Marge Allik

Warps in 2 rows, material: wool

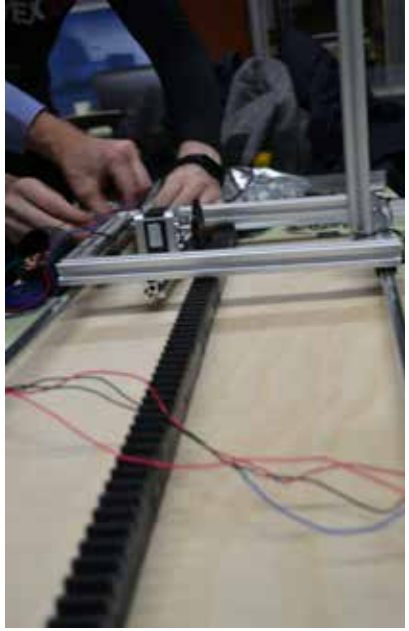
Photo Marta Tuulberg

MultiWeave

Applied research project at Pallas University of Applied Sciences.
Overview 2017-2018. Plans for 2019

Kadi Pajupuu, Associate professor

Oleg Kalinkin, Anna Jõgi, Johan Pajupuu building first version of MultiWeave at Skeemipesa Hackathon where we got the prize: The BEST prototype implementation. 2016.



SpiderWeave building at Hardware and Arts hackathon, Tartu, 2017. Team got two prizes. Above: Liisu Miller, Urmas Mägi, Taavo Lukats, Anna Jõgi.

WHAT
WHEN
WHO

Principles of the textile structure forming with the help of 3D printing logic combined with special warp supporting system were invented by Kadi Pajupuu. The idea of the structure building is to guide weft between vertically supported warp tubes, that are positioned in triangles. After a number of layers have been formed, rigid supporters can be removed, warp ends are knotted or fastened by looping one warp loop through neighbouring warp manually.

Machine prototypes built at hackathons
2016 – MultiWeave. Team members Anna Jõgi, Oleg Kalinkin, Johan Pajupuu, Kadi Pajupuu
2017 – SpiderWeave. Team members Anna Jõgi, Taavo Lukats, Liisu Miller, Kadi Pajupuu, Urmas Mägi (CEO, FeinElast)

Taavo Lukats, Kadi Pajupuu, Liisu Miller, Anna Jõgi

1

2

Applied research of Pallas

MultiWeave is an ongoing applied research project of Pallas University of Applied Sciences, with project partner Fein-Elast Estonia (Urmas Mägi). In 2017 the hardware was improved in the building sessions at Fein-Elast in Sindi. All the members of the SpiderWeave team were participating.

Building sessions at Fein-Elast (Sindi, Estonia), summer 2017

1. Taavo Lukats and Liisu Miller

2. SpiderWeave construction improved with new motors and trapezoidal lead screws.

3. Anna Jõgi (Kriimsilm Tehnoloogiad) and Urmas Mägi (CEO, Fein-Elast Estonia).

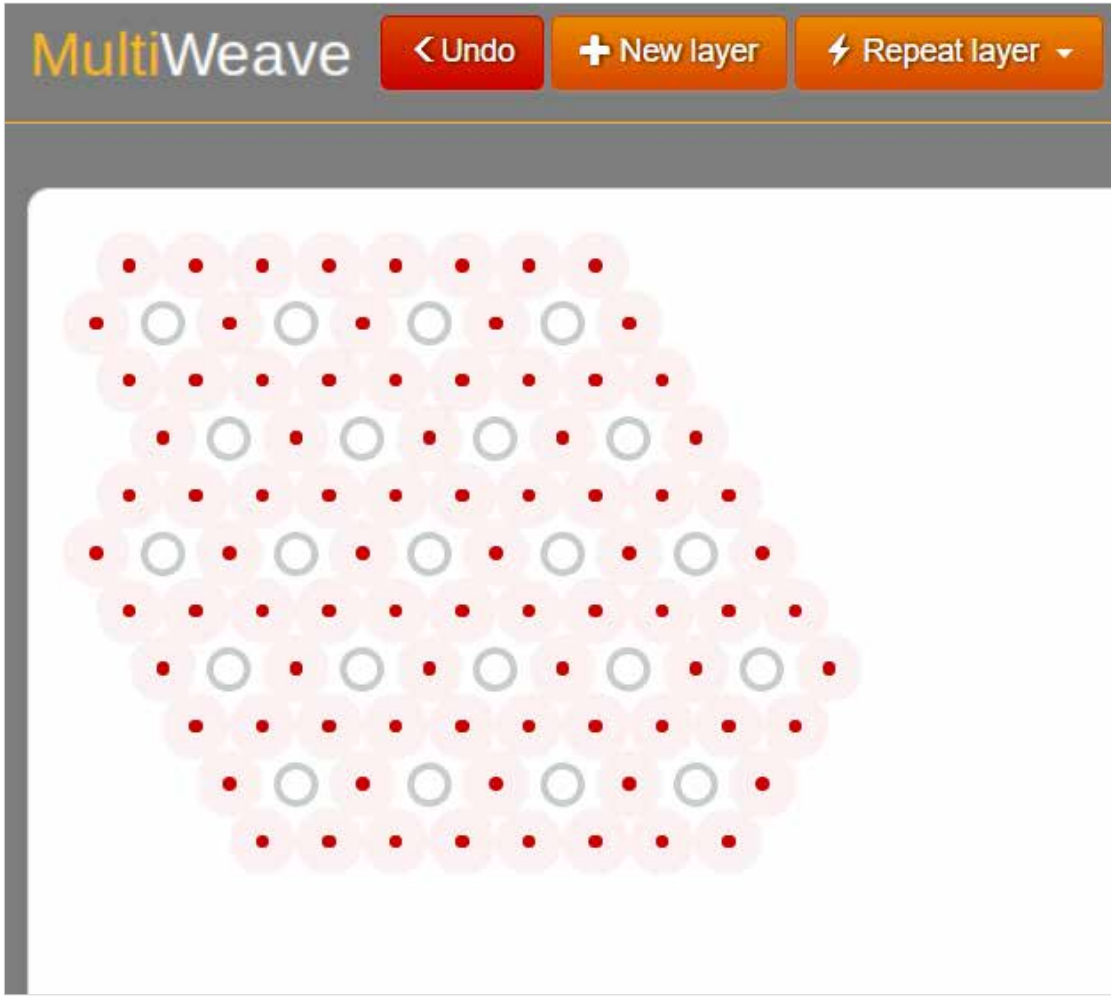
Students design MW structures

During the course Structure and Material students participated in the applied research project – MultiWeave: creating textile structures according to the added manufacturing principle of 3-D printing. These structures can be woven with the prototype of MultiWeave/SpiderWeave.

