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JRC Thinkers 'N' Tinkers Makerspace

Concept Note

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Thinkers 'N' Tinkers Makerspace

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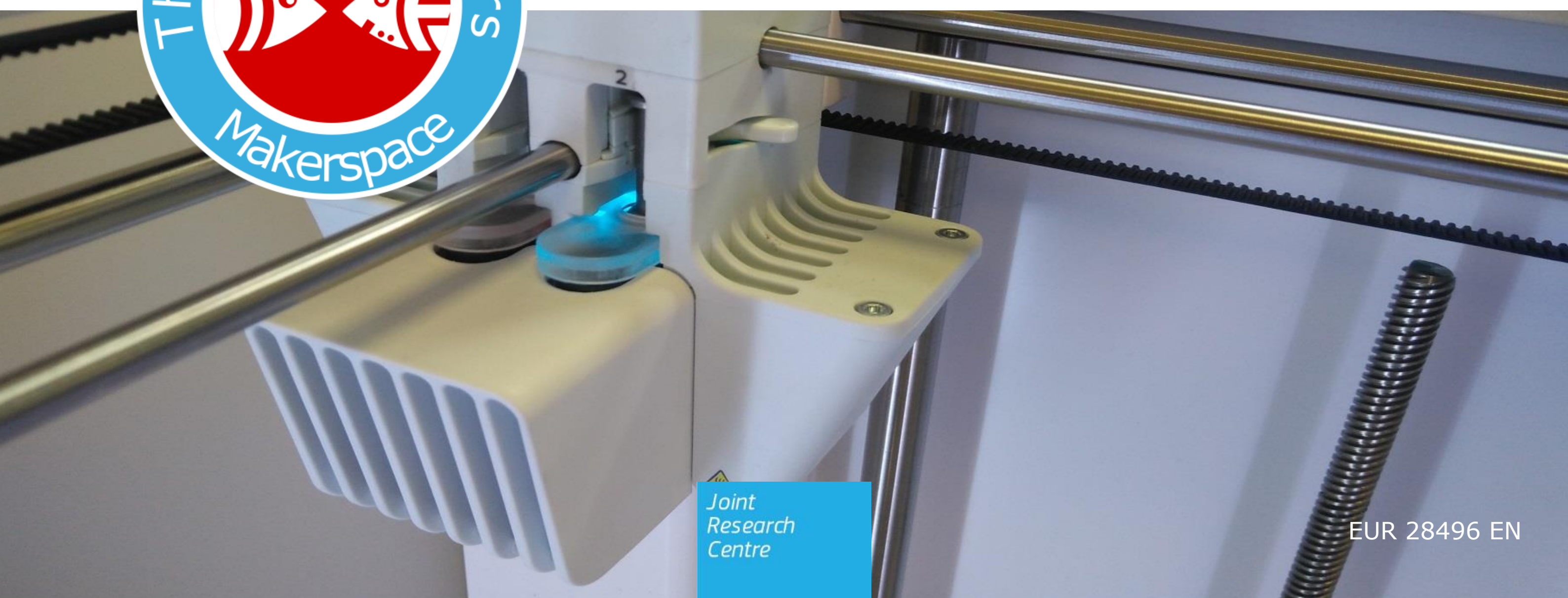

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Abstract

In this concept note, we make the case for creating an in-house makerspace oriented towards the engagement of citizens in technoscientific innovations: the *JRC Thinkers 'N' Tinkers Makerspace*. The idea behind the makerspace is to have a space located in the premises of the JRC that promotes critical thinking and tinkering about technoscientific issues relevant for policy files focusing on their societal implications. We view it as a *safe* space where we can promote dialogues with civil society through engagements that move beyond discursive methods.

Overall, the *JRC Thinkers 'N' Tinkers Makerspace* aims at:

- Develop and experiment with deeper forms of societal engagement and deliberation on technoscience governance;
- Foster internal and external collaborations across different ways of knowing (e.g. science, humanities, politics, arts, as all these areas of society are relevant to ensure quality of societal action and public policy);
- Explore approaches of quality assurance of policy relevant science based on the post-normal science[1] concept of "extended peer review";
- Nurture a culture of critical and reflexive thinking at the JRC;
- Tackle global issues through the application of dedicated local resources.

