DeMaMech Exchange student Report

Europe – Japan Exchange program

Arjan Smorenberg

Host University: Tokyo University
Home University: Technical university Delft

TU Delft

Personal Data:

Name:	Arjan Smorenberg
Email:	arjansm@gmail.com

Home Institute:

Name:	Technical University Delft (TUDelft)
Faculty:	Mechanical Engineering Faculty
Department:	Biomedical Engineering
Master:	Biomedical Engineering (Biomechatronics)
Adress:	Mekelweg 2 2628 CD Delft Holland
Supervisor:	Frans van der Helm

Host Insitute:

Name:	The University of Tokyo
Department:	Precision Engineering
Laboratory:	Bio-medical Precision Engineering Laboratory
Adress:	7-3-1, Hongo, Bunkyo-ku, Tokyo, 113-8656 Japan
Supervisor:	Prof. Jimbo, Yasuhiko

Travel Schedule:

Departure:
13 October 2005

By plane, British Airways:

Schiphol, Amsterdam	->	Heathrow, London
Heathrow, London	->	Narita airport, Narita

To the university with Public transportation

Return:
1 April 2006

To the airport of Narita using Public transportation

By plane, British Airways:

Narita airport, Narita	->	Heathrow, London
Heathrow, London	->	Schiphol, Amsterdam

Executive Summary:

I Travelled to Japan in 2005 in oktober with the DeMaMech exchange program, where I was allowed to participate in the laboratory of Bio-Medical Precision Laboratory of my professor Yasuhiko Jimbo.

The research field I entered is that of neural networks. A field I had no experience in, The laboratory itself focuses on culturing tissues and examining them with various methods. The main animal used at the time for examining during my presence was the rat.

I was given access to the university source of articles, together with big handout of articles to start learning myself into the field of neuron research. In this case the field on neuron networks. This took much of my time as the subject entails many aspects both of biology and electronics, both fields which in its application in this case was hugely unknown to me.

I only had experience about this subject what I learned on my biology courses so there where still many aspects concerning preparation of neural networks. I had the opportunity there to perform dissections on rats, to extract the brain but also other parts used in research areas else in the laboratory. They have taught me basic skills concerning dissection and also culture preparation which is a complicated set of procedures.

The neural cells extracted from the rats are grown on special electronic plates called Multi electronic array (MEA), these arrays need to be custom made for their experiments and therefore I was also taught the skills necessary to make these electronic plates by means of lithography, coming from a mechanical department I had no experience with this and the budget of the university allows its students to perform these tasks themselves.

I also was given data by my supervisor to analyse, during my stay my knowledge of the way such analyses are performed increased and I managed to give a presentation about my analysis at the end of my stay in their laboratory

Student life itself was rewarding for me, I've learned a kind of independence being in a foreign country where communicating with the people itself is challenge. The student lodge itself is located in Komaba while my laboratory is in Hongo, which made for an hour of travelling with public transportation. The lodge itself was international which was helpful to be around people who go trough the same things you go, gives you an opportunity to talk about the experiences with others.

Looking back on my experience in Japan I can say I'm very happy I took it, it taught me many things both professional as personal, it is good to experience a different culture then your own, allowing for a much wider point of view in many issues. Also I feel I will have a connection with Japan which I hope in my future ambitions can be maintained.

Assignment:

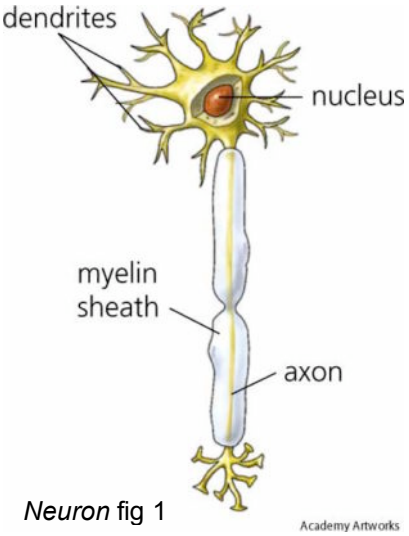
The Bio-Medical Precision Laboratory In Tokyo concentrates in much different areas as the one Biomechanical Laboratory in Delft. It's main fields of research are as followed:

