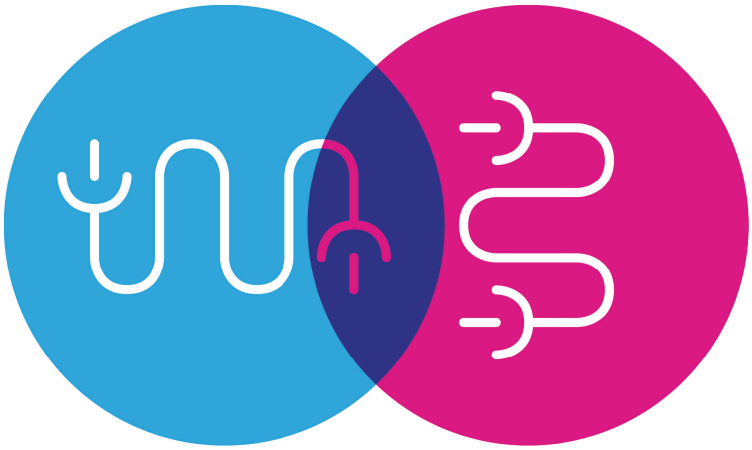

Project Acronym:	**#MusicBricks**
Project Full Title:	**Musical Building Blocks for Digital Makers and Content Creators**
Grant Agreement:	**N°644871**
Project Duration:	**18 months (Jan. 2015 - Dec. 2016)**

D5.1 First feedback on #MusicBricks for creative applications

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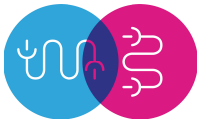

The #MusicBricks project consortium is composed of:

SO	Sigma Orionis	France
STROMATOLITE	Stromatolite Ltd	UK
IRCAM	Institut de Recherche et de Coordination Acoustique Musique	France
UPF	Universitat Pompeu Fabra - Music technology Group	Spain
Fraunhofer	Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung E.V	Germany
TU WIEN	Technische Universitaet Wien	Austria

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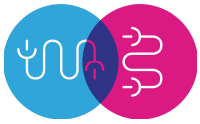

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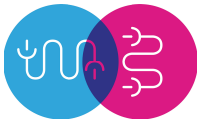

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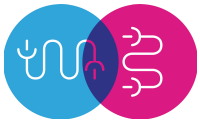

Executive summary

The present document is a deliverable of the #MusicBricks project, funded by the European Commission's Directorate-General for Communications Networks, Content & Technology (DG CONNECT), under its Horizon 2020 research and innovation programme.

The first Creative Testbed, #MTFScandi, which ran 28-30 May 2015 in Umeå, Sweden, gave the partners a clear indication of the power of #MusicBricks. With the focus on physical applications for music interaction and performance, creative developers were particularly incentivised to use the newly available #MusicBricks R-IoT microboard for motion sensing and motion analysis. A range of successful applications were produced, addressing different types of innovation: Smart Products for Smart Homes, new ways to communicate using mind and body, novel product platforms driven by motion sensors, and intelligent musical instruments. Creative developers were instructed and mentored throughout this process. At the end of the Creative Testbed, four prototypes were deemed by the judges to have creative and commercial potential and were chosen for incubation supported by #MusicBricks microfunding.

The R-IoT micro board for motion sensing and motion analysis proved extremely popular also at the Sonar +D Music Hack Day in Barcelona, 17-19 June 2015. All 12 manufactured boards which were available were reserved by teams right at the start of the Creative Testbed. This event also saw a higher uptake of 7 other #MusicBricks. The pre-event #MusicBricks workshop, run on the day preceding the 24-hour hackathon, proved very successful and contributed in great part to the developers' confidence in using all 8 #MusicBricks. A special set of graphic symbols were designed especially to identify each #MusicBrick, and these were made available as stickers. This dissemination method proved extremely popular with many developers marking their laptops with the chosen #MusicBricks. Four further seed prototypes were chosen by the judges to be supported by #MusicBricks microfunding. These included an accessibility product, a collaborative musical performance, an action music interface and music AI.

Partners gathered knowledge through observing how the tools were being used during both Creative Testbeds, gathering feedback about the use of #MusicBricks and analysing case studies. The general level of adoption, enthusiasm and the resulting creative ideas are considered to be very high. Feedback gathered about the tools has been fed back into the research and development.

The popularity of the tools has been reflected in the social media impact, with extremely high reach in M6 of the project. Over the period between 26 May and 24 June 2015, the #MusicBricks hashtag registered 837,423 impacts and 579,052 reach on social media (Twitter). Other social media channels have now been made available to the #MusicBricks community (posts on FaceBook; regular updates on Slack).

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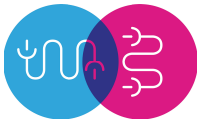

1. Introduction

This document provides an overview of the outcome of the first Creative Testbeds organised by the #MusicBricks partners, and designed to seed creative ideas for new products and applications of the #MusicBricks toolset. The document provides a useful analysis of the first feedback gathered from the use of the tools by teams of creative developers.

The document begins by summarising the context and background of the first two Creative Testbeds. It follows with the list of #MusicBricks technologies which have been made exclusively available to the creative developers through APIs, GUIs and TUIs. It then lists the methodologies deployed at the two Creative Testbeds to incentivise and inspire the Creative Developers in the use of #MusicBricks, followed by a list of all notable resulting innovations.

Nine case studies are described to illustrate the creative developers' methodologies of involvement, learning , inspiration and collaboration. Data is provided about social impacts of the adoption of the tool, and statistics about the participants countries of origin, skills and gender balance at both events. Finally feedback is described, both in terms of qualitative feedback about the participants' experience, and in terms of valuable feedback gathered about the use of the #MusicBricks tools, which is being fed back into research.

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2. Summary of Pilots Organised

2.1.#MTFScandi, Umeå, Sweden

2.1.1.About Music Tech Fest

Music Tech Fest launched in 2012 as a creative playground - a 'festival of music ideas' - in an attempt to bring all music tech creators and thinkers under one roof. The festival was a spinoff of the EU Roadmap for Music Information Research (MIReS) which aimed at opening up the scientific field of MIR to cultural, social and creative studies. Michela Magas, Scientific Director of MIReS and founder of the Music Tech Fest, brought artists and scientists as well as academia and industry into a common creative space. Through match funding and support from local organisations, MTF succeeded in showcasing 54 presenters, inventors and performers; 70 innovative hackers, makers and developers of novel instruments; and 70 creative practitioners and emerging artists.

In its second year (Music Tech Fest London, 17-19 May 2013) the event continued to explore the way that music is perceived, experienced and performed. It attracted the attention of all major music labels. Both mainstream and independent artists drew inspiration from the event to grow ideas with the music tech community and perform them at the following year's event. In its third year the event was invited to Wellington, Boston, London, Berlin and Paris by partners including the British Council, New Zealand Music Commission, Microsoft Research, London Symphony Orchestra, and IRCAM Centre Pompidou. The #MTFLondon event included a remote linkup from Berklee College of Music graduates in Boston in a 'telehackathon'; and also featured an MTF kids hackathon – in which 8-16 year-olds learned hands-on electronics and coding to make instruments which they performed on stage.

The festival also plays host to an academic symposium. At #MTFBoston, 21 top researchers from across a wide range of disciplines collaborated to produce the Manifesto for the Future of Music Technology Research in response to the Music Tech Fest experience, and the manifesto now bears hundreds of signatures. At #MTFLondon, a group of 42 musicians and researchers launched the research field of Human Music Interaction with a series of collaborative project proposals.

In 2015 the festival had 15 invitations by cities and organisations across the globe. However, organisers decided to instead stay in Europe to focus on two large regional festivals that would involve all of the creative community to think about new formats for music and new ways of combining different fields of knowledge in this space. #MTFScandi ran 29-31 May 2015 with the academic symposium on the 1st of June; and #MTFCentral will run 18-20 September 2015, with the academic symposium on the 21st.

2.1.2.About Music Tech Fest Scandinavia - #MTFScandi

#MTFScandi took place from the 29th to the 31st of May 2015 at Sliperiet, the newly-opened interdisciplinary centre at Umeå University's Arts Campus, situated between the Architecture Faculty, the Umeå School of Design and Bildmuseet - Umeå's Museum of Modern Art. The festival incorporated 74 presentations, showcases and demonstrations of new musical inventions, interfaces, performances and projects across the weekend, including:

1) Alex Nowitz - performance
2) Reeps One - Cymatics Hacks performance
3) David Fernandez - Ecce Cello performance
4) Håkan Lidbo - project demos
5) Jon Jonsson - Teenage Engineering demos
6) Edwin Joassart - Herrmutt Lobby demos

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7) Balandino Di Donato - Integra Labs presentation

8) Jonas Kjellberg - Gestrument demo

9) Patrick Bergel - Chirp demo

10) Miha Ciglar - Ultrasonic audio technologies demo

11) Jon Eades - Abbey Road Studio presentation

12) Kristina Bergenwall Sandberg - Laser Unicorns / Kung Fury presentation

13) Emmanuel Flety - IRCAM (MusicBricks R-IoT board) presentation

14) Frederic Bevilacqua - IRCAM (MusicBricks R-IoT board) presentation

15) Tracy Redhead - One Drop / Amorphous Track presentation

16) Andreas Sandström - LunaLEC demo

17) Matt Black - NinjaTune performance

18) Eden Grey (Chelsea Bruno) - The Art of the Modular Synth performance

19) Jan Bidner - Sounds that move you (gamification and motivation by using audio feedback)

20) Trond Lossius - BEk - Bergen Center for Electronic Arts / Ambisonic Toolkit (ATK) for Reaper

21) Run Dreamer (Rani Dar) performance

22) Morten Qvenild - Norwegian Academy Of Music / The HyPer(sonal) Piano Project

23) Dirk Stromberg - Strombophone perfromance

24) Tim O'Dwyer - Meta-Saxophone performance

25) Kenneth Alewine - Performing Melancholia demo

26) Alexander Schindler - TU-Wien / Video killed the Radio Star: Analyzing Music Videos for Music Recommendation

27) Katariina Nyberg - ExClaM! / Sibhack Rotterdam / You Are Here presentation

28) Terry Tyldesley - Kitmonsters / Playtime presentation

29) Dennis Braunsdorf - HKU / Prolody: Real Violin demo

30) Mark Towers - Isotonik / Arcade Series performance

31) Alex Morancy - Ironfist Music / #fistpics demo

32) Nick Zeigler (Ironfist) - Ironfist Music / #fistpics perfromance

33) Ben Dawson - Immersive Album LTD presentation

34) Johannes Taelman - Axoloti presentation

35) Willem Zwagers - Interactive Institute Swedish ICT / Audification of Absence presentation

36) Adam Scrimshire & Adam John Williams - Improvisation: Guitar and Tech performance

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37) Michela Magas, Andrew Dubber, Cyril Laurier, Peter Lundgren - Tjay Launch demo

38) Anders Lind & 40 children - Umeå University / Composition for Animated Notation performance

39) Faraz Sayed & Stan Lewry - Opto Noise demo

40) Benjamin Mørk - MØRK performance

41) Jason Singh, Graham Massey (808 State), Scanner (Robin Rimbaud) performance

42) Hasse Hjörtek & Jan Ferm - Kulturverket presentation

43) Siobhan Ramsey & Tom Flynn - Sandbox Education / Volvo Kids Hack Camp demo

44) Bil Bryant - Soundation presentation

45) Matan Berkowitz - Shift / DisCoTech - Music Technology for Special Needs presentation