[1] Post-normal Science (PNS) is a concept developed by Silvio Funtowicz and Jerome Ravetz in the early 1990s which suggests a methodology of inquiry that is appropriate for cases where "*facts are uncertain, values in dispute, stakes high and decisions urgent*". It is based on quality assurance by an extended peer community, composed by all actors that are potentially affected by particular policy issues. See: Funtowicz, S. and Ravetz, J.R. (1993): "Science for the Post-Normal Age". *Futures*, 25 (7), pp. 739-755.

1 Introduction

In the last decade, we have witnessed a global proliferation of open, community oriented, physical spaces that employ "*making*" and "*tinkering*"[2] as a deeper form of engagement. These spaces, generically known as Makerspaces, provide novel opportunities for expression and can be used to trigger new interest or deepen existing enthusiasm in science and technology issues.

Makerspaces are often valued for fostering new forms of collaboration and education in STE(A)M[3] related fields but also as spaces that foster grassroots involvement in societal matters[4]. They encourage active participation and experimentation as well as the share of experiences and expertise. Indeed, makerspaces can have a transformative and empowering role by grasping and nurturing individual capabilities for the benefit of the entire community. The Makerspace concept was developed out of do-it-yourself (DIY) culture and, as a result, a strong hands-on approach is always present. Each space is commonly equipped with a set of tools and fabrication equipment that allow individuals to create, hack, and remake their "world" as they see appropriate. In sum, Makerspaces provide individuals with access to both the collaborative knowledge and know-how of the community behind each space (whilst fostering collaborative problem solving) and the necessary tools and equipment to turn their ideas into reality[5].

We consider Makerspaces also unique spaces for dialogue, offering *natural* opportunities for engagement of citizens in matters that interest the quality of policy processes. When it comes to policy processes, classic formats of public participation commonly emphasize formalized mechanisms of dialogue and deliberation, which are not necessarily the most appropriate ones to enquire citizens' expectations, imaginaries and suggestions. Makerspaces, complementarily, can be used to explore more open and creative forms of engagement and issue framing. They can be employed for collective and collaborative experimentation, where critical approaches to technoscientific innovation are explored through material deliberation[6]. In this scenario, the concept of "*tinkering*" has a fundamental role as special attention is given to approaches that explore the crafts, skills and creativity of those being engaged, as well as privileges the material and experience of the issues that are being tackled (e.g. if we talk about health, we can use the actual objects (materiality) of that proposal such as wearable sensors, apps and other relevant objects that interest our discussions. A sense of play is promoted when creating the so necessary space for the critical reflection. The outcomes that can materialize from makerspaces can be inspiring as they often offer new approaches for looking into (and tackling) the societal issues that concern us all.

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[2] The philosophy behind tinkering is based on the playful celebration of discovery through inquire, exploration, prototyping, and iteration. For a deeper insight see: Resnick, M. and Rosenbaum, E. (2013): "Designing for Tinkerability". In Honey, M. and Kanter, D. (eds.), *Design, Make, Play: Growing the Next Generation of STEM Innovators*, pp. 163-181. Routledge.

[3] STE(A)M: Science, Technology, Engineering, (Arts) and Maths.

[4] See: Nascimento, S., Guimarães Pereira, A. and Ghezzi, A. (2014): "From Citizen Science to Do It Yourself Science". JRC Science and Policy Reports.

[5] See for instance: Walter-Herrmann, J. and Buching, C. (2013): "FabLab: of Machines, Makers and Inventors". Transcript Verlag, Bielefeld.

[6] "Material deliberation" refers here to non-traditional modes of deliberation and citizen engagement which incorporate more open and interactive forms of engagement such as, but not limited to, the sonorous (e.g. music, noise), the discursive (e.g. storytelling), the material (e.g. objects, places) and the affective (e.g. emotions raised in specific settings). See: Davies, S.R. et al. (2011): "Citizen engagement and urban change: Three case studies of material deliberation". *Cities*, 29 (6), pp. 351-357.