- Computer Aided Surgery
- Measuring physiological phenomenon
- Rehabilitation Engineering
- Medical treatment engineering

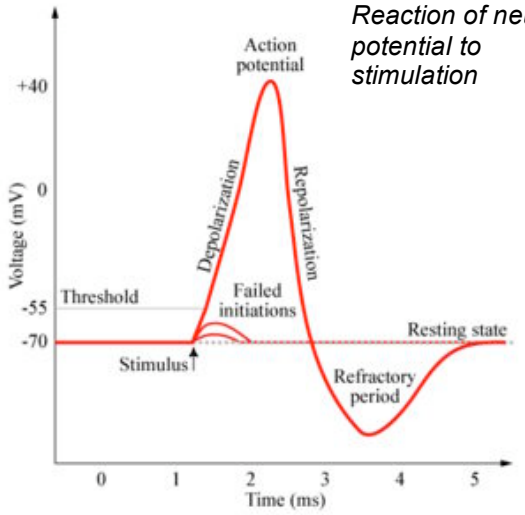
My field itself was that of the Measuring physiological phenomenon. In this case the neural networks

Introduction:

The human brain consists of many organic cells, and it's workings dough documented are still greatly unknown. It is believed many of the functions of the brain are being produced by its intricate networks of neural cells. The neuron itself basicly consists of nucleus of which several dendrites extend, together with a main axon, these connect to other neurons, forming together a neural network of cells. The properties of single neurons have been thoroughly researched and documented.



Neuron fig 1

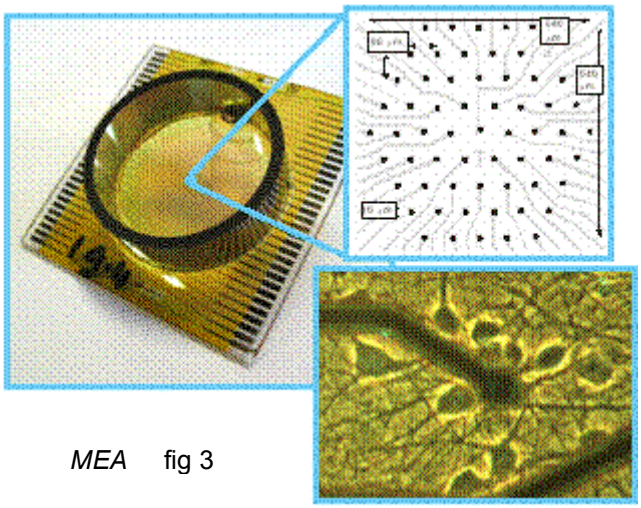


Reaction of neuron potential to stimulation *fig2*

However the workings of the brain cannot be explained by just examining it's "bricks" to get a better understanding it is necessary to watch the workings of the neurons with each other. These so called neural networks are immensely difficult to examine in living bodies, since isolating them from all the different kind of cells in bodies has proven to be quite the task. To solve this it's necessary to grow your own neural networks in controlled environment. Culturing these neuron brain cells requires special dissecting techniques as well as culturing techniques using various means of enzymes and chemical compounds to let the neurons survive on an artificial surface

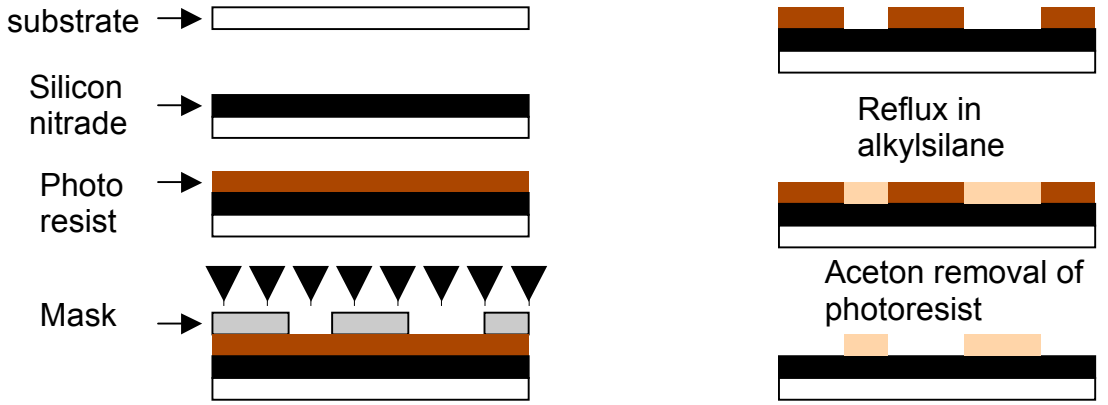
This allows you to have a neural network, capable of being monitored using optical techniques like an electronic telescope. As is known about the neurons is that they relay electronic pulses and therefore react to electronic pulses. This is believed to be

