DIMI-6000: An Early Musical Microcomputer by Erkki Kurenniemi

Kai Lassfolk
Musicology
Department of Philosophy, History, Culture and Art Studies
University of Helsinki
kai.lassfolk@helsinki.fi

Jari Suominen
jari.suominen@tasankokaiku.com

Mikko Ojanen
Musicology
Department of Philosophy, History, Culture and Art Studies
University of Helsinki
mikko.ojanen@helsinki.fi

ABSTRACT

DIMI-6000 is an early microcomputer-based synthesizer designed in the mid-1970s by the Finnish inventor Erkki Kurenniemi. Designed as a hub for electronic music studios, DIMI-6000 featured a computer-controlled analog sound synthesis circuitry and a modular design. Despite its innovative design, only two units were built, one for Finland's national broadcasting company Yle and the other for Swedish composer Ralph Lundsten. This paper presents an overview of the instrument and its use, especially of the unit built for the Experimental Studio of Yle.

1. INTRODUCTION

In the 1960s and 1970s Kurenniemi made a significant contribution to the early development of Finnish electroacoustic music. Kurenniemi played a multi-faceted role as a studio builder, composer and especially as a designer of electronic instruments. From the mid 1960s to mid 1970s, he designed ten unique musical instruments and studio devices for various composers and artists in both Finland and Sweden. After a series of custom-built one-of devices, Kurenniemi founded the Digelius Electronics Finland company for manufacturing and marketing the DIMI line of instruments. However, none of the instruments were developed beyond the prototype stage and their serial production never started. Thus most of the remaining instruments are unique. Nevertheless, Kurenniemi's instruments and their sound form a distinctive feature of early electronic music in Finland. Their sound made also their mark on Swedish electronic music through the works of composer Ralph Lundsten. An overview of Kurenniemi's instruments is presented by Ojanen et al. [1].

The microprocessor-controlled synthesizer DIMI-6000 was the last one of Digelius Electronics' musical instruments. DIMI-6000 was commissioned in mid 1970s by Yle for its newly-founded Experimental Studio. Composer Henrik Otto Donner, the head Yle's music entertainment at the time and Kurenniemi's close collaborator from the early 1960s, organized the funding for the purchase and user training of the instrument. DIMI's Finnish design and manufacture was considered a benefit and Donner and the Experimental Studio team saw the project partly as an opportunity to promote national expertise in modern technology. A second unit was built for Lundsten's Stockholm-based Andromeda studio.

DIMI-6000 was Kurenniemi's most ambitious instrument. Compared with some of Kurenniemi's previous designs, it was more than a mere case study on musical user interfaces or an application of digital electronics. Instead, it introduced many features of the computer-based synthesizers of the 1980s and even modern digital audio workstations. In contrast to typical mainframe-computer-based hybrid systems of the early 1970s, DIMI-6000 was a compact device and relatively easy to transport.

DIMI-6000 was in use at Yle until the late 1980s and was put in storage for most of the 1990s. In 2002, the Yle unit was given to the Electronic Music Studio at University of Helsinki where remains on display along with most of Kurenniemi's other instruments (see Figure 1). Lundsten's DIMI-6000 was dismantled soon after its purchase. Only a piece of a rack panel remains a reminder of the instrument at the Andromeda studio. One of the first microcomputer-based musical instruments worldwide, DIMI-6000 represented a significant technical advancement in Finland during the time when even analog synthesizers were uncommon in the country.