Students who participated were: Triin Aare, Marge Allik, Claire Pixie Aunison, Viktor Blatt, Laura Alexandra del Giudice, Kaidi Mikk, Anett Niine, Malle Soosaar, Liisi Tamm.
Marta Tuulberg (4th year student of TAC) was documenting and testing the user interface.

Structures can be programmed with the help of Javascript interface for creating 3D textile structures and converting them to CNC compatible g-code. http://libahunt.ee/multiweave/; author Anna Jõgi. Program creates g-code for the machine to guide the weft yarn guider.

As the present version does not allow yet to visualise the 3D version of the programmed structure on the screen, it is necessary to test the logic of structure manually: that was the task in front of the first-year students.



MultiWeave. User Interface

Author of the software: Anna Jõgi
Gray circles mark the position of the warp.

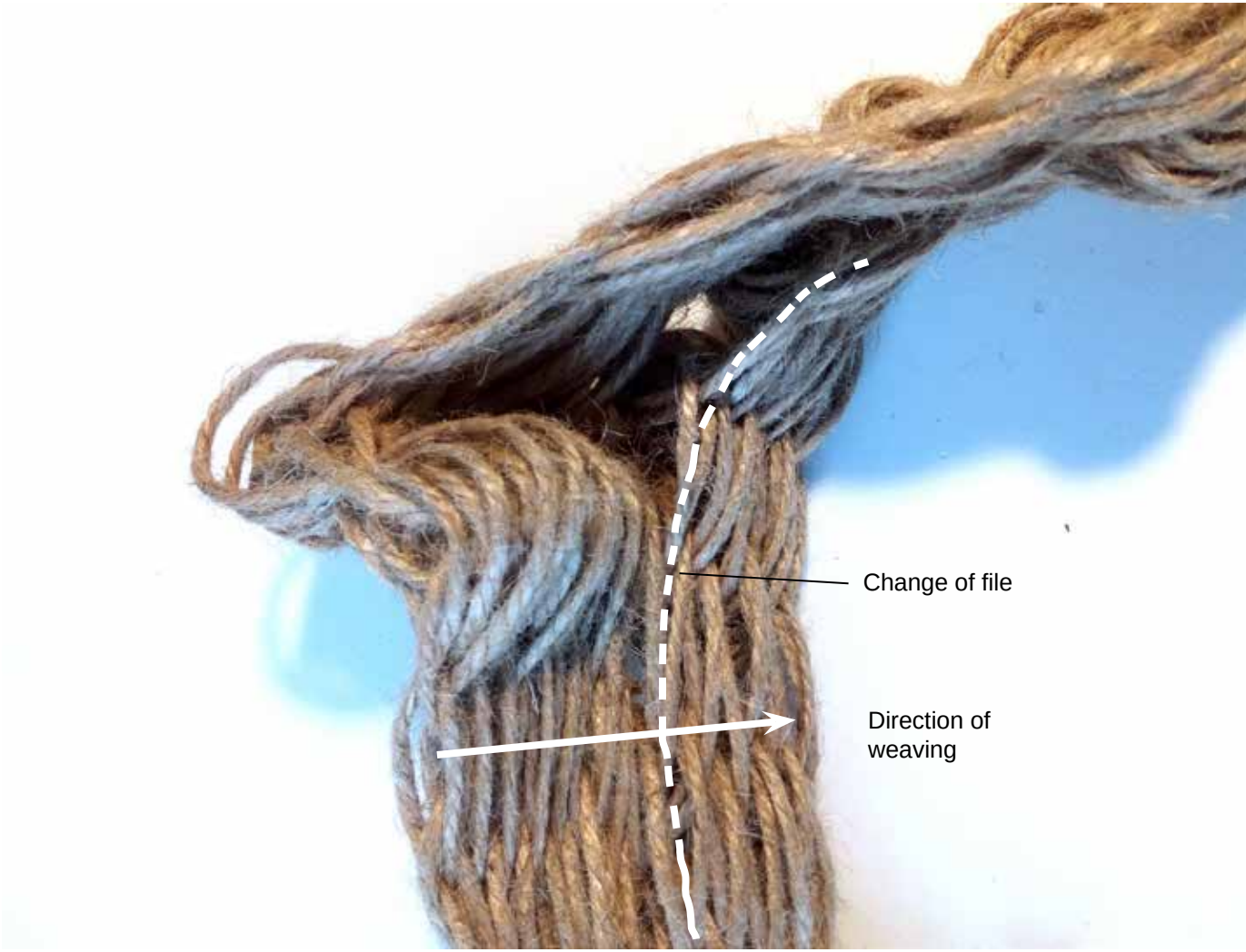
MultiWeave structures made during the course Structure and Material. 2017

Kadi Pajupuu. Pre-programmed sample woven with Multiweave

material: flax; sample shows formation of strenghtened part (corner) where warps are placed in equilateral triangle

Photo Kadi Pajupuu

Developing the support structure of warps



Woven with Multiweave.

In making this sample two files were used, notice the change of structure in the middle of the sample. View from the bottom.