the main way how the brain relays information. To research this in a culture it's necessary to be able to stimulate the network with electronic pulses, so it's possible to monitor it's reaction on the whole neural network. One way to do this is with the use of Multi Electronic Array's (MEA's). which is basicly an array of electrodes spaced out over an area on which the neuron network is cultured. This way the neuron network can be stimulated on multiple areas, and due to the nature of the electrodes it's possible both to stimulate and register electronic pulses. Allowing analysis of the behaviour of the neural network.



MEA fig 3

These arrays are very small and therefore require special techniques to be fabricated. In this case the use of lithography is applied. These techniques use UV-light to etch an electronic plate.



Process of Lithography fig 4

With these plates it's possible to stimulate the network and register it's responses on multiple places.

Long Term Potentiation

In the research of neurons a mechanism is found that is called Long-term Potentiation. It describes the fact that if two neurons are connected and one is stimulated. Both neurons have an action potential which can be registered. If the stimulation is done regularly it increases in strength, this "increasing" in strength is what is called Long Term Potentiation.

This phenomenon has been described to be an active mechanism in the way neural networks develop. Apparently the networks rewire and configure themselves to be optimal for it's usage, or so is speculated. Memory could also be possible described to this mechanism.

Studies about the long term potention can involve many aspects, in the past many studies have been done to two or three neuron cells in connection, fewer have been done to study its effects in larger networks, due to the difficulties it brings to monitor it in the Laboraty we monitor the network in vitro situation, meaning it the network will be grown on a culture that nourishes it. This culture is placed a special MEA dish, so the network grows on the electrodes allowing for stimulation and registering it. To train the network, it needs to be continually stimulated with a tetanic impulse, which means the network is continually stimulated with an electronic pulse on a certain frequency. Then after this is done, new recording are done to measure the influences of the trained network, this process is repeated once more to detect the effects of a second tetanic stimulation.

