditory experiences and conduct usability tests and help analyze and observe how the device fits in the daily life.

- *Anonymous student*

How might we tailor GMOD technology to meet the specific needs of the healthcare sector so that the medical professionals and patients could leverage its eco-friendly, high-resolution display capabilities for enhanced diagnostics, patient care, and medical training?

By optimizing the technology for healthcare applications, Megamorph can address the demand for improved diagnostics, patient care, and sustainable healthcare practices. The health sector has strict standards to maintain, and human lives cannot be compromised on so it is paramount that the product meets certain standards for compliance which may differ in different regions, so the product must essentially cater to common standards while specifically adhering on the European region. One way to do this would be clinical trials to check have substantial results that make a case for or against the safety, usage and efficiency of the product..

- *Anonymous student*

How might we refine the GMOD technology to seamlessly integrate with advanced medical imaging equipment, so that healthcare professionals could achieve higher precision in diagnoses and treatment planning, addressing the critical need for improved healthcare outcomes and patient care?

This is a promising angle for exploration, because healthcare is at the core of modern humans longevity. And, every improvement in that field is a win for everyone. Prototype testing will allow for practical evaluation of GMOD technology in real-world medical settings, identifying integration challenges and optimization needs. It will provide valuable data on GMOD's performance in delivering high-resolution medical imagery. The prototype of a GMOD display integrated with advanced medical imaging equipment should undergo rigorous testing. This includes integration testing to ensure compatibility, resolution and clarity testing to compare image quality, user experience testing to gather feedback from healthcare professionals, durability and reliability testing to assess performance in a clinical environment, power consumption analysis for energy efficiency evaluation, compatibility testing with image processing software, and security and compliance testing to ensure adherence to healthcare data regulations.

- *Anonymous student*

How might we integrate GMOD technology with medical equipment to provide healthcare professionals with enhanced visualization tools, so that doctors and surgeons can offer more precise and minimally invasive treatments, improving patient outcomes?

This is a promising angle for exploration, because GMOD displays can be used to improve medical imaging and visualization. The development direction aims to enhance the capabilities of healthcare professionals, leading to more accurate diagnoses and better treatment options for patients. Prototyping could include the integration of GMOD technology within a specific piece of medical equipment, such as an endoscopy system or a surgical microscope. This could allow for collaboration with a medical equipment manufacturer to integrate GMOD technology into a specific device, followed by testing with medical professionals in a simulated medical environment, involving realistic medical procedures. Iteration on the prototype based on feedback and insights gained during testing will be needed.

- *Anonymous student*

Exploring Applications: *Wearables*

How might we develop a proof-of-concept sport watch display so that a product in collaboration with a sport watch manufacturer could make a breakthrough into market further validating the GMOD technology?
Case description highlights the cost of GMOD technology as a major hurdle for the displays. In order to for a new technology to get widely adopted, markets need to recognize a new technology as better solutions. For this viable business cases need to be developed. Sport watches need to be light and have a bright display that can be viewed outdoors. This combination leads to insufficient battery life with current technologies. I would see sport watch as a good application for GMOD displays to prove the viability of the technology, since a sport watch benefits hugely from increased battery life while having high performance display. A sport watch with GMOD display could even prove to be a profitable product. This is because top professional athletes are ready to pay high prices for high-end sport watches. A prototype of a sport watch with a GMOD display could be built to attract interest of sport watch manufacturer. The prototype would work as a proof-of- concept for demonstrating the battery lifetime increase and weight reduction effects. Initially a prototype could be made by attaching the GMOD display to a wristwatch casing and bracelet with small battery and dummy watch computer.

- *Johannes Kallio*

How might we incorporate a GMOD display as a part of glasses so that high-end eyewear designer brands could could bring a sellable product to market to validate the viability of the product?
Alongside the low energy need, a major advantage of GMOD display over OLED and LED is its high picture resolution. High resolution is needed in AR/VR glasses. A problem with GMOD technology is that it is expensive. An application that could validate the business case for GMOD displays could be AR glasses. More specifically, the development could focus on creating an AR glasses in collaboration with a high-end eyewear designer. Designer glasses with GMOD display could be the first entry to the market for GMOD technology, bringing credibility for this new technology.