Photo Kadi Pajupuu

Front view

Back view

Structure and Material

Marge Allik

warps in two rows, material: wool

Photo Marta Tuulberg

MultiWeave structures made during the course Structure and Material. 2017

Anett Niine

material: ribbon

Photo Marta Tuulberg

Laura Alexandra del Giudice

material: wool

Photo Kadi Pajupuu

MultiWeave structures made during the course Structure and Material. 2017

Kaidi Mikk

Long weft floats in the context of wearable item

Photo Marta Tuulberg

Kaidi Mikk

Photo Kadi Pajupuu

Laura Alexandra del Giudice

material: wool; sample is felted after weaving

Photo Kadi Pajupuu

MultiWeave structures made during the course Structure and Material. 2017

Malle Soosaar

material: wool

Photo Kadi Pajupuu

Claire Pixie Aunison

7 warps, material: flax

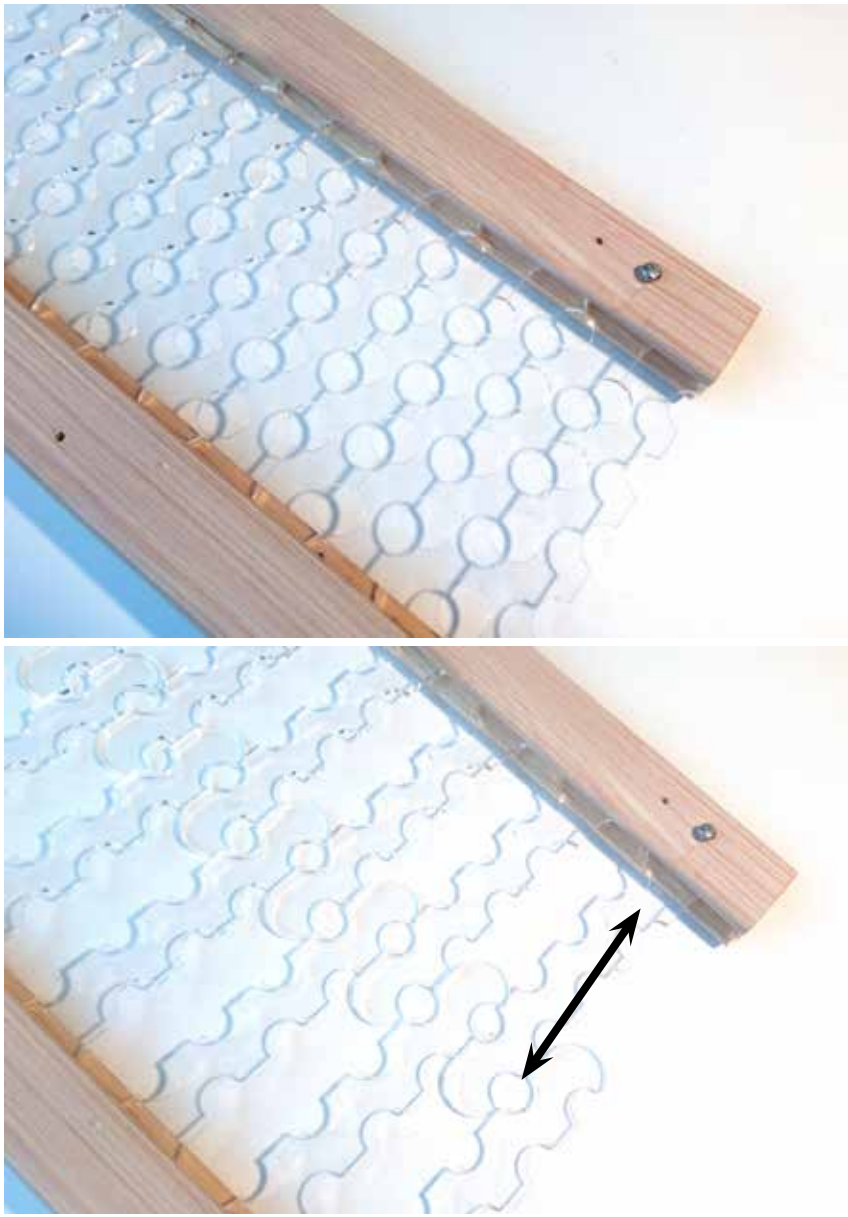
Photo Marta Tuulberg

2018

plans for January to December

Improving the hardware:
replace x-axis with 50cm trapezoidal lead screws and improve the balance of the construction.

Add the possibility of removable horisontal support board, that can be lowered and removed from the machine thus enabling to expand the z-directional weaving. (On the picture right laser-cut version of the board in two positions)



Idea: Johan Pajupuu; made and tested by Kadi Pajupuu

Technical improvements in 2018

Improving the hardware:

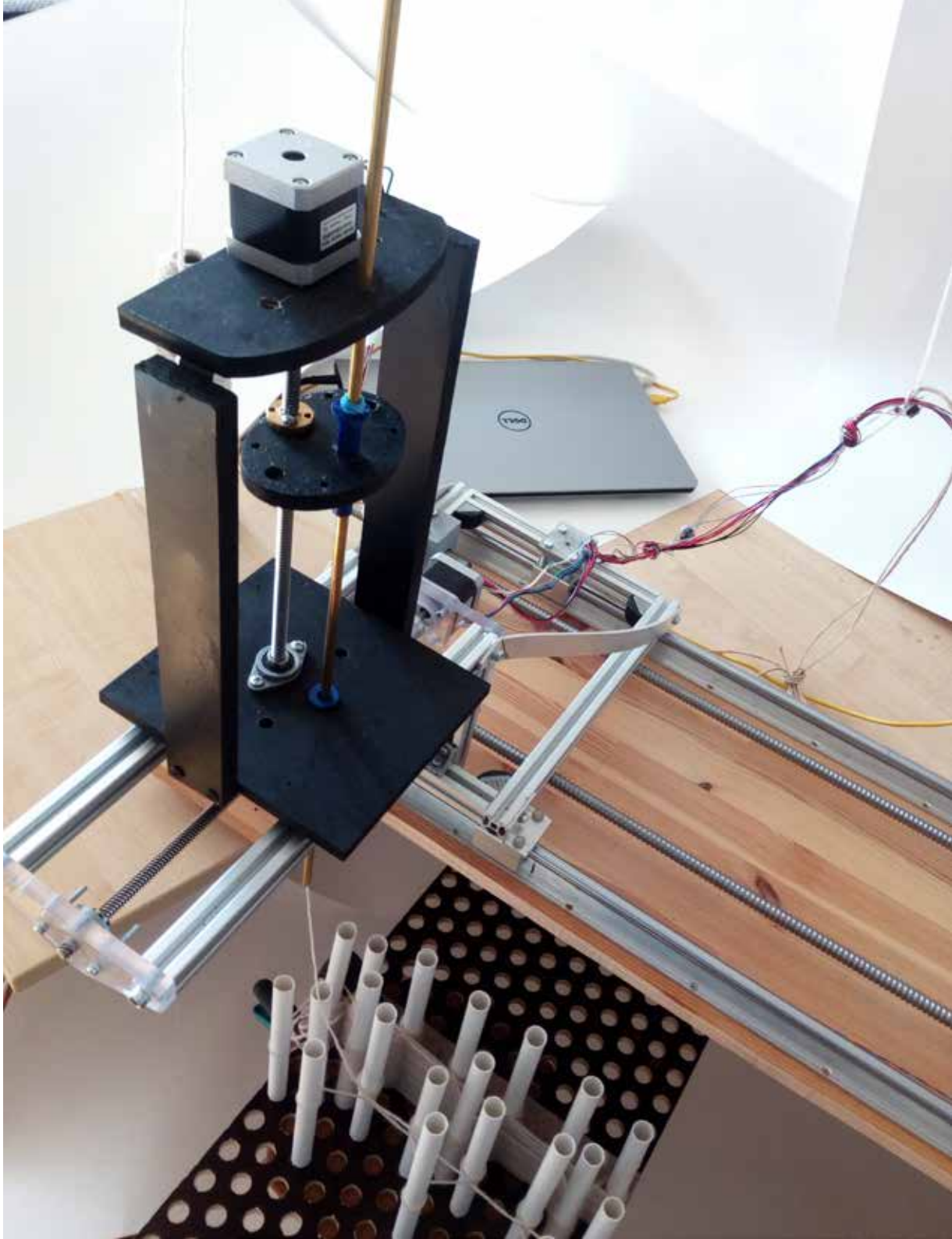
z-direction support structure (Black tower) rebuilt of wood and lowered to achieve more stability.