46) Vahakn Matossian - Human Instruments presentation

47) Nigel Papworth - Interactive Institute Swedish ICT / Voice Harvester presentation

48) Anne Dvinge - Low-Fi presentation

49) James Brewster - Electro-Acoustic Café presentation

50) Georgios Kaiafas - European Commission / EASME presentation

51) Paul Sonkamble - Deerlily presentation

52) Linda Iro - Random Bastards presentation

53) Filip Koludrovic & Piotr Paduch - Trackathon performance

54) Jordi Janer - Music Technology Group, Universitat Pompeu Fabra / #MusicBricks presentation

55) Alexandra Antonopoulou - Creative Ring Workshop presentation

56) Petter Ericson & Tomas Härdin - Umeå Hackerspace presentation

57) Balandino di Donato - Cubindisphere Hack demo

58) Laura Kriefman & Phill Tew Hack demo

59) Rojan Gharipour - Dolphin Hack demo

60) Tobias Widlund - Pictunes Hack demo

61) Kim Wong - Pictunes Hack demo

62) Horácio Tomé Marques, Xico Teixeira & Fanni Fazakas - FindingSomething BondingSounding

63) CJ Carr - Trackathon Submission Bot Hack demo

64) Patrick Bergel - Chirp / Aether Drone demo

65) Oliver Pribyl - Glove FX demo

66) Gudmar Söderin - Another Brick On The Wall demo

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67) Max Virus, Finn Juniper Denaro - Timtam Hack demo

68) Ginger Leigh (Synthestruct) - EEG Cymatics Hack demo

69) Petter Ericson Synthobone (One-Handed Instrument) demo

70) Linnea Dimitriou - Creative Director, Sliperiet presentation

71) Laura Kriefman & Phill Tew - Guerilla Dance Project performance

72) LJ Rich - Perfect Pitch Productions LTD / The Audience Experience as Co-Performance

73) LJ Rich & Emil Åreng - Synaesthetic Musical Cocktail perfromance

74) MTF Allstars - Jam Camp Live performance

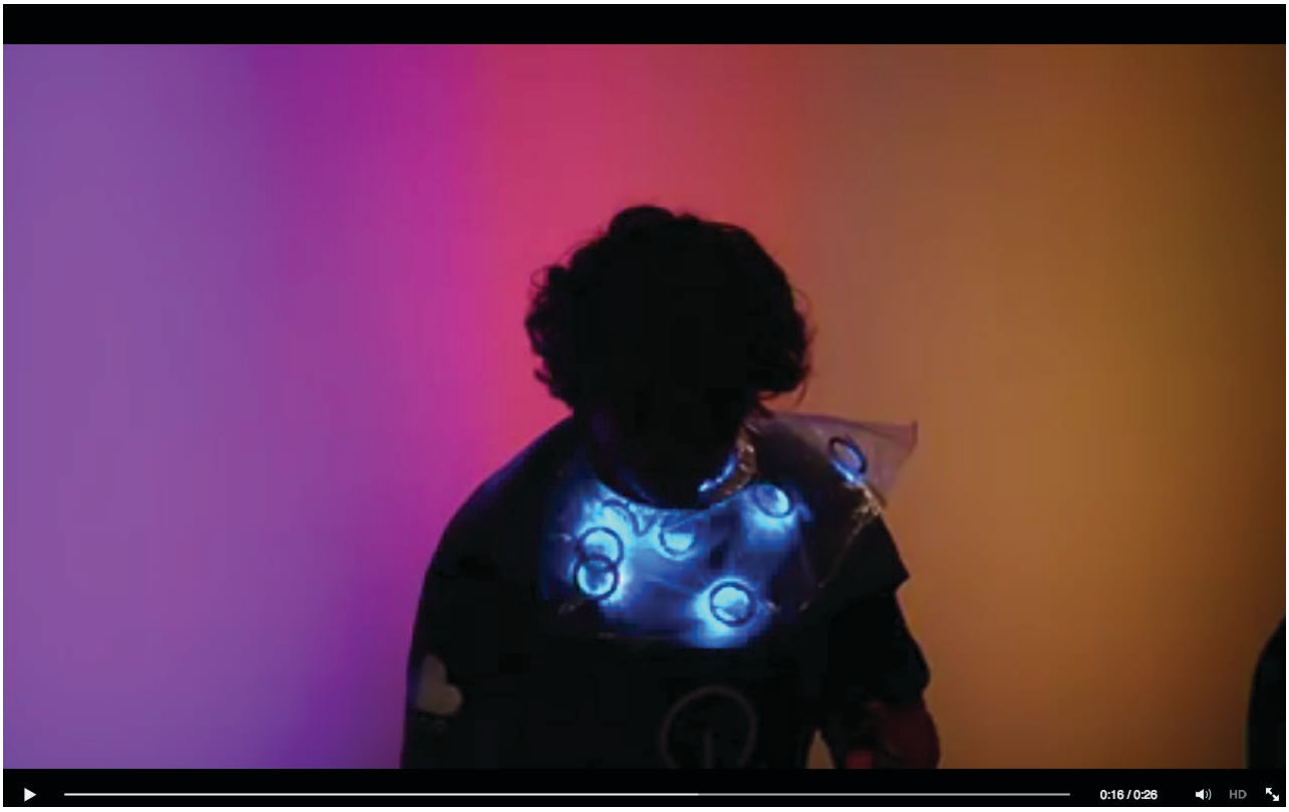

Fig 1: Hacker demo presentation on the main stage at #MTFScandi

In addition to the main festival stage, #MTFScandi also featured a sound recording studio filled with musical instruments and equipment, arranged as a 'jam camp' in which any festival attendee could pick up an instrument and join in. Sonic art installations were set up throughout the building - including a darkened room in which three 2m-tall colourful inflatable cubes comprised the world's largest MIDI controller; a forest environment and sound experience; a 'hackable music room' in which playing musical instruments controlled video projection displays; a bubble-making musical table; and a voice harvester machine, containing colourful powders and liquids that responded to the voices of festival visitors. Music producers gathered in the 'Trackathon' - a 24 hour challenge to create a new recorded work using a pre-selected library of sounds. Workshops included a Creative Ring workshop that explored ideas that would use the CreaCity platform for the city of Umeå, Sweden. CreaCity was released as part of the European SPECIFI project to develop tools for engagement with city culture and local businesses. The festival also featured a Kids Hack Camp. As an introduction to creative technologies, local children learned to work with physical computing and software to create musical inventions to showcase on the main stage at #MTFScandi. The festival also featured DJs,

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food, a beer tent, a film screening, a tour of the famous Guitar Museum in Umeå and a range of interactive experiences, product demonstrations and networking opportunities.

Fig 2: Hacker awards at #MTFScandi and Kids Hack workshop which ran in parallel to the adults Hack Camp

In amongst this environment, #MTFScandi also featured a 24-hour hack camp that provided the first Creative Testbed and seed ground of ideas for the #MusicBricks projects. 50 hackers from 14 countries gathered to respond to a series of technical and conceptual challenges, and the #MusicBricks tools and technologies were made available to the hackers for the first time. The #MusicBricks partners were on hand to both showcase the technologies' capability and coach the hackers in the use of those tools.

Because of the high calibre of the hackers selected and invited either personally or via an online application process to attend the event, four strong #MusicBricks ideas were selected by the judging panel to be supported to commercial prototype. Judges were impressed by the level of innovation and the commercial possibilities of the projects.

Music Tech Fest is filmed and live-streamed online and each performance, presentation and individual hack demonstration - including the hacker awards - is made available globally via YouTube. The event is actively promoted through MTF social channels - including over 3000 Twitter followers, and a mailing list of nearly 4000 people. At #MTFScandi, a high proportion of the hacker projects used the #MusicBricks tools, and these were discussed in some depth across social media resulting in a social reach of over half a million people.

2.2.Sonar+D Music Hack Day, Barcelona

2.2.1.About the Music Hack Day

The first Music Hack Day was organised by Dave Haynes and James Darling and held at the London offices of The Guardian newspaper over the weekend 11/12 July 2009. Since then, this initiative has proved to be a great way to demonstrate the creativity around music that comes from the tech community, fostering **cross-platform and cross-device innovation**.

In the past six years, more than 50 Music Hack Day events have taken place around the world, with over 3500 participants who have built over 1300 innovative hacks with the support of about 250 music and technology companies. The events are attended by a diverse range of music and technology enthusiasts who are creating increasingly more interesting projects as each event goes by. Its mission is to fast prototype and **create brand new music apps** (web, mobile or physical) in just **24hrs, t**o bring together the music industry and the developer community to highlight and **software and hardware tools of companies** working in and around music tech, and to foster cross-platform and cross-device innovation.

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2.2.2.Music Hack Day in Barcelona

The **MHD in Barcelona** was started in 2010 by the Music Technology Group of the Universitat Pompeu Fabra in Barcelona. This is one of the most popular Music Hack Days because it is organised as a satellite event of the Sonar+D – the space for creativity and technology within the pioneering electronic music festival Sonar in Barcelona.

Thanks to this collaboration, the companies participating in the Music Hack Day benefit from the great exposure of this Festival (about 118.473 spectators coming from 104 countries, 200k visits streaming, 4.000 accredited professionals, 2.000 companies and almost 1.000 journalists accredited this year 2015) and all hackers enjoy the concerts and activities included as a reward for the hard work in the hacking session.

2.2.3.About Sonar Festival

Sonar is an advanced music and new media art festival that has taken place in Barcelona for the last twenty years. A pioneer in its format and content, it combines entertainment with art, divulging the latest trends in advanced music and its interactions with other musical genres and artistic disciplines.

Sonar+D is the meeting point for professionals from the music and applied audiovisual and new media creation industries. It pledges its commitment on the creative industries and connects the local with the international initiative. A new pro-active concept encourages interaction and the interrelation more than ever in the unique context of the festival, proposing ideas debate, interchange of experiences, live experimentation, training, exhibitions and demonstrations.

2.2.4.Music Hack Day in Barcelona 2015

This year the Barcelona MHD offered a **special track on wearable and multimodal technology applied to music creation and performance**. This special track brought together experts on bio and motion sensing, interaction design and wearable interface prototyping. Special track activities and resources included:

- A hands-on **workshop** sponsored by the RAPÌD-MIX European project on *Designing expressive wearable technology for music performance*, where participants will combine innovative multimodal sensing technology (BITalino), real-time machine learning interfaces (Wekinator, GVF) and audio synthesis/processing libraries (Maximilian, JUCE) for prototyping wearable, mobile music interfaces and instruments involving physiological computing and motion sensing.

- A second practical workshop specialised in music processing tools sponsored by #MusicBricks. Further details about this workshop are available in Section 3.2.1.

- A **talk** on Yuya Kikukawa's journey in wearable interface design, from winning the Sonar+D challenge at last year's Barcelona MHD with the first prototype of his smart-shoes system *Orphe*, to developing it as a product through a successful crowdfunding campaign earlier this year.

- A **talk** by Alex Murray-Leslie and Sam Ferguson, about their fascinating work on *Computer enhanced footwear for live art*, including a live demonstration of their prototype system.

- A **performance** curated by Di Mainstone and Becky Stewart, based on the latest iteration of their instrument/installation *The Human Harp*.

- A **performance** by Atau Tanaka, one of the pioneers in music performance with biosignal interfaces, who will be performing his piece *Myogram*, an 8 channel sonification of muscular corporeal states.