- *Anonymous student*

How might we combine a display and a solar cell so that consumers could have wearable devices that require no charging?
The number of different everyday wearables, such as smart watches, are constantly rising, but having to keep them charged constantly is often a hassle. But what if it is possible to both display an image and harvest solar energy through the same interface? One could prototype to find out if it's possible to pass enough light through while still having a legible display. If the pixel density is high, then it could be possible to leave "holes" in the display where light could go through to a photovoltaic cell. The intensity and electricity generated could be measured to see if it 1) works, and 2) could be a feasible solution to both display an image and collect solar energy.

- *Anonymous student*

Exploring Applications: *Built Environments*

How might we integrate GMOD systems to smart buildings so that occupants could experience more vivid and informative environments?

This is a promising angle for exploration because it joins the growing trend of smart building development and could lead to a new futuristic standard of living environments. The screens could display information or vivid visuals depending on the needs of the user. As the displays are also energy efficient this could also reduce the energy consumption of smart buildings that use regular displays currently. All in all, GMOD displays integrated into smart buildings aligns with the broader goal of creating more sustainable intelligent environments and infrastructure. GMOD displays on the walls of a building could serve as a user test. The user experience is central when creating these close-to-user systems. In practice one could apply a GMOD display to the wall of a test room and have a person interact with the display. We can for example test how the displays work in dark environments, how they react if there's a power outage or a malfunction, and how does the user interact with the displays. Especially the user interaction information can greatly influence for example, how many displays per area there should be and what kind of information are the users interested in while moving in the smart building.

- *Anonymous student*

Exploring Applications: *Transportation*

How might we integrate GMOD to automotive HUD-systems so that drivers could enhance their safety?

A fully functional Heads-Up display could revolutionize the driving experience in terms of safety and augmented reality. With a HUD the driver could be provided with essential information about the environment, weather, car status and more. A GMOD based HUD- system integrated to cars could be a major advancement in the development of safer and more efficient transportation. When developing a system such as a car HUD, it can be a bit intrusive. For this reason, it is important to do an early-stage user feedback test to see how much clutter would be too much, for example. This could give important information on how large the HUDs could be and what kind of information could be useful and in what format. At the early-stage the prototype can be fully improvised without any advanced technology because at this point the interest is in the viability of the product. Once the initial feedback is received, the development can be oriented in a way that takes account those user suggestions or worries. It is important to keep doing more user tests as the development progresses to ensure the user experience aspect is well developed.

- *Anonymous student*

How might we adapt GMOD displays to meet the stringent requirements of aerospace cockpit environments, so that pilots could benefit from highly detailed and energy-efficient head-up displays, addressing the demand for safer and more efficient aviation operations?

After Covid it is easy to see how aviation is not slowing down in popularity, on the contrary it is gaining ever more traction. Airplanes have had HUDs for a long time, but more efficient and cheaper models would improve the amount of information it can relay onto pilots. Prototype testing will validate GMOD's suitability for aerospace use, addressing the demand for safer and more efficient aviation operations. The GMOD cockpit display prototype could undergo a series of specialized tests. This includes rigorous integration testing to ensure seamless compatibility with existing avionics systems, assessments of visibility and clarity under diverse cockpit conditions, hands-on user trials with experienced pilots to gather feedback on usability and performance in-flight scenarios, stringent durability and reliability trials to confirm resilience to environmental stressors, comprehensive power consumption analysis to evaluate energy efficiency and its impact on aircraft systems, compatibility tests with avionics software, and thorough compliance checks to meet aviation safety and regulatory standards.

- *Anonymous student*

How might we expand the application of GMOD displays for use in the space industry so that astronauts and mission control teams could benefit from reliable and energy-efficient information displays, ensuring the success and safety of space missions?

This is a promising angle for exploration, because by making GMOD displays suitable for space applications, it addresses the goal of providing reliable and energy-efficient information displays for astronauts and mission control teams. This can contribute to the success and safety of space missions. Prototype GMOD displays in the context of space equipment, such as the display systems in spacecraft or mission control centers can allow for the assessment of durability, reliability, and energy efficiency in space conditions. This can support the development of prototypes that can withstand radiation, temperature extremes, and limited power resources. Collaboration with space agencies or aerospace companies to integrate GMOD displays into space equipment could also be considered.

- *Anonymous student*

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