The board with warp supports is lowered situated under the table of MultiWeave. Board can be moved independantly from the machine, thus making it possible to build horizontally expanded sheets of material that use the repetition of the same file with limited number of warps.

Problem

that needs to be solved: weft yarn feeding. Weft yarn flow from the spool is not fluent enough, tensioning of weft yarn results into bending of warp supports.

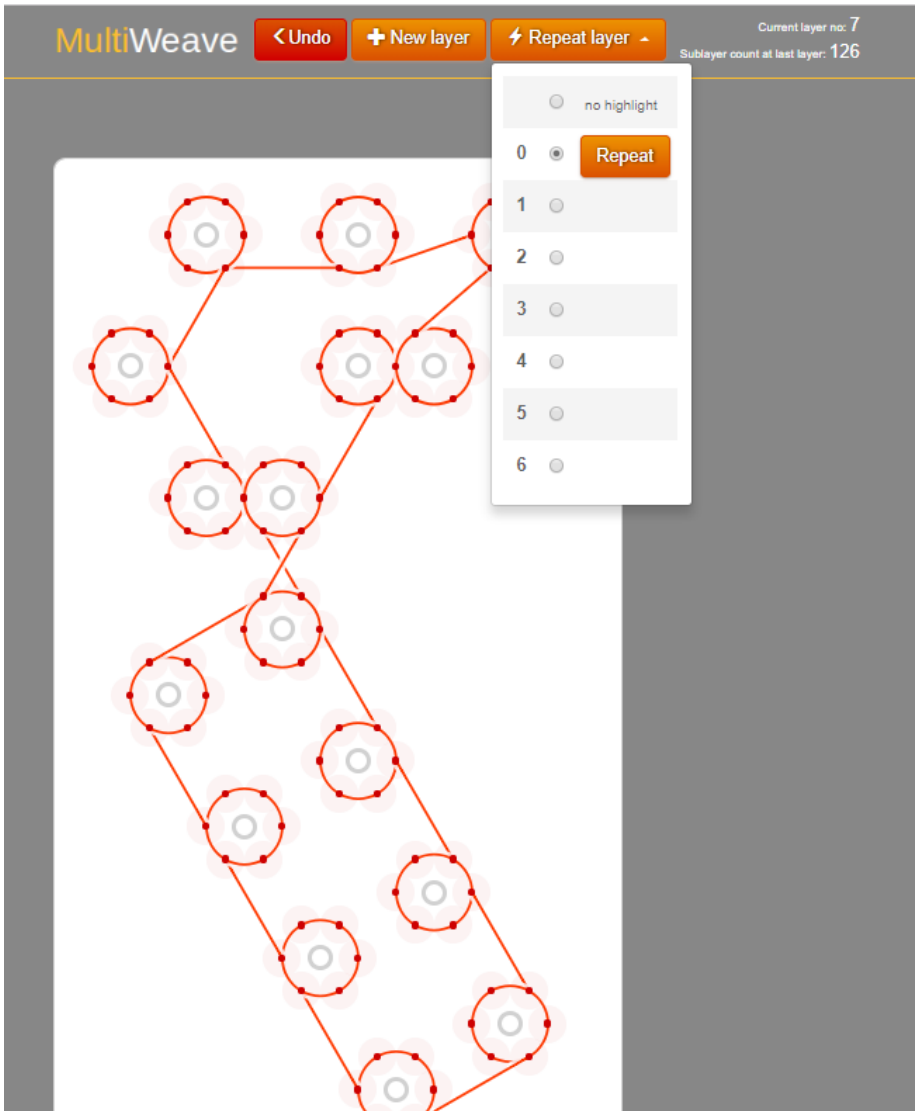
Probable solution: to construct motorized yarn feeder, that is triggered when the loop of the weft is leaving the reach of the sensor.

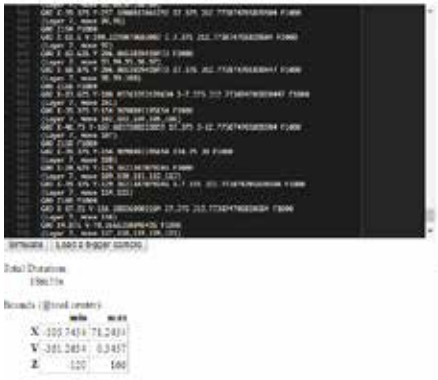


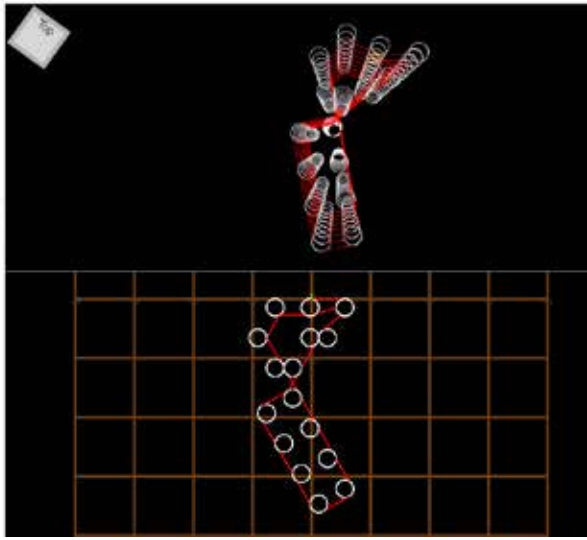
Developing the documentation and planning of the structures. 2018