- An innovative **set of technologies** (both software and hardware) that helped participants to conceptualise, build and demonstrate you their wearable interfaces. The list of technologies available included 3d printers, knitting machines, toolkits for rapid prototyping using body signals, hackable shoes, Nao robots, Brain Computer Interfaces, conductive ink, etc (see the event's Tools page for more details).

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- 100 hackers selected from 200 applicants based on their skills, previous portfolio of projects and plans for hacking.

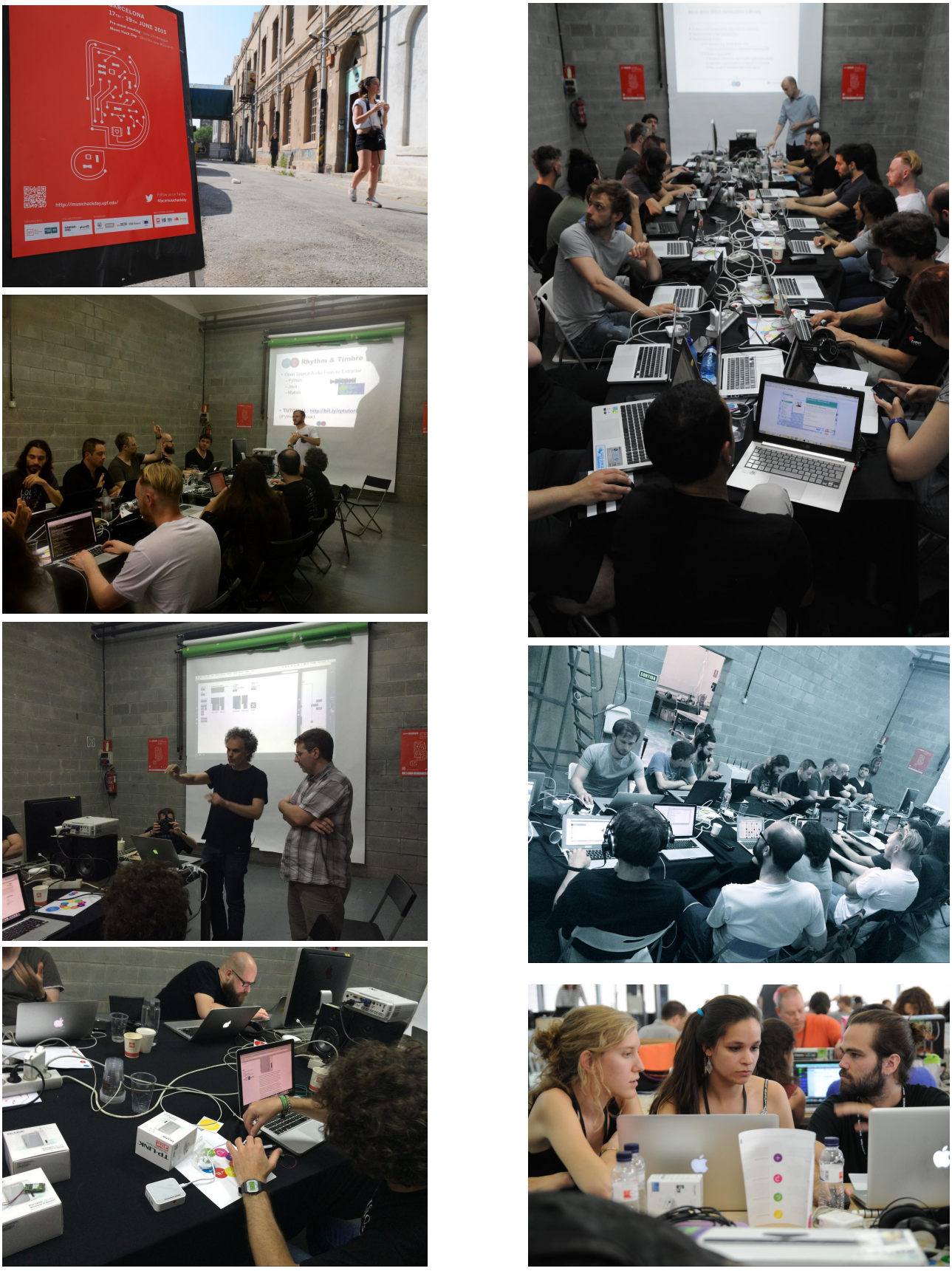

Fig 3: Successful #MusicBricks workshop at Sonar+D on the day before the Music Hack Day (bottom right)

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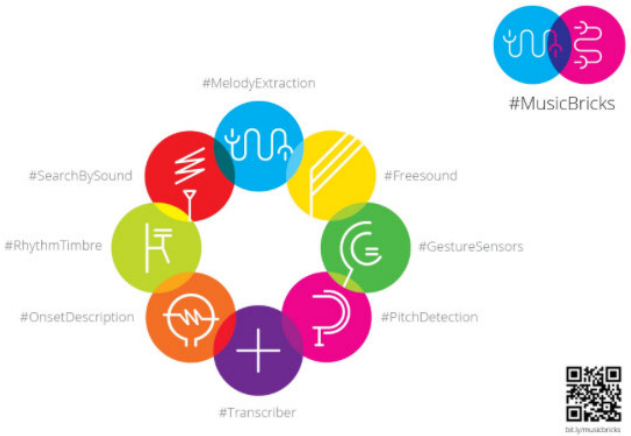
3. #MusicBricks at the Creative Testbed Pilots

The **list of technologies** and APIs provided by each research partner and the links to specific information is found below (for more information about each #MusicBrick please refer to D3.1):

- Melody & Bass Transcription, Beat & Key & Tempo Detection API (by Fraunhofer),
- Realtime Pitch Detection API (by Fraunhofer),
- RP extract: Rhythmic and Timbral Audio Feature Extraction (by TU Wien),
- Search by Sound Music Similarity Retrieval API (by TU Wien / Spectralmind),
- Freesound 2.0 Web API (by MTG-UPF),
- Melody Extraction / Essentia Library API (by MTG-UPF),
- Onset Detection (by MTG-UPF),
- R-IoT sensor (by IRCAM)

At the Sonar+D Music Hack Day, special graphic symbols were designed to distinguish each of these technologies and stickers were printed for creative developers to use on their hardware and laptops to indicate which #MusicBricks they were using.



All these technologies were introduced in a series of presentations and workshops. The content was structured in four sessions under the name of “Music Processing”. Each session addresses one music processing topic, giving hints about the use of #MusicBricks technologies in practical applications.

i. **Melody Analysis**: presented a number of pitch tracking and melody transcription algorithms implemented in the Essentia library. Differences in performance were demonstrated and suggestions on which algorithm to use with respect to instrumentation, genre and task on a number of practical examples were given.

ii. **Rhythm and Timbre Analysis from Music**: gave an overview and introduction on how to extract rhythmic and timbral information out of music, showing how specifically Rhythm Patterns and Statistical Spectrum Descriptors manage to capture a song’s rhythmic and timbral content for real-world applications such as music search by acoustic similarity.

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iii. **Real-time Pitch Detection and Applications**: focused on the real-time automatic transcription of melody and bass line from polyphonic audio signals. It showed how music transcription algorithms are integrated in music learning and music performance assessment applications.

iv. **Gesture Analysis for New Musical Instruments** The R-IoT sensor module embeds a 9 axis sensor with 3 accelerometers, 3 gyroscopes and 3 magnetometers, all 16 bit. It allows for getting 3D acceleration, 3-axis angular velocity and absolute orientation at a framerate of 200 Hz over WiFi. The sensor module is completed with a series of analysis MaxMSP modules that facilitates its use, based on the MuBu & Co Max library. This collection of analysis tools allows for: filtering and analyzing, computing scalar intensity from accelerometer or gyroscope, kick detection, detection motion patterns such as “freefall”, spinning, shaking, slow motion. Further motion recognition tools are available in the MuBu & Co library.

3.1.#MusicBricks at #MTFScandi

The hack camp at #MTFScandi brought together 50 hackers, artists & musicians from 14 different countries and gave them exclusive access to tools from #MusicBricks research partners. The most talented creative developers were headhunted and recruited from a week-long hacker gathering at Transmediale in Berlin, from the London Music Hackspace, from the Music Tech Fest global hacker community, and through a specially organised competition based on ideas of Cymatics. Winners of the Cymatics challenge came from Olando and Boston in the US and from Budapest in Hungary.

Participants were challenged to devise & create a project within 24 hours, culminating with the presentation of that project on the main Music Tech Fest stage. With the focus on physical applications for music interaction and performance, creative developers were particularly incentivised to use the newly available #MusicBricks R-IoT microboard for motion sensing and motion analysis. Prizes & the possibility of sponsorship/incubation were available for participants who created projects to fit within one of the four challenge categories, written especially to fit the open methodology of a Music Tech Fest Creative Testbed. In the run-up to the festival each challenge category was created in such a way that participants would be inspired to create innovative projects, whilst not being prescriptive or directly describing exactly what sort of projects people were expected to create. The challenge categories & descriptions were as follows:

- **Music Things for Music Ecosystems**

Devices & things used to stay separate unless physically connected. The Internet Of Things enables everyday objects to connect wirelessly and communicate through the cloud, but what are the implications of this for musical composition & performance? Invent a ‘music thing’ that can connect with other devices either locally or remotely, and form part of a musical ecosystem, a cloud orchestra of compatible devices for collaborative musical expression.

- **Sound Objects in Smart Homes**

High quality music playback in the home was once reserved for nerds and audiophiles only, but thanks to advances in technology and acoustic research, high quality music playback is accessible to everyone. The new challenge this creates for designers & developers is that we now want these objects to fit in with our lives, in terms of their form, aesthetically & ergonomically, as well as with the way we now live our lives, how we use our devices, and how we connect with other people, discover new music and share the music we love with others. Invent a sound object for the smart home.

- **Cymatics**

Cymatics is the creation of visual patterns in physical matter through sonic vibration. Continents have been shaped through vibrations. From the microscopically small to the cosmic scale, Cymatics is integral to nature. Cymatics comes together with brainwave entrainment through binaural beats. Create a performance, installation or system that demonstrates the power of cymatics.

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- **Music as Communication**

Music has always been used as a form of communication & expression which transcends language, enabling exchange of information between people who speak different languages to one another or even people who cannot speak at all. This communication process goes more than just two ways, from one party to another, but also devices can communicate to their users the ways in which they can be used. Invent a device or system which enables musical communication & expression which requires no instructions.

3.2.#MusicBricks at Sonar+D Music Hack Day, Barcelona

#MusicBricks involvement with the Sonar +D Music Hack Day took place over three consecutive days; an initial workshop and introduction to the #MusicBricks tools and team on day one, followed by the 24 hour hackathon event itself. Participants signed-up for both of these events online where they also found background information about the #MusicBricks project. It was not compulsory to attend the workshop session in order to use the #MusicBricks technologies during the Hack Day event.

During the workshop session the #MusicBricks technologies available for the Sonar+D Music Hack Day were explained in depth by the #MusicBricks project partners responsible for the development of each tool and participants were guided through any necessary download and set-up protocols to get them up and running. This session allowed interested hackers the chance to find out in much more detail the scope and potential of each tool as well as a first opportunity to get hands on experience of using them in advance of the Sonar +D Music Hack Day competition itself. Furthermore, it allowed #MusicBricks team to get to know the hackers, to answers queries about the tools, the project and the incubation process and to spot how project ideas and hack teams began form.