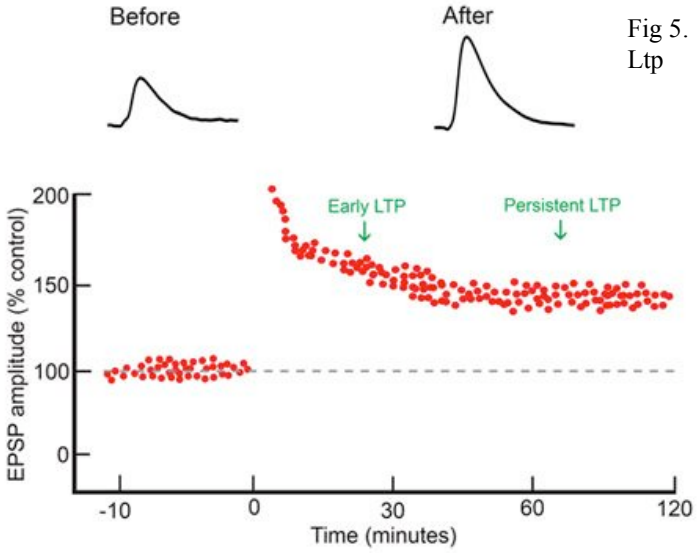


Fig 5. Ltp

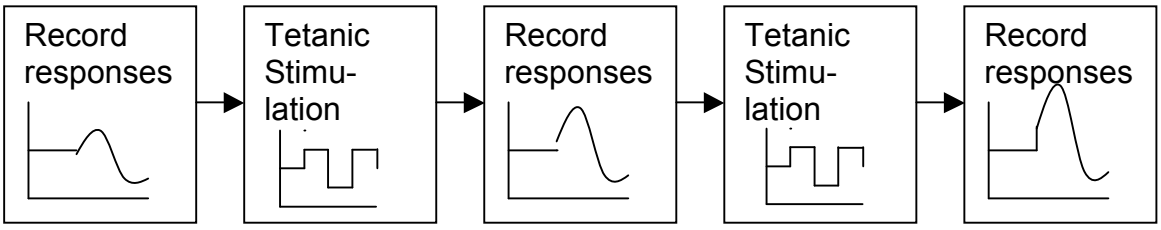


Fig 6. Basic procedure

The MEA used in the experiments has 64 nodes, the neural network however does not have a neuron on every node, they are spread out on the area, this means not every node will record a neuron, will some nodes will record the effects of several neurons, a complicated mathematical procedure allows for separation of the several action potentials from the nodes, when processing the data coming from them.

Results

During recording every electronic node is given a pulse in succession, with time between the pulses to properly record the responses in all the nodes, this is repeated 5 times, so that generalisations can be made. Then with mathematical procedures the intensity and number of spikes is recorded, allowing to make conclusions about the experiment, to see long term Potentiation effects the network cannot behave differently.

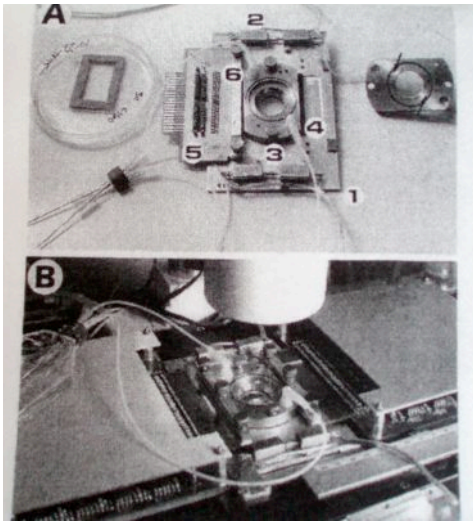


Fig 7. Recording the networks

Conclusion

From the results, the number of spikes as well as the intensity of the spikes increases after the tetanic stimulation. After a second stimulation another increase in action potentials and activity is seen.

Monitoring these results, they enforce the idea that the network is somehow adapting to the given impulses, thus the network is “learning” to react with a given impulse.

Of course you can not deduct from these results if learning is really happening, as you adept to much from the original situation from the network inside living tissues, since procuring the cells necessary to grow the network requires you to dissolve the networks first, as well as the removal of other cells that do influence network growth (like glial cells present in many networks in organisms). However, experiments like these do offer insights about certain mechanics that play roles with neurons, allowing us slowly to comprehend better what yet remains a great mystery.

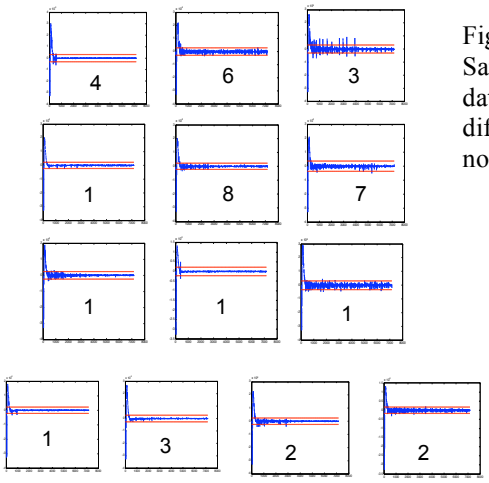


Fig8. Sample data or different nodes

Exchange Student Life:

This short chapter will be about the student life of exchange students at Tokyo University starting with the beginning and then how it generally was for me:

Upon arrival at Narita Airport I had the luck of being helped by my assigned tutor and Professor who guided me the whole first day. This was very good for me as I already felt totally lost at the airport, which was only the beginning of Japan. They guided me the whole day and I had a nice welcoming diner with my new laboratory members and professor. They made me feel welcome and asked me many things about Holland already.

As is with good Japanese Tradition of the laboratory a welcoming party was organised for me later that month. These parties were really a lot of fun, and made me feel really welcome even though communicating with them was difficult most of the times.