Improving

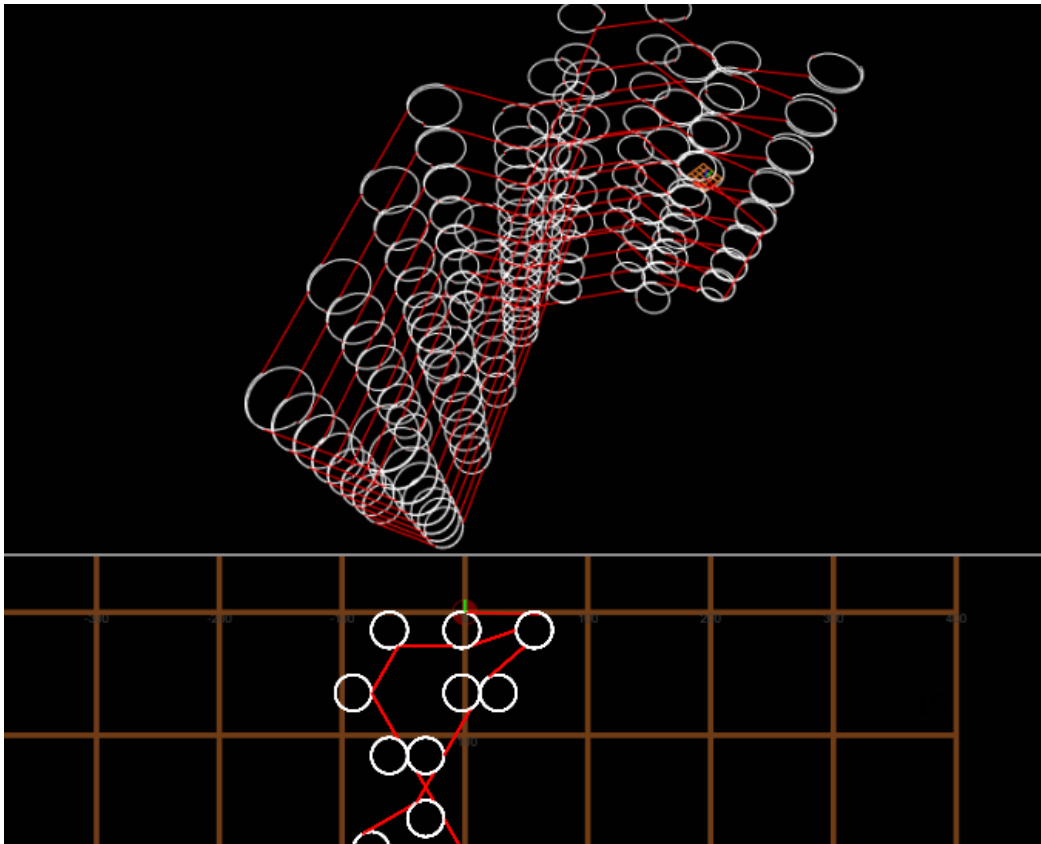
the visual documentation of the structure can be done in free g-code simulation program online https://nraynaud.github.io/webgcode/.
This possibility was introduced to students during the course of Textile related software.







g-code created with MultiWeave program is copied and pasted into the left-hand window and simulation of the tool path can be viewed and rotated in 3D.



Distributing information. 2018

International student exhibition MYTH at gallery Noorus, Tartu, 22.02-17.03.2018.

Display of MultiWeave structures was organised in cellar room by Marta Tuulberg. Exhibits were made by Marta Tuulberg and first-year students.

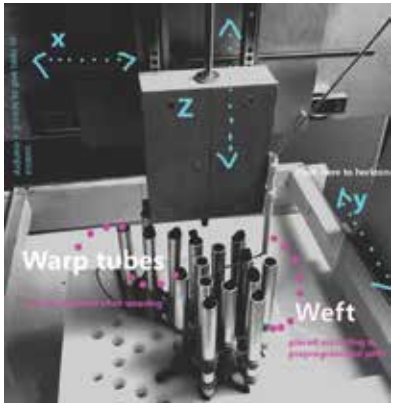
Exhibition was documented in the articles by Aet Ollisaar in newsletter of Estonian Textile Artist's Association *Koiliblikas 53* (Estonian and English versions)
https://tekstiilikunst.ee/koiliblikas

https://tartu.postimees.ee/4429617/nooruse-galeriis-kusitakse-kuidas-luua-muuti

Koiliblikas 53

Rakendusuuring. **MultiWeave**

mai 2017 – detsember 2018



MultiWeave'i esimene prototüüp. *First prototype of MultiWeave, built at Technohack 2016*

SpiderWeave tiim: Taavo Lukats, Kadi Pajupuu, Liisu Miller, Anna Jõgi. Pildilt puudub Urmas Mägi. *Team SpiderWeave at Hardware and Arts 2017.*

Rakendusuuring. 3D printeri põhimõttel töötava kudumismasina MultiWeave arendamine.

MultiWeave on Kadi Pajupuu leiutis, mis võimaldab valmistada uudse struktuuriga tekstiilmaterjali. Struktuur koosneb lõimest ja koest, kuid erinevalt telgedel kootud materjalidest, saab koelõng liikuda ka ümber lõimelõngade haarates neid näiteks o- või 8-kujuliselt. Leiutis toimib CNC tehnoloogia kombineerimisel originaalse lõimelõngatoestamise seadeldisega.

Masinate prototüübid nimetustega MultiWeave (2016) ja SpiderWeave (2017) ehitati häkatonide raames.
2017. aastal alustati Tartu Kõrgemas Kunstikoolis rakendusuuringuga MultiWeave, mille eesmärk on seadet edasi arendada ja testida sellega valmistatud materjalide omadusi. Rakendusuuringu partnerina finantseerib tarkvaraarendust tekstiiliettevõte Fein-Elast Estonia oü. Anna Jõgi programmeeris kasutajaliidese, mis võimaldab juhtida koelõnga liikumist. Koelõnga liikumisjoonisest tehakse g-kood, mis võimaldab mootoritel juhtida koelõngavedajat x, y ja z telje suunaliselt. Mustri-tarkvaraga saab tutvuda saidil: libahunt.ee/multiweave
MultiWeave projekti on kaasatud TKK tudengid Marta Tuulberg ja Rena Punnison. Võimalike struktuuride aretamisel on kaasa löönud 1. kursuse tudengid kursuse Struktuur ja materjal raames.

Applied research project. Developing of MultiWeave – weaving machine that uses the cocept of 3D printing.

MultiWeave, an invention by Kadi Pajupuu, enables to build textile structure that consists of warp and weft but the difference from conventional weaving is that the weft yarn can move around warp yarns forming clusters of connected material. The invention combines CNC technology with an original warp support device.

Prototypes of the machine MultiWeave (2016) and SpiderWeave (2017) were built during hackathons. In 2017 Tartu Art College started an applied research project to develop the machine and test the materials built with it. The partner from textile industry Fein-Elast Estonia is financing the development of the software designed by Anna Jõgi. User interface enables the user to define which warps are present in the forming of the structure and draw the path of the weft. Program creates the g-code for the machine that guides the movement of the weft guider in the direction of W, Y, Z. Software can be seen: libahunt.ee/multiweave

Tartu Art College students Marta Tuulberg and Rena Punnison will be working on testing the machine. During the course Structure and material first year students were developing MultiWeave structures.

Kadi Pajupuu poolt arendatud lõimetoe süsteem. *Warp support system developed by Kadi Pajupuu*

Anna Jõgi arendab MultiWeave'i programmi ja kasutajaliidest. Software developed by Anna Jõgi.