Case Example – UNICEF Innovation Labs:

In 2010, UNICEF started an ambitious network of innovation labs[7], "*recognizing that best practice applications require an intimate understanding of challenges at the grassroots level*". According to UNICEF, "*innovation labs combine UNICEF's hyperlocal knowledge with global scale*". By making local communities a part of the innovation process, it becomes easier to identify, adapt, and scale solutions.

The project started with the conception of four Innovation Labs in Kosovo, Uganda, Zimbabwe, and Copenhagen, and passed six years, it counts with 12 labs. Each lab has a unique focus, strategy, and partners. For example, "*the lab in Kosovo works with technology created in Prishtina, in Kampala, and elsewhere, and adapts it to the needs of a young, determined population. The lab in Uganda connects academia from the US, Europe, and Kampala, and creates system change at a national scale. The CCORE lab in Zimbabwe takes best practices from the world of operational research and applies them to pressing programmatic issues*". For UNICEF, the added value of having a network of labs is that "*learning can happen globally, and mistakes can be caught early on and corrected quickly in the future*".

[7] UNICEF (2012): "Innovation Labs: A Do-It-Yourself Guide". Available online at (last access April 2016): http://www.unicef.org/videoaudio/PDFs/Innovation_Labs_A_Do-It-Yourself_Guide.pdf

2 JRC Thinkers 'N' Tinkers Makerspace

Following the introductory note above, we conceive the *JRC Thinkers 'N' Tinkers Makerspace (TNT)* as a collaborative open space, designed to promote active participation, knowledge sharing, and citizenship through open-ended experimentation and exploration. It will be an opportunity to explore new methodologies of citizen engagement, as well as on recent phenomena like citizen science and DIY movements as more profound and care-oriented forms of societal participation in technoscientific innovation processes. Equally important, it will be used to investigate how these loci of knowledge production speak to the policy realm and the issues of quality that they trigger. In this sense, the TNT makerspace will be a space for experimenting on two different levels simultaneously: first, it will be a place to tinker with potential solutions for contemporary societal problems; and second, it will be a space for probing and testing different modes of collaboration and engagement.

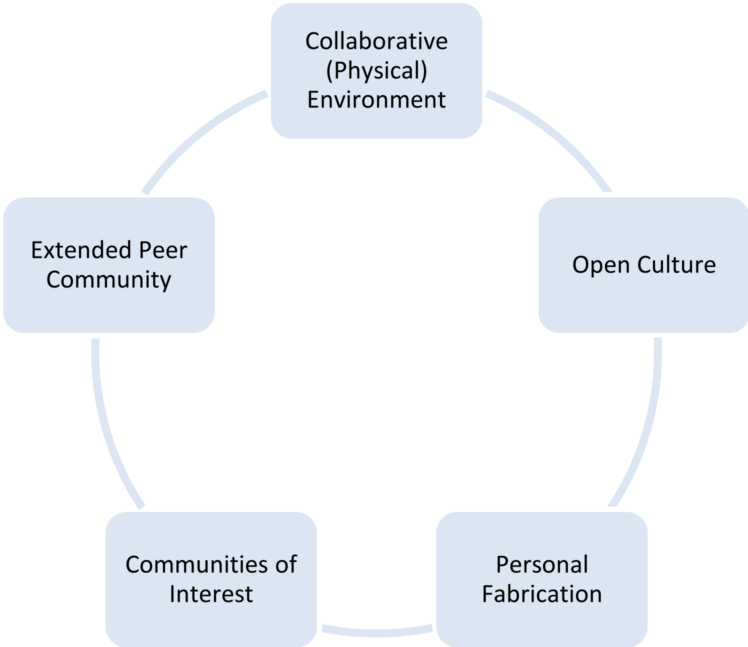
The framework of the makerspace follows the work developed by the STS team in the Quality Assurance Hub[8]. It is based around the broader concern of providing quality assurance for policy relevant science, recognising that quality assurance needs to be naturally performed collectively and collaboratively in continuous engagements, the makerspace being a fundamental space to sustain this "extended peer review" process.