The project team also reiterated that the project incubation programme offered hackathon projects that made use of the #MusicBricks tools the possibility to develop their initial hack further towards a more stable and sustainable prototype, by providing support for a several month long incubation phase. Videos of the winning #MusicBricks projects from the previous #MTFScandi event were shown to illustrate the standard of winning hacks, show the potential of the tools and to help teams come up with original concepts.

22 participants took part in the workshop and were introduced to the #MusicBricks dealing with Melody & Bass Transcription, Beat & Key & Tempo Detection, Real-time Monophonic & Polyphonic Pitch Detection, Rhythm and Timbre Analysis & Extraction, “Search by Sound” Music Similarity Retrieval and Gesture Sensors for Music Performance (R-IoT board).

During the session, outside of technological and implementation queries for the #MusicBricks technologies, the most common questions surrounded the competition prize and how the incubation process worked. What were the judges looking for? To what stage where projects expected to be developed within 24 hours? What exactly were incubations? Were they residencies in one particular location with a #MusicBricks partner? How much financial support would be given?

These questions were not unexpected. This was not due to any unintended lack of clarity in the prize description, rather it was a consortium decision to keep such parameters open. During previous EU FP7 project ICT&ART Connect, in which #MusicBricks partners Sigma Orionis and Stromatolite both formed part of the consortium, it was found that awarding equal allocations of incubation support, both financially and in terms of partner time, did not reflect the actual needs of projects. Factors such as the number of team members, where they each lived, how they best worked and what specific type of help was needed where much more significant to the success of all projects rather than equal apportioning of available support. Furthermore, not concentrating on specific tangible prizes allows those that are more interested in their own ideas and project goals, rather than winning prizes come to the fore.

After the workshop, the attendees enjoyed talks and performances related with the topic of this year’s MHD wearables and music performance. The pre-event meeting ran from 10 to 19.30 hour and included meals for

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participants. The Music Hack Day edition served as Creative Testbed for the #MusicBricks interfaces and tools. #MusicBricks involved the 100 hackers in the process of applying creative seed ideas to the use of the #MusicBricks data and assets to discover new use cases and applications.

3.3.Results from #MTFScandi

There were 50 places in the 24-hour hack camp at #MTFScandi for the most talented creative developers who had, for the very first time, access to exclusive new #MusicBricks technology and to microfinance for the best projects to incubate and further develop to commercial prototype. In order to ensure that ideas that start at Music Tech Fest go on to have a sustainable life outside of the festival, some great music tech minds joined to help choose those projects:

- Matt Black is one half of the legendary electronic music duo Coldcut, and co-founder of the Ninja Tune label which has brought us the amazing talent of the Cinematic Orchestra, Bonobo and Amon Tobin. At Music Tech Fest we think of Matt as the "godfather of our festival" - he has been with us right from the start, premiered Ninja Jamm at the first fest, engaged some of our community in building the app, and has been demoing new ideas at every fest since.

- Joshua Saunders is Head of Technical and Creative (UK Digital) at the Warner Music Group. Josh has worked on award winning web and mobile and social projects for artists such as Gorillaz, Coldplay, David Guetta, Lily Allen, Swedish House Mafia, Damon Albarn and Blur, Emeli Sande, Deadmau5, Tinie Tempah, and also directly with partners at Apple, Google, Spotify, Facebook, Twitter and Soundcloud.

- LJ Rich is a presenter for BBC Click, specialising in music, tech, sci-fi and social, as well as a composer and pianist. At Music Tech Fest Boston LJ joined as a first time hacker and hasn't looked back since - she teamed up with fellow #MTFHacks winners and has continued to develop a series of music therapy apps as well as report on hacking. She spoke about her conversion to a hacker at TEDx Tokyo.

- Paul Sonkamble has worked on the creative side of business development as Senior Director, Creative Business Development & Innovation, EMEA at Warner Music Group, and previously Head of Innovation and Insight at EMI Music Nordic. Paul is currently involved in a number of innovative ventures for the music industry.

- Jason Singh is a versatile vocal sculptor and beatboxer, who has worked with the likes of Nitin Sawhney, Rokia Traore, and Sebastian Rochford and has been resident sound artist at the V&A in London. Jason has been central to every one of our London fests, and has collaborated with a wide variety of hackers and artists, often in amazing impromptu performances, which have included a world first with Leafcutter John, Tim Exile and Yazz Ahmed at the Barbican LSO St Lukes.

These invited judges were joined by representatives of the #MusicBricks partners:

- TU Wien: Thomas Lidy, Alexander Schindler, Andreas Rauber
- Sigma: Marta Arniani
- Stromatolite: Adam John Williams, Cyril Laurier
- Fraunhofer: Stephen Holly
- IRCAM: Frederic Bevilacqua, Emmanuel Flety,
- UPF: Alba Rosado, Jordi Janer

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#MusicBricks Winning Hacks:

- ***Dolphin*** – by Rojan Gharipour: **Product Platform**

Using the #MusicBricks R-IoT board, Dolphin is an accessible gestural interface for controlling music selection & playback using head movements and head gestures. As a platform for interaction, the motion sensitive headphones can be used to track movement in space with respect to the audio played, as well as control that audio. Watch the video here. Judges felt that the use of headphones as a platform for developing a range of head-motion applications using the R-IoT microboard had very good commercial potential. They were very impressed by the talent of the developer who had, for the very first time, been working with sound and with music-related programming packages (for more information about this case study see Section 4.1.2.

- ***Airstrument*** – by Matan Berkowitz, Ariel Angel and Rani Dar: **Musical Instrument**

Airstrument uses #MusicBricks technology to analyse an existing song, then allows the user to use hand gestures in order to play a melody within the scale and musical context. The aim is to create an intuitive instrument that will make music more accessible in new and exciting ways. Watch the video here. Judges were impressed by the range of #MusicBricks used for this prototype, as well as the originality of their application. More about this Case Study can be found in Section 4.1.3.

- ***FindingSomething BondingSounding*** – by Francisco Marques-Teixeir, Horacio Tome-Marques and Fanni Fazakas: **Performance Interaction**

This project is a response to the challenge of music as communication. It represents a duality between the mind and the body in a combination of performance and EEG brainscan data. The mind controls audio and video samples organized according to activation or relaxation; the body controls the effects according to position, acceleration and angle. Watch the video here. Judges felt that this use of the R-IoT board creates an engaging performance which operates at the junction of science and art. The combination of EEG and motion sensing to drive this performance was highly original and had potential to be developed further.

- ***Interactive Cube*** - by Per-Olav Jernberg and Balandino Di Donato: **Smart Home Music Product**

The Interactive Cube is a physical interface for manipulating audio. The cube is composed by 5 led displays which show the projection of a sphere on each side of the cube. The position of the sphere within the cube is determined by the orientation of the cube, which is tracked using the R-IoT device, and this defines the balance mix of 5 audio loops, while the movement of the cube drives a stereo panning effect. The colour and size of the sphere, as well as the VU audio meters, are regulated by the audio signal elaboration outcome. Watch the video here. Judges felt that this prototype had immediate potential to be developed into a lifestyle product.

3.4.Results from the Sonar+D Music Hack Day

As main outcome of the 24-hour non-stop hacking 12 hacks in total were using one or several of the #MusicBricks available. The details of the #MusicBricks powered hacks are as follows (same order as presentations):

- ***Roli Stoned*** **-** by Harris Christopoulos and Stylianos Ioannis Mimilakis

Expressive surfaces in digital audio synthesis and music production have been practically proved to be a good choice for extending the capabilities of the users/players. Nevertheless, manipulation of audio samples can be further extended, in terms of spectral modifications, in order to overwhelm current expression capabilities. In this project, we present an audio analysis and synthesis engine, that allows cross synthesis and morphing, based on spectral templates. Thus, the user cannot only manipulate, but also generate new

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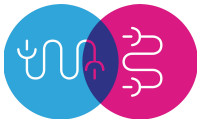

sounds under restrictive, in number, databases(audio banks) with just using his/her fingertips. The video recording of the hack presentation is here.

- ***JucyPaintAlinoBrick*** - by Richard Vogl and Peter Knees

A (wireless) tangible Synthesizer based on Jucy using ElectricPaint and Touchboard as input, #MusicBricks GestureSensor and Bitalino Data for Modulation. The video recording of the hack presentation is here.

- ***La Neurona Tropical*** - by Andres Perez, Carles Julià, Carles Tardio and Martí Umbert

How can the "one-man band" concept can be extended? In this project we plan to do a performance with two musicians. The setup and technologies used by each musician is explained as follows. There are two modes/songs of the performance (controlled with PD): 1. "Harder better faster stronger" by Daft Punk: from which lyrics and onsets are analyzed and visually shown with the wearables (glasses, shoes) and 2. "Paella" song by La Neurona Tropical: This is loaded in 8 tracks, each one is controlled/triggered with the wearables. Musician 1: (i) Myo (arm): Is used to control Ardour sound effects; (ii) Bare (body): The electrically conductive paint is used to activate/deactivate tracks and effects; (iii) LED Glasses (1/3): light flashes are synched with tempo (used for any song); (iv) LED Glasses (2/3): lyrics are synched with MusiXmatch, only showing the lyrics of long words (only used when playing "Harder better faster stronger" by Daft Punk); (v) LED Glasses (3/3): the glasses have been cut with the Trotec laser cutter. Musician 2: (i) Orphe (shoes): show the song onsets analyzed with EssentiaRT; (ii) GuitarHero: controls the bass track of the Paella song; (iii) R-Iot (guitar): sound effects. The video recording of the hack presentation is here.

- ***ENBOARD*** - by Steven Bolaños and Juan Felipe Gómez

ENBOARD is an audiovisual experiment using a skateboard. The video recording of the hack presentation is here.

- ***High Note*** - by Vahakn Matossian and Pere Calopa Piedra

Accessible hands free wireless Midi controller instrument (aimed at, but not exclusively for, people with limited physical mobility or strength). The video recording of the hack presentation is here.

- ***Flyte Club*** - by John Murdoch and Pere Calopa Piedra

A fresh social game based on a 5th century Scots tradition, Flyte Club is a sensory rap battle of techno sound as the audience vote passively with their mobiles. Download the Android development version here: www.untellect.com/FlyteClub. The video recording of the hack presentation is here.

- ***Tibetan Synths*** - by Lucas Thompson, Carl Bussey and Béla Balázs

We created a mobile application which uses the #MusicBricks realtime pitch detection algorithm to transmit pitch data from the live microphone recording to a desktop application via WiFi. The application, made using the Juce audio framework, then creates MIDI events which are then sent to a VST or AU synthesiser. The video recording of the hack presentation is here.

- ***Live gesture-controlled harmonica*** - sampler by Corné Driesprong and Stacy Hsueh

A real-time music performance tool that samples audio on the fly and plays it back to the user allowing one to play and improvise along with live input while manipulating the sounds. The audio input is pitch-tracked and segmented, then stored in a sampling buffer on the fly. Pitch transitions are recorded into a 2nd-order Markov chain in order to generate melodic material based on the previous input using the sampled audio. Gestural control using the Ircam Mo Motion Sensor allows the user to manipulate the pitch and playback speed of the recorded audio. The video recording of the hack presentation is here.