MultiWeave struktuur, pärast lõimetugede eemaldamist. *The woven structure of Multiweave after removing the warp support.*

TARTU KÕRGEM KUNSTIKOOL | TARTU ART COLLEGE

Tekstiiliosakond
2017

Distributing information. 2018

Display at the exhibition MYTH.
MultiWeave structures by Marta Tuulberg and students.

Distributing information. 2018

Conference.
During the international exhibition Identity (the 6th Riga International Textile and Fibre Art Triennial “Tradition and Innovation”) a two day international scientific conference IDENTITY took place at the Art Museum RIGA BOURSE on 7 and 8 June 2018. There were 20 guest speakers from Lithuania, Estonia, Poland, USA, United Kingdom, Finland, Sweden, France, Kenya, Mexico, and other countries. Artists, art experts, museum representatives will tell about the latest novelties in textiles in their home countries, as well as give deeper insights into their creative activities.

Kadi Pajupuu gave a speech about hacking the weaving tools. Among other inventions (RailReed, stepping reed) also MultiWeave was introduced and the logic of developing ideas during hackathons were described.

Abstract.

Hacking the weaving tools
Kadi Pajupuu
Associate Professor, Pallas University of Applied Sciences

My invention Rail Reed is an adjustable weaving reed allowing to change the warp density and fabric width while weaving. Stepping reed is an attachment to normal reed that enables to push weft yarn in waves while weaving.
In 2016 I entered a Hackathon in Tallinn– a competition where you pitch your idea in front of the engineers and try to gather a team of 4 members that will help to build the prototype in 48 hours. My idea was a 3D printer that uses conventional yarns that are placed according to preprogrammed path around the rigid elements that support the warp. After the weaving is done the rigid elements are removed from the structure, so that only woven structure remains.

In 2017 we developed MultiWeave further and it also became an applied research project of Tartu Art College. Thanks to the financial support from Urmas Mägi (CEO of Fein-Elast Estonia) a special program was developed by Anna Jõgi, the user interface enables the weaver to define the path of weft yarn around warps.
In the Skeemipesa Hackathon in the autumn of 2017 I presented the idea of BitPat, a computer operated heddles that can be added to ordinary looms. A team built the working prototype.

Hackathons are great opportunities to test innovations and get a team of people with different backgrounds to make prototypes of the devives that solve certain weave-related tasks.

Distributing information. 2018

Annual exhibition of Estonian Textile Artists' Association *KOLM värvi/ põlvkonda/Eestit.*
5-29.07.2018, Haapsalu Town Gallery.
Display of multiweave structures by Kadi Pajupuu.

Wall text at the exhibition KOLM. Partners of MultiWeave applied research project are also documented.

Multiweave structure with and without the warp supports.

MultiWeave

3D printerid ehitavad ruumilisi objekte lisades materjali kiht-kihilt. MultiWeave on eksperimentaalne masin, mis võimaldab „printida“ lõngaga, kasvatades koelõngakihte etteantud punktide vahel. Lõimi toestab kudumise ajal jäik tugistruktuur, mis töö lõppedes tekstiilist eemaldatakse. MultiWeave esimene prototüüp ehitati 2016. aasta Skeemipesa Hackathonil Anna Jõgi juhtimisel tiimiga Kadi Pajupuu (idee), Johan Pajupuu, Oleg Kalinkin. Järgmistes arendustes lõid kaasa Liisu Miller, Taavo Lukats, Urmas Mägi. Täna on MultiWeave Tartu Kõrgema Kunstikooli rakendusuuring, arenduskoostöö on firmaga Fein-Elast Estonia (Urmas Mägi). Anna Jõgi (kriimuteh.ee) on loonud ka kasutajaliidese, mis võimaldab kudujal kanga ristlõiget disainida ning programmi, mis koevedajat suunavaid mootoreid juhib.

Milles seisneb MultiWeave struktuuride erinevus traditsioonilisest kangakudumisest? Siin eksponeeritud objektid demonstreerivad seda mitmeti.

1) Koelõnga teekond ümber lõime loob ribilise efekti
2) 8-kujulise koelõngaliikumisega toestatud nurgad
3) Rakuline ehitus: taskud ja avad
4) Hargnevad tasandid
5) Kasvamine kõrgusesse kasutades korruste ühendamiseks samu lõimi
6) Järelvanutamine võimaldab luua struktuurset viltmaterjali

Objektides on kasutatud UpYarn vaibalõnga, koostöös Haine paelavabrikuga valmistatud ümarpaelu ja kraasvilla. MultiWeave struktuuride arenduses osalevad Tartu Kõrgema Kunstikooli tudengid.

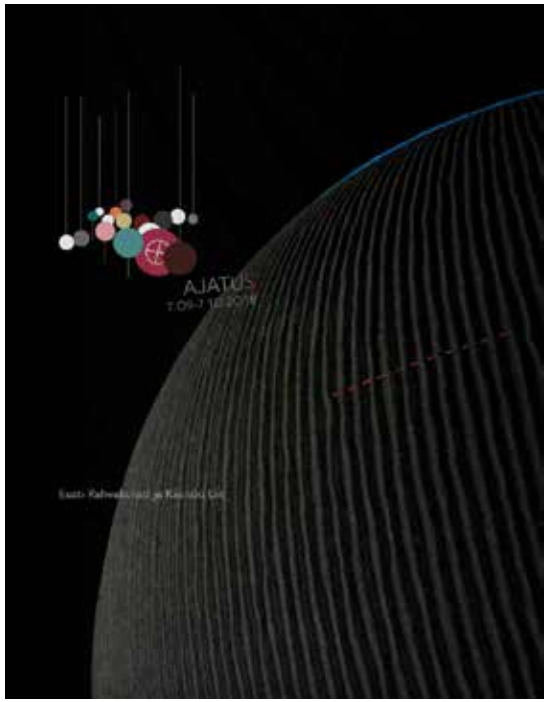
Kadi Pajupuu

2018

Distributing information. 2018

Exhibition *Ajatus* / Timeless 8.09-7.10. 2018 in St Catherine's Church, Vene 14a Tallinn. Project of Estonian Folk Art and Craft Union. Curated by Mae Kivilo. Kadi Pajupuu was invited to participate. Name of the work was AEGNA, it used MultiWeave structures.

In the catalogue
https://issuu.com/kataloog/docs/ajatus_issuu2
connections to our applied research were documented (pp 42-43)



KADI PAJUPUU

kadi@pajupuu.com
http://kadipuu.ee/inventions

Aegna

Enne on lõim ja siis on kude. Siin on vastupidi: kude siugleb ümber punktide, kuhu lõim siseneb hiljem. MultiWeave on kudumisviis, kus koelõnga saab panna naaberlõimede ümber kaheksaid joonistama. Kujutlen kangast, mis koosneb lõpmatusemärkidest. Kangast saab kududa nii, et tekivad taskud, tasandid, kraatrid. Nii saan kududa taevakeha. Kududa või „multiveevida"? Veevi oli minu tekstiilikunstnikust ema nimi.