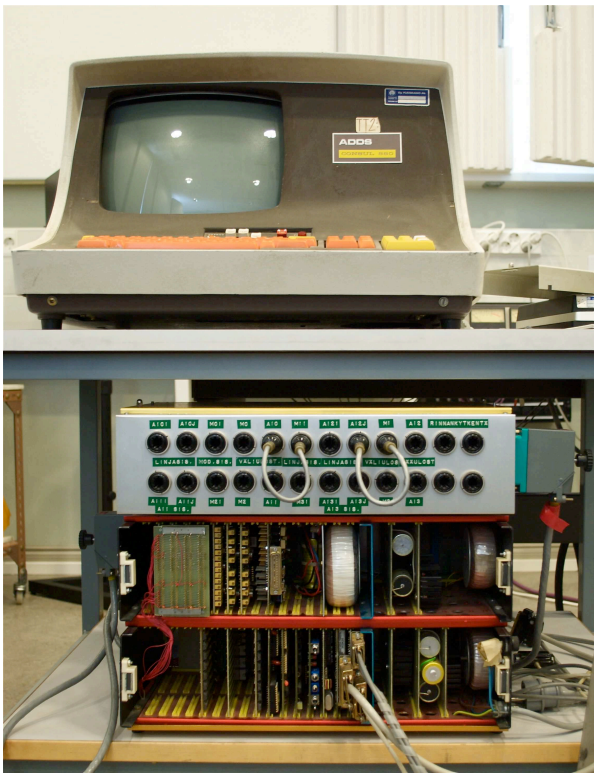

Figure 1. The Yle DIMI-6000 system at the University of Helsinki Electronic Music Studio in 2014.

2. EARLY DESIGN IDEAS

Kurenniemi's working style has often been described as impulsive. Indeed, many of his instruments remained in prototype stage as he already started working on the next one. Even the DIMI-6000, the most advanced of his projects in many ways, can be regarded as a prototype when examined as an individual instrument. However, when Kurenniemi's instrument design work is viewed as a hole, it forms a logical process that points directly towards modern music production methods and computer-based modular digital audio workstations. In this process, DIMI-6000 is an important step.

Already in the 1960s Kurenniemi was well known for his advanced instrument designs among the Finnish electroacoustic music community. A radio amateur in his teens, Kurenniemi gained strong knowledge with electronics very early on. With his school mates Erkki Salmenhaara and Ilkka Oramo, both future professors and musicologists, Kurenniemi build a modest electronic music studio in the organ balcony of his school in the late 1950s. Some years later the newly appointed professor in musicology, Erik Tawaststjerna, was looking for someone to build an electronic music studio under the premises of the Department of Musicology at the University of Helsinki. During the 1960s, Kurenniemi was free to design instruments according to his visions. He didn't get any salary, but the department provided funding for the studio equipment and component purchases.

Two primary trends directed Kurenniemi's studio and instrument design plans during the 1960s and early 1970s. Firstly, he was interested in algorithmic composition and in designing an instrument that could produce pre-programmed music with "a flick of a switch". Application of digital logic to sound production and control became important to Kurenniemi. Among his sources of inspiration were the RCA synthesizer by Olson and Belar [2] of the 1950s as well as his programming experience from the analog computer of the Department of Nuclear Physics, University of Helsinki in the early 1960s. Kurenniemi was convinced that "the future would be digital" and chose to design his studio based on digital logic - a trend which was already applied in the Siemens studio in Munich and followed couple of years later in Stockholm in EMS.

Secondly, already in his early studio design Kurenniemi envisioned the studio as an integrated system of sound producing and processing modules. The first version of this idea was his three piece studio device initially called Sähkö-Ääni-Kone (Electric Sound Machine). Later in Kurenniemi's memos this integrated set of equipment is called System-1 and years later it has been entitled Integrated synthesizer. In the 1970s, this design trend appeared in Kurenniemi's work as the modular DIMI-U (U for Universal) system. DIMI-U was based on an idea that the customer could choose from a set of different sound producing and processing modules. No DIMI-U systems were built, but the microcomputer controlled DIMI-6000 can be seen as one manifestation of the basic idea and anticipated a computer-based music production suite.

Until the early 1970s, the University of Helsinki Electronic Music Studio was the best equipped of its kind in Finland. In contrast, the equipment of the YLE experimental studio, founded in 1973, was initially modest, consisting of a couple of tape recorders and sound generators. Therefore, DIMI-6000 was a major endeavor for Yle. By Donner's request, Kurenniemi presented his ideas for the possible features of the new instrument at YLE. The first steps in designing the instrument were made in 1974 [3]. Although YLE's main objective was to acquire an advanced synthesizer, one of the initial ideas was also to substitute the studio mixer, an expensive device at the time [4].

Kurenniemi's earlier instrument, DIMI-A was used as a starting point, although a much more advanced design was aimed for. Instead of the discrete digital logic circuitry and shift register memory of the DIMI-A, a modern microprocessor chip and random access memory was chosen for DIMI-6000. Moreover, the DIMI-A was severely limited by its small parameter memory and lack of mass storage device. Ideas from analog synthesizers, such as the VCS-3 synthesizer of the University studio, were also adapted. As a result, DIMI-6000 became a microcomputer-controlled analog synthesizer with a semi-modular architecture. In April 1975, the instrument was delivered to the Yle studio. One month course on user training by Digelius and Kurenniemi followed the delivery [3].