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- ***Sound In Translation*** - by Juanjo Bosch, Andres Bucci, Tim Schmele and Eros Blanco

The idea for this hack is to explore the possibilities of assisted live remixing in a musical performance. Using a hardware controller the user creates a sound and the system searches for a similar sound and adds it to the inputs available for the remix process to start over. This process can continue as the performer listens and reacts to the new sound, finding relevant information within his/her music collection. Another performer can join in the conversation by using Bitalino Signals to control effects that alter the sound that is used for the search. The video recording of the hack presentation is here.

- ***Music Cocktail*** - by Maria Panteli and Yading Song

Mix your (music) ingredients and get a cocktail A music recommendation system based on audio features (rhythm, timbre, melody, tempo) and metadata (year). The video recording of the hack presentation is here.

- ***ear we go!*** - by Martin Hernant, Angel Faraldo, Dani Gómez and Cárthach Ó Nuanáin

Bionic ear to help musicians get in tune with an existing musical ambience. This will simplify the way you jam and improvise with other musicians. Just press a button to listen and your sampler/synthesizer will be auto configured to be in tune. The video recording of the hack presentation is here.

- ***Nao Music Dance*** - by Helena Bantula, Helena Cuesta and Eduard Frigola

Making Nao robot dance according to the beat of an audio which is modified through gestures in real time using Kinect. The video recording of the hack presentation is here.

From the above-mentioned list of hacks, 4 of them were also using RAPID-MIX technologies in addition to the #MusicBricks, integrating and taking advantage of the most sophisticated tools developed by European research centres: 'Roli Stoned', 'JucyPaintAlinoBrick', 'Tibetan Synths' and 'Sound in Translation'.

Finally, there was one additional hack developed by Xavier Salleras, Sergi Armengol, Nadia Campo and Clara Borras which was started but not presented in the end which used #MusicBricks. The concept idea was related to an interactive installation emulating a tree built with wooden stickers which would have hanging mobile phones capable to synthesize sounds depending on the gesture/body movement of the performers. The technologies used were R-IoT, Maximilian, OSC, OpenFrameworks and MaxMSP.

#MusicBricks rewarded the most promising ideas and hacks with a prize consisting of incubating them to the next stage prototype and facilitate routes to placement, residencies and sponsorship, in view of taking the best ideas to market.

The #MusicBricks consortium set a challenge for the hackers in order to establish a minimum criteria for the selection of the winning hacks but at the same time trying not to add constraints to the creativity of hackers. The challenge was phrased as follows:

"Many great accomplishments come from the play between order and chaos.
In september 1928 a series of chance incidents within the highly controlled conditions of a hospital laboratory led to the discovery of penicillin by Alexander Fleming and the saving of an estimated 100 million lives.
Within the field of the arts, in the 1950s and 60s composers such as John Cage and Terry Riley changed the rules of conventional music composition and performance by combining precise and specific scores with elements of indeterminacy and randomness.
Music is essentially about both rules (pitch, timbre, tempo, genre) and freedom (creativity, uncertainty, chance, the unexpected).
Make something that addresses this paradox. Your creation should use one or more #MusicBrick, or have the potential itself to become a #MusicBrick in the future."

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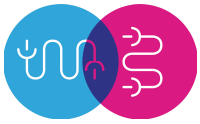

The jury for the #MusicBricks hacks was composed of 1 member (with 1 vote) of every consortium partner attending the Music Hack Day together with 3 external members coming from other companies taking part in the event. The list of key persons that took part in the decision is as follows:

#MusicBricks partners:

- **Dr.-Ing. Jakob Abeßer**, Researcher in Semantic Music Technologies at Fraunhofer
- **Thomas Lidy**, Researcher at Institute of Software Technology and Interactive Systems (ISIS) of Vienna University of Technology
- **Cyril Laurier**, Senior Researcher in Music Information Retrieval at Stromatolite
- **Emmanuel Flety**, Project manager at IRCAM
- **Jordi Janer**, PostDoc at Music Technology Group (Universitat Pompeu Fabra)

Guest judges:

- **Ching-Wei Chen**, Engineering Manager, Content ID at SoundCloud (see more information here)
- **Matt Johnson**, Bare Conductive Founder & Aspiring Polymath (see more information here)
- **Gustavo Giudici**, Co Founder en Bastly (see more information here)

The discussions and criteria that lead to make the decision on the winning hacks are summarised as follows:

- **High note** (used Ircam R-IoT sensor): This was the most convincing demonstration and a very clear winner for the jury. It is a hands-free musical audio interface for disabled people or people with limited mobility. A wireless in-mouth musical controller combined with a motion sensor (IRCAM R-IoT) that tracks breath, bite pressure, tongue position, and head movements in several directions etc. The jury was really convinced by the demonstration but also by the engagement of the creators: *"They are already working on similar projects, so they seem to be committed to bring it further. They want to particularly develop it for their target users (disabled people), but it can also be used in music therapy and has a number of wider applications. As they were very much interested in the #MusicBricks Incubation program it only makes sense to award them for this program."*

- **ear we go** (using the Essentia library by Music Technology Group, UPF): Also very clear winner for the jury: the jury was impressed by the convincing presentation and the chain of #MusicBricks analysis tools that are used to generate the result (Beatport - BPM - Essentia - Key - Juce - extract features - create loops). An acoustic guitar (or any other instrument) controlling loops to play along was considered a very nice idea. Though a lot of technology in the background, the idea is simple to understand and a lot of fun: *"This has a lot of potential in the consumer market: Music participation for beginners - you can jam alone, find new music, or people to jam along with. This project will clearly benefit from #MusicBricks incubation and has a great potential in the consumer market."*

- **Sound in Translation** (used TU rhythm timbre + Fraunhofer transcriber): It was a bit of a difficult decision because the demo setup did poorly work and it was hard to get the essence. The jury however liked several aspects of it: *"First, because of its novel innovative idea to generate and map sound samples on a MIDI matrix board: each time the musician plays samples in a row, the next matrix row is populated by sound samples sourced from songs found via audio analysis, music similarity, onset detection and beat mapping. Second, because it uses a clever combination of #MusicBricks. Also the idea of playing the 'Snake' game on the matrix board to generate sounds was nice. The entire setup seemed a bit overkilled and not quite finished. But in the end this has a lot of potential if polished during the incubation period, because a) it can benefit a lot from the #MusicBricks tools and proper know-how that is put into it and b) it has the potential of*

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both becoming a commercial product (music instrument for generating samples) and being used in performances."

- **Enboard - Skateboard** (used the Ircam R-IoT sensor): Although the demonstration had difficulties in getting set up the jury really liked the simple idea of putting a gyro-sensor and accelerometer (IRCAM R-IoT device) under a skateboard and enabling so many things with it: *"The short demo showed how it triggers / creates sound and also very compelling visual output. In the first moment it looked just cool. The usefulness was discussed; the jury saw that this is extendable in many ways and has a lot of potential: detect moves, select or transform music depending on analysis, combine with the smartphone via app over Wifi or bluetooth; create visuals / video while skateboarding, etc. - or even combine with Orphe shoes. There is a lot of open room for much more ideas and applications."*

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4. Case Studies, Impact Data and Statistics

It is useful to follow a few of the participants on their journey through the event to help assess how teams are formed, what drives them and where they might go next. Much that happened at the Creative Testbed events can be significant for participants regardless of the outcome of the competition - e.g. three of the described case studies did not win #MusicBricks project incubation, but there is much knowledge to be gained from analysing the impact of the experience and the potential for further development.

Partner facilitators worked through the night with creative developers during the Creative Testbeds and chose to describe particularly interesting studies of participants' behaviours and what drove them to collaborate with others. We have preserved their anonymity for the sake of this public report, however these personal accounts on behalf of three of our facilitators offer insights into the dynamics of the open collaborative innovation processes.

4.1.#MTFScandi Case Studies

4.1.1.Case Study 1: Open Methodology

Thanks to purposefully open-ended challenges, and the high quality tools & APIs available from the #MusicBricks research partners, the selection of different types of projects created by participants was especially varied. The presence of representatives from each #MusicBricks partner was a substantial help, as their support enabled participants to spend less of their 24 hours getting bogged down in technical problem solving, and spend more of their time implementing the #MusicBricks tools in creative & innovative ways. The quality and completeness of the provided tools, as well as their documentation, encouraged participants to work outside of their comfort zones or usual areas of expertise, and the result of this was that some highly innovative & well thought-out projects were created with those tools.

4.1.2.Case Study 2: Rapid Knowledge Transfer

One excellent example of this came from a Hack Camp participant local to Umeå who described himself as a highly proficient C# coder but who had never made any attempt to code a music/audio related project. He was particularly interested in physical interaction and after the #MusicBricks partner presentation decided to use the IRCAM R-IoT sensor board in his project. He was mentored by Adam John Williams, the Hacker Manager (Stromatolite) while he worked on his project. At first he was considering attempting to read the messages coming from the board as OSC-packets directly within the C# environment he was used to coding with. From the Hacker Manager's experience it seemed likely that this would end up being an incredibly time-consuming approach and that it would possibly affect his ability to produce a working demonstration of his idea in time to present it. Once the Hacker Manager had demonstrated the amount of the complex technical work which had already been done by the IRCAM team and integrated into the provided Max MSP patches which accompanied the R-IoT board, he seemed less daunted by working with a totally new workflow & programming environment. The Hacker Manager spent a few hours throughout the night giving him a Max MSP masterclass and helping him integrate the new skills he had learned into his project, and as a result of this he ended up creating an innovative & accessible gestural controller for music selection and playback, and his project was selected by the judges to go forward for #MusicBricks project funding.

4.1.3.Case Study 3: Ease of Integration of Various #MusicBricks

Another side-effect of the provided #MusicBricks tools being highly complete & well documented was that teams seemed undaunted by the prospect of incorporating multiple different #MusicBricks tools within their projects. This led to the realisation of highly ambitious projects containing combinations of tools from separate institutions, which would otherwise not normally be integrated in single projects alongside each other outside of the institutions which created those tools. One such example integrated the R- IoT sensor board as well as one of the music analysis APIs which were provided by #MusicBricks partners, to create

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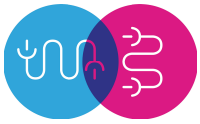

an instrument which would enable people of varying levels of musical and physical ability to gesturally play along to songs of their choice by utilising simple & intuitive hand gestures.

4.1.4.Case Study 4: Rapid ICT Skills Transfer to Design Professionals

Three designers were inspired by #MusicBricks to create a beautiful physical interface and attempt to program it to be used with the #MusicBricks technology. None of them were experienced programmers, however they had a simple yet powerful idea. They were also proficient at using 3-D printing technologies and were able to execute the physical product idea very well. With some tuition by the Hacker Manager they were able to master the programming basics, though not sufficiently to have a fully-working prototype. Judges felt that the team had great potential and ought to be encouraged to progress further, despite not being in the top 4 teams to be awarded #MusicBricks incubation. #MusicBricks partners Fraunhofer offered to mentor the team and encourage them to progress towards the third Creative Testbed at #MTFCentral in Ljubljana, on the 18-20 September 2015. The team will be encouraged to attempt at winning the #MusicBricks incubation for the second time, and use the Fraunhofer mentorship and preparation time to develop their programming skills further.

4.2.Sonar+D Music Hack Day Case Studies

4.2.1.Case study 5: Successful Entry Point for Accessibility Specialist

A participant from #MTFScandi dedicated to the design and production of digital musical instrument interfaces for people with varying physical ability was interested in continuing this work at the Music Hack Day event using the #MusicBricks R-IoT Gesture Sensors which he had seen demoed by Hack Camp participants at #MTFScandi. Having limited programming skills and having missed the workshop day, he found help from a student at Universitat Pompeu Fabra in Barcelona.