Which brings me to the biggest difficulty I had being in Japan, is the level of English people posses. Though my fellow labmembers were good at English, it was not as natural to them as it was to me, which made conversations difficult because they couldn't understand me that well, however if you compare their English with the rest of Japan it's impressive to say the least.

Thankfully, something truly amazing as I experienced it is that Japanese people are almost always friendly if you ask them even in English for help. They will honestly try their best to help you solve your problem and even if you cannot understand each other, you can sense his willingness and eventually it will lead to a solution.

However, making small talk which I'm used to with friends is difficult with Japanese, since they have difficult sensing certain humour forms like sarcasm. Also my friends at the laboratory don't go to clubs and areas, which means if you want to go to clubs a lot (which is in Holland quite normal) you be better of finding a fellow foreigner who likes it as well.

My lodge was at Komaba Campus, which is about a hour away from Hongo Campus, this lodge is mainly for foreign students which is very convenient. Because you are centered with so many foreigners it's easy to make friends with people who are in the same "boat" as you are. Many of my friends were all from the lodge and I did many fun things with them.

For example I tried to see something different of Japan every weekend, as it's the only time you can really travel around a bit, and I've seen many things with people from the Lodge, for example on of the first weekend we walked over the Rainbow bridge in Tokyo, and in another I went with some friends to Kamakura, which is a nice place with lot's of temples.

During the normal weekdays it's mostly work at the university doing your research, you stay there for quite long (mostly till 6-7 in the evening, but later is also possible) and you go back to your lodge, In which I most of the time retreated to my room and entertained myself with my laptop internet connection. This is a point of importance I believe as it's important you can enjoy spending time alone, as that is quite common during the weekdays. For me it was very important to have an internet connection and a laptop with me, else I would have been terrible bored on those evenings.

Daily life itself is not difficult, it's a bit overwhelming walking in parts like Shibuya (famous shopping area) for the first time trying to find the right wash suppliant to get your clothes clean. As reading Japanese on the package is impossible for foreigners.

Thankfully the lodge supplies a lot of practical stuff like waste bags and toilet paper. Buying food is possible at every convenient store (24 hour open, and can be found almost everywhere)

Dining is really cheap in Japan, at least some of the food is. Since cooking is quite difficult at the lodge you're kind of forced to always eat out. The Campus provides a restaurant option in which you can get many cheap foods. But eating in busy areas like Shibuya doesn't have to be expensive as well. However these "cheap" foods are generally very alike, and I found myself bored with them after a few months. Having really good diner is of course possible. However it's not cheap as well, which makes it hard to do often as a student.

The money supplied (700 euro each month) Is enough to get around with, as the lodge fee is really low (especially compared with the normal rent prices in Tokyo) you have around 550 euro to spend on necessary supplies and entertainment. Going out itself is expensive however, as you easily pay 5-6 euro for a beer. But the "sustaining" yourself with the money given is more then possible.

Generally student life is what you make of it, it's important to get in touch with your fellow foreigners as soon as possible, it will make life much more enjoyable. The friendliness of the Japanese are truly remarkable, but do not expect your laboratory to entertain you as you have to do that yourself.

Summary:

It doesn't feel right to talk about the whole experience in just a couple of pages, the whole journey of me to Japan to take part in the most prestigious university beholds so much more.

I feel like I've got to experience a culture that even though there are many similarities is fundamentally different then that of Holland, giving a lot of personal challenges to overcome. Some of these are the language barriers, as Japanese do not speak English generally. The people at the university are proficient enough with the language that you can make yourself clear, but normal conversations are difficult. To communicate with the general public is another challenge on itself, requiring body languages as well as a rudimentary knowledge of Japanese. Luckily I was given the opportunity to learn the language at the university.

At the university I also was allowed to participate and learn many different things, from dissection rats, acquiring their brain-,heart and eye cells to analyse, to culturing these on special substrates. I also was allowed to participate in official presentations of the laboratory, though in Japanese still gave me a general view on what areas where researched. I also got in touch with basic lithography, and got to make my own micro electric array which was exciting to experience.

The fellow foreign students a long with the hearth warm welcome of my laboratory and the university made me feel very pleasant and it's been a life experience I'll forever cherish.