Pirita teel sõites näidati bussiaknast lastele: näe, see valge maja seal Aegnal, seal me suvitasime ühel aastal. Mina mäletangi seda maja ainult valge täpina sinises saaretriibus. Seda sai vaadata lohutuseks bussisõidust tekkinud iivelduse eest. Valge täpp oli ringi keskpunkt, tähistamas kogetud-unustatud põnevust. „Aegna" on loodud koostöös graafik Marilyn Piirsaluga.

MultiWeave on masin, mis ehitati häkatonide raames aastatel 2016 ja 2017 Anna Jõgi juhtimisel. Kuduja saab arvutis planeerida koelõnga teekonna ümber lõimetugede. Programm annab juhised mootoritele, mis liigutavad koelõngavedajat kolme telje suunas. Tegu on omamoodi 3D-lõngaprinteriga. Nüüd on MultiWeave Kõrgema Kunstikooli Pallas rakendusuuring. MultiWeave'i ehitamisel on osalenud Oleg Kalinkin, Johan Pajupuu, Urmas Mägi, Liisu Miller, Taavo Lukats. Kasutajaprogrammi lõi Anna Jõgi. MultiWeave'i struktuuride arendamisel on osalenud Kõrgema Kunstikooli Pallas tudengid Marge Allik, Liisi Tamm, Anett Niine, Marta Tuulberg jt.

Aegna

First comes warp, then weft. Here it is just the opposite: weft winds around the points, warp is inserted afterwards. MultiWeave is a way of weaving, where the weft can move in "eights" around neighbouring warps. I envision a textile made out of infinity symbols. The textile can be woven so that pockets, layers and craters are created. I can weave a celestial body. Weave or "multiveev" (a play on the Estonian way of pronouncing "weave")? Veevi was my mothers name, she was a textile artist.

Riding the bus on Pirita tee, the children were shown a white house on the island of Aegna: look, one year we spent the summer there. I remember this house as a white dot in the blue stripe of the island. It was a consolation prize for the nausea the busride caused. This white dot was the center of the circle, marking the once experienced and now forgotten exoterment. "Aegna" is created in collaboration with the graphic artist Marilyn Piirsalu.

MultiWeave is a machine built during hackathons in 2016 and 2017 under Anna Jõgi's guidance. The weaver can plan the weft's route around warp supports. The program guides motors, which move the weft guider along three axes. It is like a 3D yarn printer. Now MultiWeave is an applied research project of Pallas University of Applied Sciences. Oleg Kalinkin, Johan Pajupuu, Urmas Mägi, Liisu Miller, Taavo Lukats have participated in building MultiWeave. The user interface was created by Anna Jõgi.

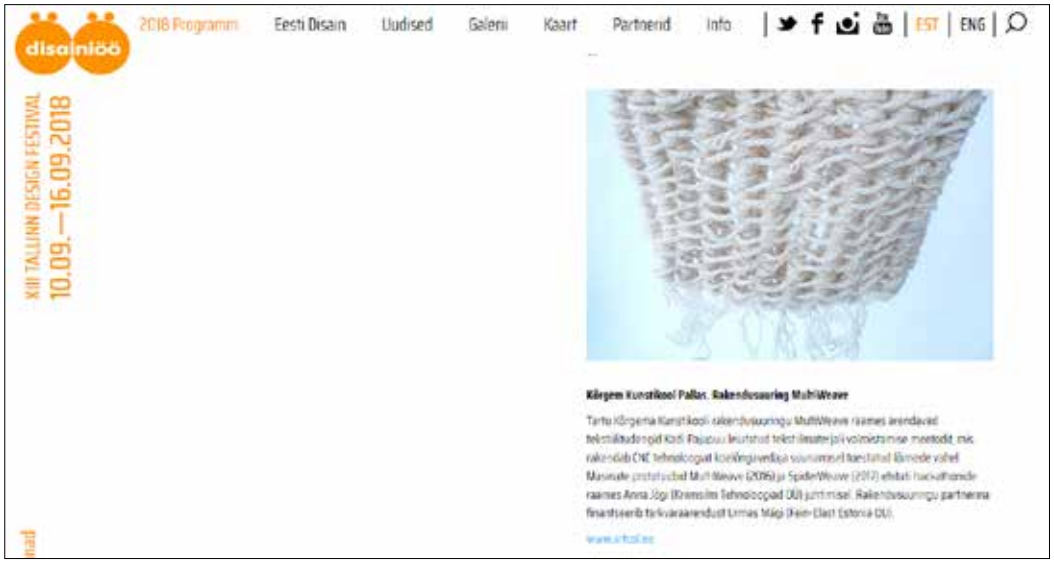
Pallas's students Marge Allik, Liisi Tamm, Anett Niine, Marta Tuulberg and others have taken part in developing MultiWeave structures.