3. HARDWARE ARCHITECTURE

DIMI-6000 consists of a main chassis, a video computer terminal and one or two C cassette mass storage devices.

Both the terminal and C cassette units are general purpose devices. The terminal is an ADDS Consul 880 and C cassette units were ITT SL 56 Automatic models, standard reporter tape recorders at Yle. The main chassis was manufactured by Digelius Electronics.

The main chassis of the Yle's DIMI-6000 consists of three parts: processor unit, (sound) generator unit and patch bay. The physical patch bay was added by special request from Yle. The processor unit of the DIMI-6000 was based on the Digelius Electronics' DIS System, the first microcomputer manufactured in Finland. Like the DIS System, the control unit is based on the Intel C8008 8-bit microprocessor. The random access memory was expanded in several stages. Initially, the instrument had 4 kilobytes of RAM [3]. Later it was expanded to 7 kilobytes and further expansion of 4 KB was planned [5]. 1.25 KB of the processor memory map was allocated for ROM and the remaining memory was left for the system software and user programs.

The generator unit contains four oscillators, four multiplier modulators, two filters and two main audio outputs. The oscillators have separate outputs for sine, triangular and square waveforms. Kurenniemi considered 8-bit digital oscillators for DIMI-6000, but, interestingly, did not find the sound quality sufficient for this application [6]. Instead, he used ICL8038 waveform generator chips that had been introduced few years earlier and would later end up being one of the most popular microchips for such purposes [7]. Multiplier units are based on the ICL8013 chip and may be used either as ring modulators or voltage controlled amplifiers, depending on the input signals. The filters have dedicated low-pass, band-pass, and high-pass outputs [8]. Both the processor and generator units contain standard size interchangeable PCB cards based on the Eurocard system.

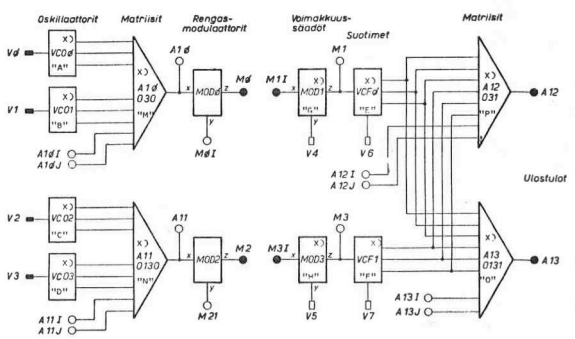

Figure 2: Block diagram of the DIMI-6000 signal path [5]

The signal path is divided into two parallel halves each with two oscillators, a ring modulator, an amplifier and a filter. (See Figure 2.) Each oscillator pair is followed by an 8-input/1-output switching matrix that allows to mix the oscillator waveforms and two external input signals. Another pair of switching matrices is located between the filters and main audio outputs. Each of these matrices allows to mix the outputs of the three filter bands of both two filters and two external input signals. The oscillators, amplifiers and filters are voltage controlled with 10 bit resolution while the semiconductor switching matrices are controlled by digital on/off signals.

The audio inputs and outputs as well as various signal insert and input/output connectors are located in the Tuchel connector based patch bay unit. Furthermore, each of the parrallel signal paths is split into two sections in between the ring modulator and amplifier. The matrices and the physical patch bay provide a two-level modular architecture for the generator unit. Installed as a late addition, the batch bay unit includes D-connectors for 8 digital-to-analog and 16 analog-to-digital converter signals.

The C cassette players act both as mass storage devices and as recording and reproduction devices for real-time digital control commands. Typically, one C cassette player was used to play back previously recorded control data and the other one was used for simultaneous recording. This allowed to make real-time overdub recordings of the control data. The ADDS terminal provides the main user interface of the system through its computer keyboard and ASCII character output.

4. USER INTERFACE AND SOFTWARE

The first system software of DIMI-6000 was DISCORD, written by Kurenniemi. DISCORD was a simple program that allowed to play the instrument [9]. DISCORD allowed to program timed sequences as well as real-time control from the terminal keyboard. Only miscellaneous handwritten notes remain from the DISCORD documentation.