This work focused on making a mouth instrument, especially adapted for disabled people. It allows to play only with the head and mouth, without the arms or other body parts. The team expressed their interest for several #MusicBricks tools but focused on the first that would help them to achieve their primary goal: the RIoT board from Ircam. Detecting the orientation of the instrument, the sound generated would be of higher or lower pitch. This task is pretty straightforward with the R-IoT and the Max/MSP tools provided by Ircam. However, they came with a breath sensor (working in and out) that would control the amplitude of the sound, very important for the instrument expressivity. The technical challenge for the team was to add the sensor to the Ircam board. With some help from the Ircam team, they easily achieved this objective and could add this additional feature.

The lessons learned from this experience is that it is relatively easy to augment this brick. However it made the partners realise that we should document how to do so and enable the code update to the microcontroller from any platform as soon as it is technically possible (now restricted to Windows). This seed prototype is a good example of a potential product using #MusicBricks and was selected for the incubation program.

4.2.2.Case study 6: Identifying Specialist Developer Needs

Another team at MusicHackDay Sonar did a great job with a work focusing on enabling people with no musical skills to enter a jam session. This system would analyze the music generated in realtime and offer a simple interface (simple pads like the Akai MPC or Ableton Push), using pre-selected samples that would fit the current context (harmony, timbre, rhythm). The challenge was to use the current technology in a realtime environment. They used the UPF tools Essentia in a realtime version.

The partners realised that this example illustrates one clear need for the creatives during those sessions: they want realtime bricks. If the tool is not realtime, they would find ways to use them with its limitations, but partners should focus on offering as many realtime versions of the bricks as possible.

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4.2.3. Case study 7: Impacts Outside of Incubation

A group of developers from London and Berlin were keen to explore the potential of the #MusicBricks to realise novel ideas rather than focusing on winning prizes. They already knew each other and had a firm bond but didn't have pre-conceived ideas about what they would make.

During the 24 hour Music Hack Day they came up with an Android mobile application that used the #MusicBricks real-time pitch detection algorithm to transmit pitch data from the mobile phone microphone to a desktop application via Wi-Fi. The application then creates MIDI events which are sent to a VST or AU synthesiser. This ingenious device allows anyone, however well they can sing, to hum a melody into a phone and then have that melody transcribed to real midi note data to be played back (potentially far more tunefully) by a synthesiser.

The application was very nearly awarded #MusicBricks incubation though lost out to an application which was deemed similar by the judges. The developers were keen to know about ways in which they could remain involved with the #MusicBricks project despite missing out on a prize and were further keen to develop as far as possible without incubation assistance. Despite not gaining incubation, it is recommended that the #MusicBricks consortium keeps monitoring their progress.

4.2.4. Case study 8: #Musicbricks Prove Useful for Unleashing Creativity

A participant arrived at the pre-event #MusicBricks workshop late, without knowing anyone else there and very unsure as to whether a Music Hack Day was for him. Despite having a background in coding and a strong creative bent he was not musical and had never made anything relating to music. Furthermore, his delayed entrance and only passing attention to the online information meant that he had little concept of what #MusicBricks were, or the incubation prize on offer.

During the morning break the #MusicBricks team supplied him with all the information he had missed and helped allay his concerns. His initial fear was that his lack of musical experience and no team mates meant there was little he could offer, however he was assured that our experience from projects such as EU FP7 ICT&ART Connect showed that effective teams are made from members with differing skills and backgrounds and that events such as this are the best place to find potential team mates. During the rest of the day John showed great enthusiasm in finding out all he could about the #MusicBricks tools and teamed up with an experienced programmer at Universitat Pompeu Fabra, Barcelona.

By the start of the Music Hack Day, he had two strong ideas which he was interested in pursuing: an idea to create a "musical massage bed" using #MusicBricks Melody Analysis and Real-time Pitch Detection tools, as well as a potential reverse engineering of the R-IoT Gesture Sensors. Users would lay on the "bed" whereupon hundreds of small pistons contained within the device would massage the body in response to a music file being played - similar to a graphic equaliser read-out across a 3D space. The potential of this device was for a wide range of applications from home or health spa relaxation, to 'musical chairs' for nightclubs or other leisure environments, to sensory stimulation for the deaf.

His second idea was a mobile application game based on a 5th century Scots tradition allowing two contestants to battle musically onstage using gloves, incorporating the #MusicBricks R-IoT board, whilst the audience voted with their mobiles to decide who's winning. John teamed up with a student from University Pompeu Fabra in Barcelona to realise this second project for the competition. Although the team managed to create a great working demo of the software, the hardware failed during the judging demonstration and the project was not chosen for incubation. However, the team are encouraged to progress with their project and work towards a functioning prototype for the next Creative Testbed.

4.2.5. Case study 9: #MusicBricks Workshop, technical results

During the pre-event, one day before the MusicHackDay at Hangar in Barcelona, each partner focused on their tools and presented a theoretical session, followed by a hands-on sessions. This event was a great opportunity for hackers to get prepared and learn about #MusicBricks tools. It was for us a very useful way

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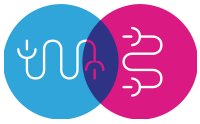

to see how easy to use our bricks are. We identified positive and negative feedbacks that we summarize here:

- In practice, people are very enthusiastic about the tools. They were active in trying to understand the work behind them and motivated to install and work with all the tools from #MusicBricks. Several bricks are easier to use than others and the first attempt for any hacker is crucial. If they can install in a short time, they are most likely to use it. Or, simply put, if they have installation problems, we are quite sure they won't use it.

- The easiest approach was to use binaries for all current platforms such as Mac, Windows and Linux (e.g. Fraunhofer). Having to compile from the source code was a problem for the hackers as many dependencies and installation steps are difficult to follow (this was the case for the Essentia workshop for instance). Having a mandatory registration step can be blocking but this is also a nice way to follow up. Having a simple registration step would enable to then follow and ask feedback from #MusicBricks users.

- The most interesting way to make tutorials has been to use the iPyhon notebook (or any similar live testing alternative, e.g. TU Wien). This is a particularly great tool to document a tutorial and execute the code inside it. This is only for libraries using Python (or Python bindings), but it is the case of most tools from #MusicBricks.

- At the actual MusicHackDay we had great adoptions of the technologies. A third of the hacks used #MusicBricks, even with strong technology competition from the likes of Nao robots, Epson smart glasses, RapidMix project etc.. This event also allowed our teams to enhance their technology to match hackers needs. We followed people during the whole process and now have a list of very relevant feedback summarised in Section 5.2.

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4.3.Impact Data

#MusicBricks has proven extremely popular as a system of tools for generating new ideas. Social activity shows widespread interest from followers and the social impact data is extremely high for M6 of the project: 827,423 impacts and 579,052 reach on 24 June 2015 over the period of 1 month of social activity.

Binders details

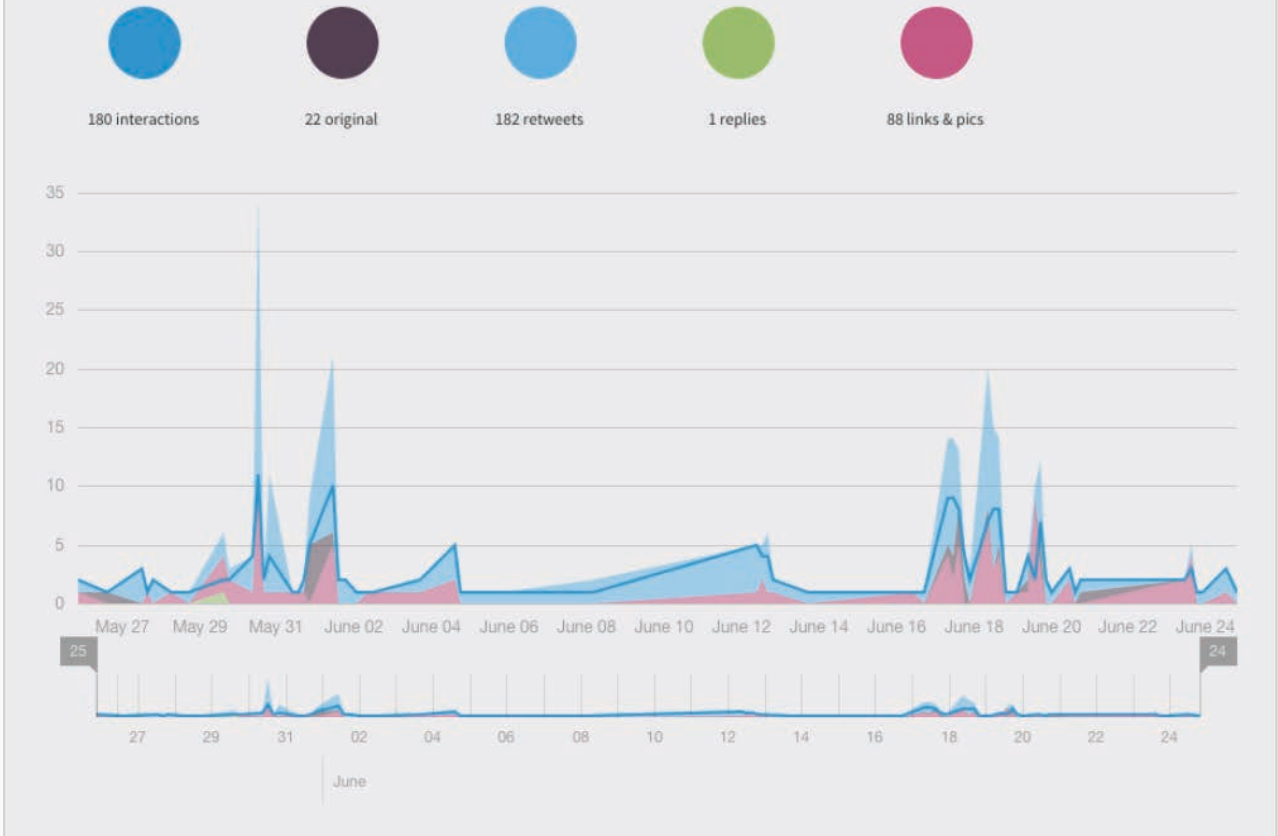
Binder	Tweets	%Total	Impacts	Reach	Contributors	Tweets/contr.	Follow./contr.	Links/pics	Retweets
No binder	292	100.00%	827,423	579,052	71	4.11	3,426	88	182

General overview May 26, 2015 4:41:41 PM - Jun 24, 2015 8:22:59 PM

292 tweets

22 Text tweets 8.21% | 182 Retweets 67.91% | 1 Replies 0.37% | 88 Links/imgs 23.51%

Activity



#MusicBricks was promoted through existing pilot portals, but due to the widespread interest it now has its own Facebook page and has already started to gather likes.