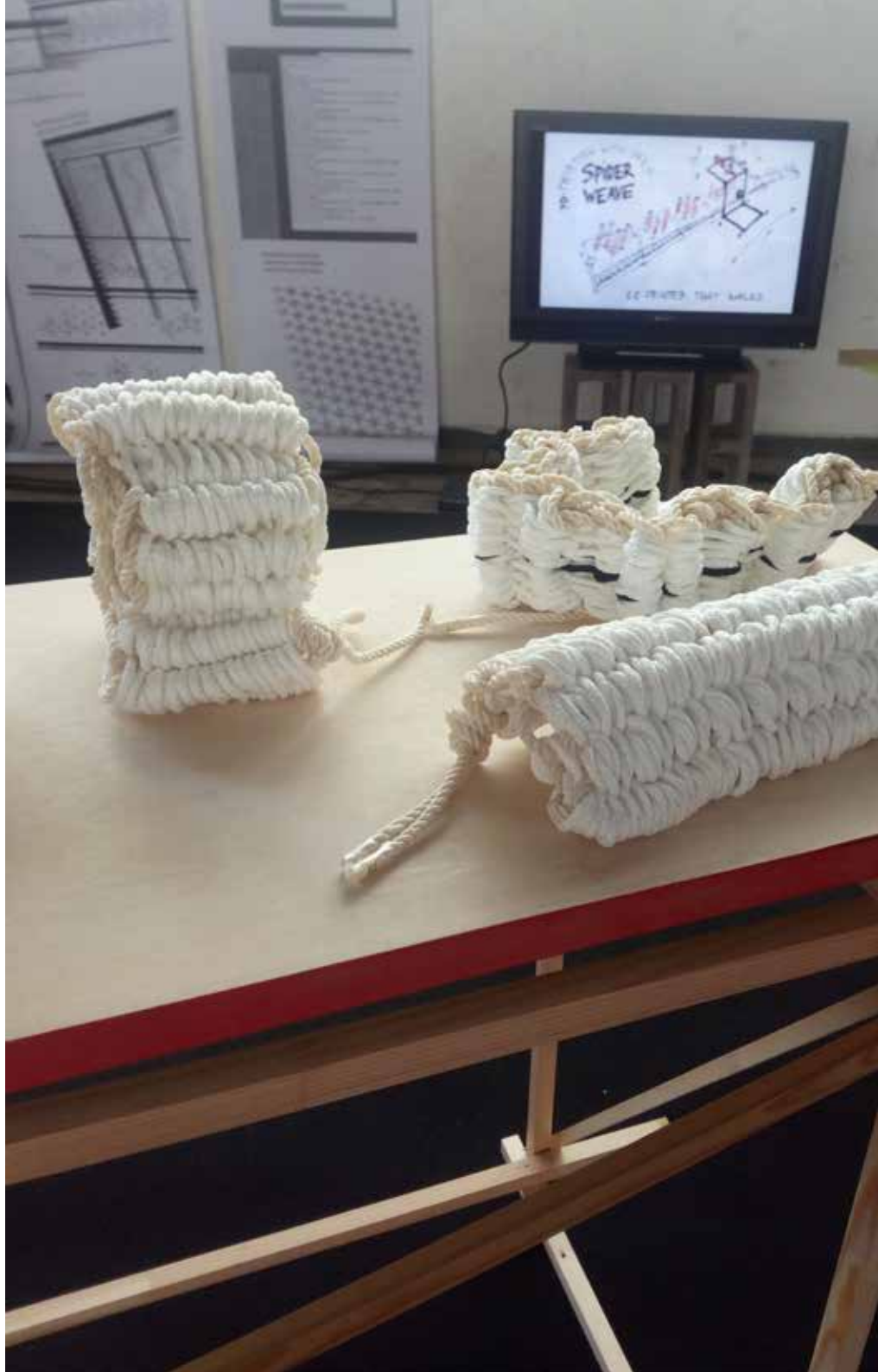
Distributing information. 2018

XIII Tallinn Design Festival.
Display of design and architecture schools at Roheline saal (Telliskivi 60A) 11.09.–16.09.

Multiweave display included information on the screen about the project phases, poster and objects made by Liisi Tamm, Anett Niine, Marge Allik.

Design festival website





Distributing information. 2018

XIII Tallinn Design Festival.
Display of design and architecture schools at Roheline saal

Multiweave display included information on the screen about the project phases, and people behind it, poster and objects made by Liisi Tamm, Anett Niine, Marge Allik.

https://www.artsthread.com/news/xiii-tallinn-design-festival-school-shows/

Plans for 2019.

1) The leader of project MultiWeave Kadi Pajupuu is invited to share information and give a course about her weave related inventions in Vilnius Academy of Arts (textile departments in Vilnius and Kaunas). 18-22 February 2019. Financing: ERASMUS

2) Kadi Pajupuu is invited to speak at the Nordic Textile Art conference in Iceland in March 30th. Financing: Kadipuu oü and the organizer.

SATURDAY 30.3 - TEXTILE CONFERENCE DAY

10:00 – 15:00 NTA conference at VEROLD – The house of Vigdís.

NTA conference hosted by the The Icelandic Textile Association "Heritage meets the future" . Speakers at the conference come from the nordic countries and from the USA and Estonia. *(scroll down for more information about the speakers)*

- Jessica Hemmings "The Textile Art of Tomorrow"
- Philip Fimmano "Archaeology of the Future"
- Bryndís Bolladóttir "Functional Art – The sheep in me"
- Katrin Þorvaldsdóttir "Aspiration for equilibrium"
- Kadi Pajupuu "Hacking the Weaving Tools"
- Isabel Berglund "Textile surface – identity"
- Kyoshi Yamanmoto "Conversation with Annie Albers"

Abstract of the speech from the website of NTA

Kadi Pajupuu - *Hacking the Weaving Tools.*

Kadi Pajupuu Associate Professor, Pallas University of Applied Sciences. Her invention Rail Reed is an adjustable weaving reed allowing to change the warp density and fabric width while weaving. Stepping reed is an attachment to normal reed that enables to push weft yarn in waves while weaving. Together with Marilyn Piirsalu, Kadi has been giving Rail Reed courses in Estonia, Finland, Sweden and Netherlands. Railreed is used by inventive weavers in USA, Japan, Australia and Africa and Europe.

In 2016 I entered a Hackathon in Tallinn- a competition where you pitch your idea in front of the engineers and try to gather a team of 4 members that will help to build the prototype in 48 hours. My idea was a 3D printer that uses conventional yarns that are placed according to pre programmed path around the rigid elements that support the warp. After the weaving is done the rigid elements are removed from the structure, so that only woven structure remains.

Kadi believes in sharing ideas, questioning traditions and cooperation. In the last years she has developed many intuitive weaving tools that challenges the traditional way of working with yarn and textiles

3) Project Multiweave is represented in Lodz at the 3rd Textile Art triennial by Anett Niine, Liisi Tamm, Marge Allik; Pallas University of Applied Sciences Tartu, Estonia.
Financing: Pallas, Cultural Endowment, project partner Fein-Elast.

YTAT 3RD YOUNG TEXTILE ART TRIENNIAL | 2019

4) International conference The Loom Tamers, takes place in 11.05.2019 at Pärnu Museum. Kadi Pajupuu is among the speakers of the conference. Event is organised by Estonian Textile Artists' Association.

Applied research project MultiWeave has been successful
THANKS TO

financial support of Pallas University of Applied Sciences, we could build and test the hardware during the project;

textile department Professor Aet Ollisaar who has organised exhibitions and events where MultiWeave structures could be displayed;

financial support and developing help from Urmas Mägi from Fein-Elast Estonia, we were able to develop software MultiWeave and make improvements into hardware.

Special thanks to textile students Marta Tuulberg, Liisi Tamm, Anett Niine and Marge Allik, who show initiative and always do more than they are supposed to and demonstrate remarkable professional attitude towards inventive solutions.

MultiWeave would not exist without the passion and knowledge of Anna Jõgi: the maker and software developer from Kriimsilm Tehnoloogiad.

And we were very lucky that Taavo Lukats, Liisu Miller, Oleg Kalinkin, Johan Pajupuu, Urmas Mägi showed their engineering talent during hackathons were MultiWeave and SpiderWeave were built.

Kadi Pajupuu