The Problem:
Limited Treatment for memory loss and degeneration (Alzheimer’s, amnesia, stroke, severe brain injury)

Memory:
Memory is one of the brain’s most complex functions, enabling the storage and recall of experiences and knowledge for later use. It is mainly located in the Hippocampus and Prefrontal Cortex of the brain. The Hippocampus contains two subfields, CA1 and CA3 that deal entirely with input and output to long-term memory. Each memory is encoded with a specific neural pathway and a unique firing output pattern.

The hierarchical networks of the brain consist of simple neural cells at the basis. These cells can be grouped into conjunctive cells which group to form neural networks. These hierarchical networks allow for advantageous features like increased efficiency, generalization, and categorization.

Hippocampal Neuroprosthetics:
Neuroprosthetics aim to create, restore, or replace natural neural function. Hippocampal neuroprostheses are “cognitive prostheses,” meaning that their goal is completely replacing a small section of neural functionality that has been damaged.

What is the Memory Implant?
The “Memory Implant” is a small silicon chip that is surgically augmented with the hippocampal and prefrontal regions of the brain. This chip functions by receiving input “spikes” of over-activity caused by changes in stimuli (such as color, sound, texture, scent, etc.). These impulses from the CA1 and CA3 hippocampal subfields are sent to a electrode cascade which connects to the implanted chip. These impulses are processed by a Multi-input, multi-output algorithm (MIMO), which aims to generate output that meets the hippocampus’s expectations. This process allows the memory in process to move from short-term to long-term memory as if no impairment existed.

Advantages of MIMO:
MIMO has proven capable of consistently producing “strong” codes in testing, accurate trial performance, can improve memory in healthy neural tissue and permanently strengthen memory. It can also be generalized to different animals and brain areas and continue to successfully predict outputs.

Success in Testing:
The tests performed on the Memory Implant can be broken down into two types of tests. The first test evaluated the relationship between the CA1 and CA3 subfields, and the second test evaluated the extent of the memory enhancement that MIMO provides. The tests and trials run all proved to be successful and projections suggest that the chip will be ready for human testing within five years.

Ethical Implications:
Memory is linked to identity and emotion in ways still not fully understood. To alter memory with technology could have unintended consequences on the subject’s identity, emotion, and other brain systems. This needs to be considered before moving toward human trials.

Sustainability:
In order for the Memory Implant to be considered sustainable, it must improve the quality of life of its patients without degrading their social, environmental and economic resources. Because the Implant would restore memory and serve to facilitate interaction, it can replenish social resources. Environmentally, the impact is negligible. Economically, the chip will be incredibly expensive until it becomes widely popular; once its use is popular, it will become economically sustainable.