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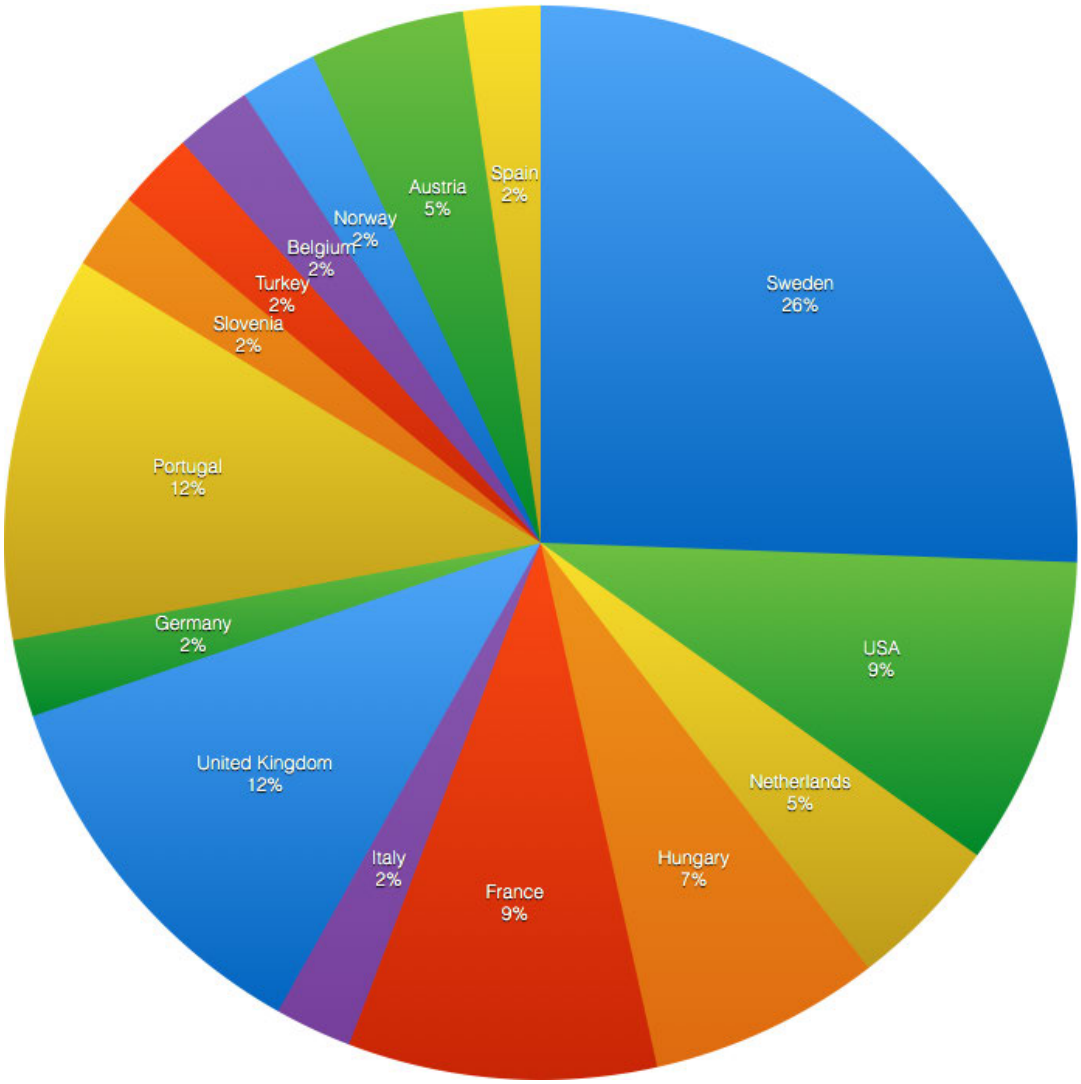
4.4.Statistics

4.4.1.#MTFScandi

43 out of the 50 hackers at #MTFScandi participated in the data survey identifying their country of origin, their specialism and gender.

Due to #MTFScandi being held in Umeå, Sweden, the largest portion of participants came from Sweden, even though some of those were born in other countries (e.g. the #MusicBricks incubatee Rojan Gharipour is originally from Iran). Out of the participants who arrived from Germany, one was Australian, and one Israeli. All three authors of the winning prototype *Airstrument* are originally from Israel - a fact which is not reflected on this data chart. In summary, the participants in the #MTFScandi Creative Testbed were culturally very diverse.



Participants were also widely distributed across a range of specialisms. Due to the interest in #MusicBricks, we were joined by many designers who attempted programming for the very first time. Equally, there was a range of musicians and artists who wanted to experiment with the new tools. In three out of four winning teams, one member is a musician or an artist.

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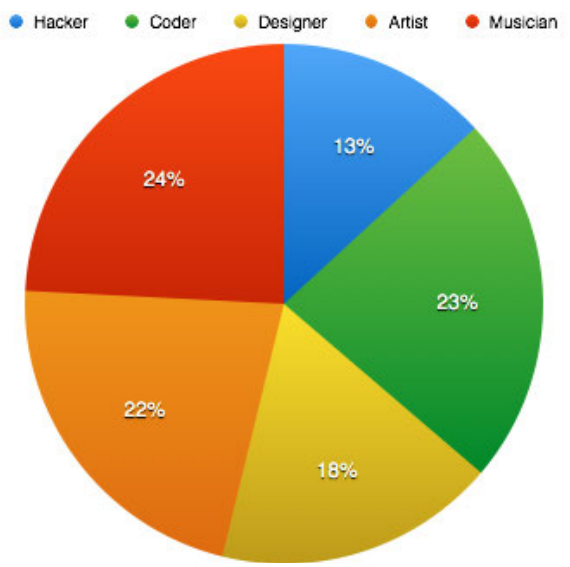
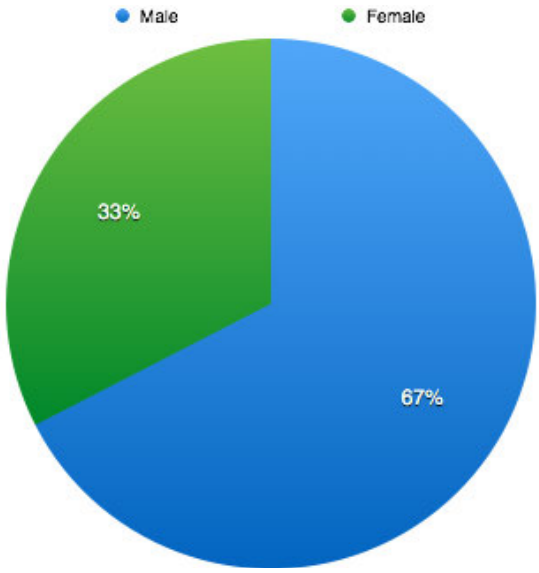
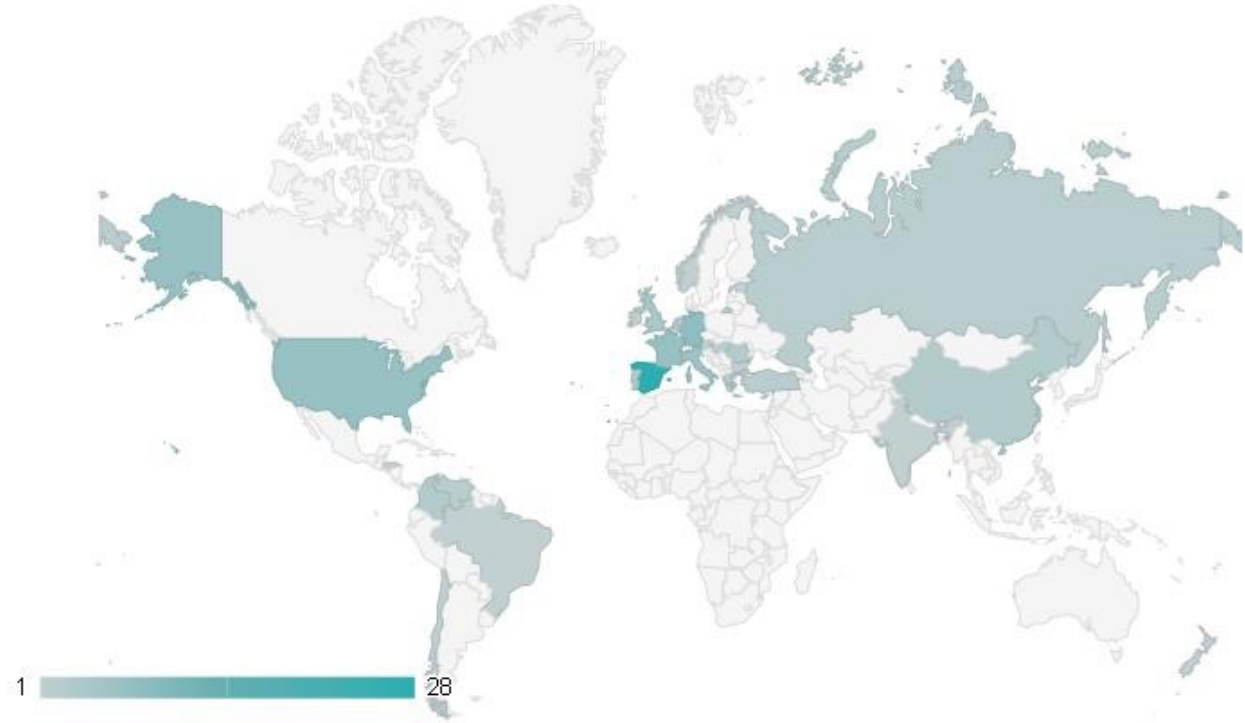
The ratio of male to female participants was an improvement on most events which combine art and technology: one third of the participants were female, and three out of 8 overall winning teams had female members, including one of the #MusicBricks winners.





4.4.2.Barcelona MHD

Following the tradition, this year the Barcelona MHD has been a quite **international** event with 100 hackers coming from **28 different countries** in **4 continents.**



17% of the participants were women. This is **better than previous years** and shows a **positive tendency**, but we know we can and we want to do better than that.

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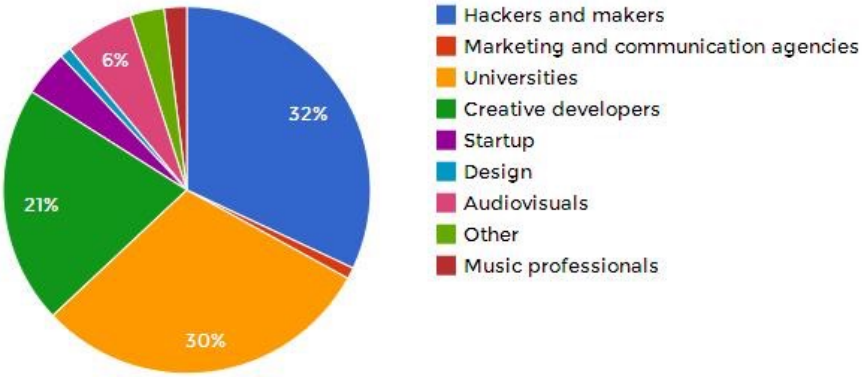
In order to keep improving in this aspect in the following years, we plan to collaborate with existing initiatives aiming at empowering female programming learners, like PyLadies or Berlin Geekettes. More women won't just make the Barcelona MHD "as good", they will make it better.

The event had a good mixture of **skill profiles**. We think this is an important factor for creating a good atmosphere for collaboration between participants, and we encourage hackers to form multidisciplinary teams. This is how the hackers defined themselves:

The **professional profile** of the hackers was also quite varied, with researchers, hackers/makers and software developers being the most common occupations.