Based on the user experiences from DISCORD, composer and programmer Jukka Ruohomäki was hired to develop new software both to address the instrument's technical shortcomings and to enhance its user interface. In 1977, he completed the DISMAL (DIS Musical Assembly Language) program. In particular, DISMAL addressed the problems of tuning the unstable oscillators through tuning tables. Ruohomäki also wrote a detailed operating manual for DISMAL and the overall use of the instrument.

Like DISCORD, DISMAL allowed both real-time playing and writing pre-programmed sequences called scores. In practice, DIMI-6000 was typically used by typing the 8008 processor instructions as octal codes which, according to Ruohomäki (2014), were easy to memorize.

The DISMAL user manual [5] points out several shortcomings and peculiarities of the instrument. The 8008 processor was already considered outdated and too slow for advanced use. Furthermore, the control voltage values of the DACs had to be refreshed periodically by the user, which added to the processing overhead of the system. The boot procedure of the instrument was cumbersome and could require several trials to get it into a stable state. The DISMAL system worked as a program

interpreter rather than a compiler with obvious penalties to the program execution speed.

After the completion of DISMAL version 1.0, a 16 channel AD converter was added to the main chassis. Ruohomäki was once again contracted to write the sequencer program DISEQ to take advantage of the new hardware. However, both DISMAL and DISEQ saw little or no use besides Ruohomäki himself. DISEQ was neither fully completed nor documented [9].

5. USE IN THE YLE EXPERIMENTAL STUDIO

Among the users were composers Pekka Sirén, Otto Romanowski, Joe Davidow, Jukka Ruohomäki and Marja Vesterinen. Ruohomäki, for example, used DIMI-6000 to make sound material for his composition *Ennen iltaa* (*Late Afternoon* 1977). Sirén, a full-time sound engineer and one of the main forces at the experimental studio, was the most active user and advocate of the instrument. Sirén made several compositions and miscellaneous recordings with it. He also assisted and instructed many of the other users. Additionally, the DIMI was used to make sound effects for various YLE programs. However, overall usage of the instrument was limited.

According to Sirén [4], DIMI-6000 served best as a chaotic sound generator. It produced a raw and rough sound and was capable of producing more complex sound gestures than the Minimoog, for example. On the other hand, the computer terminal user interface diverted many "keyboard-oriented" composers from the DIMI. Therefore, it did not fulfill all the initial expectations. Instead of a substitute of a mixer, and the central hub of the studio, the DIMI-6000 was used as a special purpose instrument among the other devices of the studio. Gradually, as the studio acquired new equipment, the role of DIMI-6000 diminished even further. Especially, the acquisition of a PDP-11 minicomputer and the Synclavier programmable synthesizer made DIMI-6000 practically obsolete.

In the 1990s, the instrument lay abandoned in storage at Yle. In the early 2000s, with the renewed interest in Kurenniemi's work, DIMI-6000 was given to the University of Helsinki Electronic Music Studio, where most of Kurenniemi's other remaining instruments are stored. The instrument was on display at the Kurenniemi exhibition in the Kiasma Museum of Modern Art in Helsinki from November 2013 through February 2014.

Despite some efforts to revive the instrument, DIMI-6000 is currently in an in-operational state. Its system software cassettes are either lost or destroyed. All hardware components and most of its documentation are, however, still present.

6. CONCLUSIONS

Kurenniemi's impulsive working style also reflects itself from DIMI-6000. In particular, he was eager to use the first available microprocessor, which proved to be too slow for the instrument to be used as a serious compositional tool or integrated music production device. On the other hand, the bankruptcy of Digelius Electronics prevented from developing a next generation instrument.

Like Kurenniemi's designs in general, the DIMI-6000 had two typical characteristics: application of digital electronics and an unconventional user interface. Lack of a piano-style keyboard and the steep learning curve diverted many composers from using the instrument. Furthermore, due to its technical shortcomings, especially the limited processing power of the C8008 microprocessor, DIMI-6000 saw only limited use even by composers interested in computer programming.

However, during its time, DIMI-6000 was a significant technical achievement. For a short period in mid 1970s, it placed the Yle studio to the forefront of electronic music technology.

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