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5. Creative Testbed Participant Feedback

5.1. Feedback on Creative Testbed Collaboration and Co-creation

Our intention at the Hack Camp for Music Tech Fest has always been to encourage the creation of projects which have a life beyond the end of the festival. Thanks to the #MusicBricks project that is now happening more than ever. The quality of the produced projects was consistently extremely high, and the attendees left the event inspired to continue on the paths upon which they had started, as shown by the feedback gathered from them after the event, some excerpts of which can be seen below:

- **Matan Berkowitz:** “Third time at the MTF Hack Camp and it just keeps getting better. As a producer of hackathons myself you'd think I'll have a lot of feedback to give, but it worked really well as is - and the results speak for themselves.”
- **Petter Ericson:** “The hackathon was a really nice experience overall. Having access to various tools and materials both well-known and new to us (Polymorph) really helped us experiment and figure out not only what to do, but how. It was especially helpful, of course, to have people around which one could ask for advice or guidance.”
- **Ginger Leigh:** “Attending Music Tech Fest was an incredibly enriching experience for me. I learned so much during the 3 days of the festival - from the educational talks, to the inspiring performances - there were so many things to take in. Its rare to find so many creative people in one place, and being able to collaborate and share ideas at the Hackathon was an amazing opportunity that I will never forget.”
- **Horácio Tomé-Marques:** “Just to begin, I think that everybody in this email list might agree that you could say to the EU commission that we find that YOU are one of the most extraordinary hackers that intruded in our lives ;–} (and I really mean it). And you are a truly amazing hard worker, so they can — and should — keep sponsoring all the activities you are involved with…Secondly, a big warm hug to everybody in this list, for the amazing effort to devise something that each one believes and shares life energy to make it happen… And finally, but not lastly, we can tell you that we will try to take (raise) our project to another level. A level that we intend could be able to blow-up everybody's minds (literally ;–}”

5.2. Feedback on the use of #MusicBricks tools

5.2.1. Melody & Bass Transcription, Beat & Key & Tempo Detection API (by Fraunhofer)

The #MusicBricks Transcriber was used in the Sound in Translation project, one of the winning projects at MHD Barcelona, in particular the beat tracking functionality. It is also used for main melody and BPM extraction by Airstrument which won at MTF Scandinavia. From the feedback gathered during the hands-on workshop, the participants had no problems to run the tool, which was provided as an executable for different platforms such as Windows, Linux, and Mac OSX. One of the participants voted for supporting 24 bit WAV files. We are currently looking into this feature.

5.2.2. Realtime Monophonic & Polyphonic Pitch Detection API (by Fraunhofer)

The Realtime Pitch Detection library was used in at least one project during the MHD Barcelona, which involved an Android app for real-time transcription of hummed melodies and sending the transcription results as MIDI signals to a remote synthesizer app.

One of the developers initially had problems linking against the library for the Android app using the JUCE framework. The issue could be solved quickly after sending him a complete Android project as an example.

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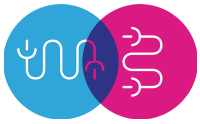

Apart from that, we received feedback from some workshop participants that providing sample projects for different platforms such as iOS, Android, and Mac OSX was a good starting point to get hands on the technology and think about ways how to integrate the Pitch Detection Library into own projects.

5.2.3.RP extract: Rhythmic and Timbral Audio Feature Extraction (by TU Vienna)

The Rhythmic and Timbral Audio Feature Extraction library (#RhythmTimbre) was used in one winning project each of the MTF Scandinavia and MHD Barcelona events. The following feedback has been gathered, and some of them have already been reacted upon for the second event:

- The installation requirements (Python dependencies) have been more complex than expected.
  → The provided tutorial has already been updated to better outline all needed prerequisites.
- Issue with reading 24 bit WAV audio files: Thanks to the hackers using 24 bit Wav files, an issue with normalization of the audio has been resolved.
  → This has been improved live in parallel to the MTF Scandi hackathon, providing the hackers an updated version in time to use it in their prototype presented at the final session (Airstrument project, awarded at MTF Scandi)
- Improved Error handling: When problems with a audio file (reading, decoding) appears, the library would stop the analysis of further files. This shall be improved to continue and write an informational log entry instead. In detail:
  - proper Exception handling → already improved during MHD Barcelona
  - adding Logging capabilities
  - add Error for too short wave data (requires a minimum of 5.94 sec of audio data)
- A feature request of returning not only aggregate audio features for a song, but also detailed segment level features has been received.
  → This has been reacted upon and been added as new capabilities of the library during MHD Barcelona. The #RhythmTimbre library now:
  - returns segment features
  - returns timestamps and sample positions of the segments
  - is able to return individual segment's audio data (and optionally export it)

  This enables a more accurate search of similar audio in a (longer) audio stream.
- Improvement of CSV export: When exporting features to a CSV file, there has been a problem with long filenames containing special characters such as “, ‘ or ,
  → This has been improved an a CSV read function added that is capable of handling all filenames with these special characters.

5.2.4.“Search by Sound” Music Similarity Retrieval API (by TU Vienna / Spectralmind)

This API was not used in the first 2 events but nevertheless we gathered some feedback in discussions with several hackers considering the use of the Search by Sound API:

- it seems very positive to be able to use music analysis without the need of installing any libraries or dependencies and completely use it online through a web server doing the audio analysis using a simple REST API

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- on the other hand, people who would like to use it expect more flexibility on what can be processed (mp3, wav via upload or from external services)
- and also the values returned: for now the API returns only similar song IDs together with distances; returning audio files alongside metadata is desirable (though the audio files might involve some rights issues)
- at least a link to the audio file on a web resource (e.g. freemusicarchive.org) shall be provided; this is to be checked for the next release

5.2.5.Melody Extraction API (MTG-UPF)

This API was presented in a workshop session in the scope of Melody Analysis from music signals. Many participants appreciated the general explanations on the different approaches to melody description (predominant, monophonic, polyphonic), and giving more conceptual insights beyond the technical documentation of the API. Some comments were gathered from participants:

- MIDI support could be a useful addition to the API. The current Melody Extraction algorithms only output pitch values per frame. Converting it to a note segmentation can increase its integration in creative usages such as controlling a MIDI synthesizer.
- This API requires to install the Essentia Library (http://essentia.upf.edu/). Essentia installation worked well for most participants. This consists of several steps and involves installing some additional libraries to the system. Some participants had some problems compiling if they not strictly followed the installation steps, but our support staff was able to help.
- This API is non-realtime. Some participants were concerned that for many hack ideas, the non-realtime implementations had limitations, especially for creating novel musical instruments. Some algorithms integrated in this API do not allow for a real-time implementation (i.e. Melodia) due to their internal structure. Still, for batch analysis-hacks (i.e. for music recommendation...) these extraction algorithms yield good results.
- This API offers Python bindings, so that participants could code in Python directly while using the Melody Extraction algorithms. There was a problem in the latest release of the Python bindings that was solved during the workshop thanks to the feedback.

5.2.6.Onset Description (MTG-UPF)

- This 'brick' is part of the Real-time implementation of the MTG's Essentia Library. It contains a subset of algorithms available as Puredata and MaxMSP objects.
- The feedback was very positive thanks to its real-time functionalities and off-the-shelf usage in Pd
- The specific improvements were demanded by participants were related to the online documentation. currently it consists of a Tutorial Patch, and the object help. We will provide further information about the functionality of "Onset Description" from a more general perspective.

5.2.7.Freesound 2.0 Web API (MTG-UPF)

- Freesound was used during the Creative Testbeds for some of the projects.
- Most of the usages were using content from FreeSound, and not explicitly using the web API in their projects.
- We plan to foster the usage of the FreeSound API in coming Creative Testbeds, by showing a Demo Application (Drum Machine) that combines Ircam's Gesture Sensor and a Web application.

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5.2.8.R-IoT Motion Sensing and Motion Analysis (IRCAM)

- The R-IoT is used in 6 of the 8 incubation projects. Several groups requested several of R-IoT for a given project.
- Hackathons were a good place to experiment with the various setups (computer, OS) of the user's. Some users asked to "bend" the configuration to their setup, which went smoothly in most cases except when the user wanted to avoid the external (provided) wifi router and instead use soft access point on his computer, which makes configuring his computer IP address cumbersome.
- Soft AP has been successfully tested on PC (windows) using MyPublicWifi to enable a hotspot on the machine to which the R-IoT can connect.
- The choice of the provided TP-link MR-3020 mini wifi router pleased everyone. Contestants enjoy both the small size and the ability to power the module via USB.
- Wired Ethernet tends to be forgotten and seen as old school, so many users didn't have their thunderbolt to ethernet adapter (newer Macbooks don't have a native ethernet plug). The user can still manage to connect to the provided router in wifi, but the data flow quality isn't as good as it's consuming radio bandwidth. Participants should be informed that they must bring an ethernet adapter or a computer with a native port to fully benefit from the motion sensing module.
- We yet have to make a variant of the firmware that uses Wifi-direct (a newer version of the former adhoc networks)
- The initial session at #MTFScandi showed an issue with flashing the firmware (or developing on the R-IoT platform) on Mac OS due to an incomplete driver of the serial port USB chip used on the board. With no answer from the manufacturer when asked to address this issue, we changed the design of the board to use another USB chip which was proven to work correctly, which now allows R-IoT to be programed by PC and Mac and becomes a real arduino-like development platform
- The second hackathon at #MHD had us add more features to the current firmware, in response to the demand of a participant. We added the support of the analog inputs of the module that are now exported in OSC just like the motion sensing data.
- All 10 modules along with 10 wifi networks were used during the hackathon and the R-IoT module showed no connection issues despite the very high ambient RF "noise" and signal load.
- The absolute angles are now fully reliable and usable which allows the module to be used as a head tracker.
- Users reported their enjoyment of using the unit, liking in particular the size / form factor but also the runtime. The battery size remains the limiting factor of the size, a round battery was selected only to allow safe plane transportation while complying with aircraft regulations regarding li-ion batteries which had to remain removable from the device. We keep looking for a reliable source of lipo (flat) batteries as a replacement
- Users should be warned more about the need to recharge the battery / module using the provided USB cable. The long runtime (6hrs) tends to fool most users who tend to forget about checking the battery level (provided as a Voltage, which could be improved with a graphical feedback), then the battery ends up being totally depleted in the last (critical) part of the hackathon during which the system needs to be operational.
- Proposing the motion recognition patches & objects in MaxMSP received a good feedback. Nevertheless, there was also a demand to have those ported to other environments such as Pure Data (PD).

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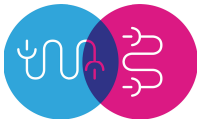

6. Conclusions

The following general conclusions can be drawn from observing the use of #MusicBricks at the Creative Testbeds:

Positive feedback:

- Great adoptions of the tools
- Many hacks using #MusicBricks at MusicHackDay Barcelona

Recommendations:

- Distribute compiled versions for Mac, Windows, Linux
- Tutorials with example code. If using python, iPython notebook is a great tool
- Realtime version of the tools when possible

The social media analytics show very promising results, with Twitter excelling at over half a million reach, the new #MusicBricks FaceBook channel starting to pick up now, and regular, buzzing activity over the newly opened #MusicBricks Slack discussion channel, where partners and the awarded incubatees have regular exchanges.

The general interest, enthusiasm and adoption of the tools in the first Creative Testbeds has exceeded expectations. Challenges still remain in ensuring more robust prototypes and securing a place in the market for the innovative seed ideas. However, the ease of adoption and the range of creative ideas demonstrate #MusicBricks as a successful model of an Open Product - a set of tools which inspire and stimulate Open Innovation.

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