The makerspace is to be located in the premises of the JRC, open and accessible to the local community. As it is conceived as a space for "dialogue" between different ways of knowing from science, arts, humanities and politics, the space will promote the active involvement of different expertise starting from in-house expertise. Hence, the TNT makerspace will consist of a multidisciplinary space where any person, regardless of their age, gender, ability, or status, can feel comfortable and included in collaborative working, prototyping and critical thinking. Dialogue will be nurtured through the organization of a series of events such as prototyping workshops and tinkering sessions on specific policy matters relevant to the JRC.

Broader collaborations with other makerspaces are also fundamental and foreseen; initial contacts were already established in this direction (see section 3). It is expected that these collaborations will end up resulting in meaningful partnerships, expanding the role of the *JRC Thinkers 'N' Tinkers Makerspace* within the maker community.

At its core, the *JRC Thinkers 'N' Tinkers Makerspace* is sustained by five interconnected elements:

[8] See "Aleph - Proposal for a quality assurance hub at the JRC", March 2016 by the JRC-STS team.



- Collaborative (Physical) Environment: The *JRC Thinkers 'N' Tinkers Makerspace* will function as a multidisciplinary learning environment that stimulates new ideas and concepts whilst enhancing existing practices and expertise. In this sense, the space will take advantage of its community knowledge, as well as from the greater creative input associated to collaborative communities.

- Extended Peer Community: The dialogue on quality, along with that on policy, must be extended to all those who have a stake in the issue, that is, to the extended peer community – a "post-normal science" concept.

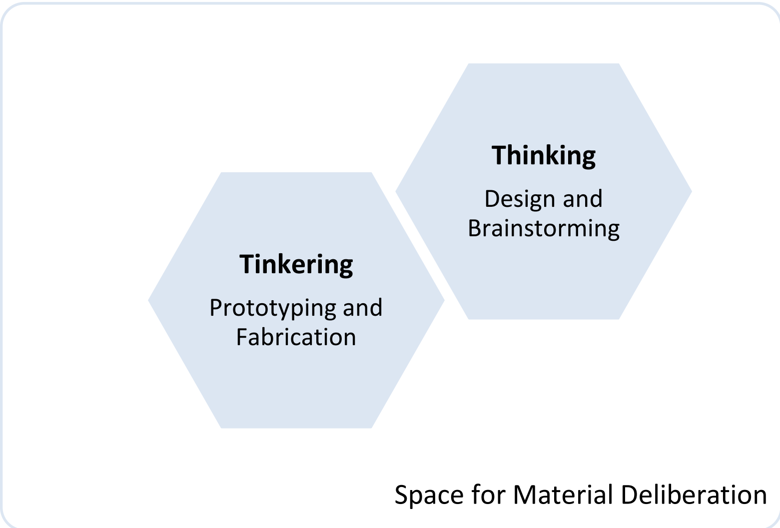
- Open Culture: The *JRC Thinkers 'N' Tinkers Makerspace* is oriented towards the creation of an environment that fosters the sharing of experiences and expertise. It promotes the use and creation of open content and data, including open hardware and software. By following a creation process based on the unconstrained access to documentation, manuals, source code or design blueprints, we are opening our projects to anyone who wishes to reuse, revise, remix, and further redistribute them. It becomes easier for anyone in the world to pick up our work and continuously improve it or to simply change it to reflect something that better suits its needs.

- Communities of Interest: The development of a community or network of partner makerspaces' facilitates the creation of new knowledge from existing knowledge as well as the overall process of knowledge dissemination. Communities can tackle problems with novel approaches as they are formed by individuals with different experiences and expertise, thus bringing different perspectives to community. Moreover, it re-enforces the collaborative aspect of makerspaces by allowing individuals to work and collaborate remotely in projects they find relevant and for solution to be implemented anywhere they are needed. Collaborating with different makerspaces can as well be a way to comparatively look at different maker cultures and thus to explore how innovation is "made" in culturally specific ways.

- Personal Fabrication: Personal fabrication technologies allow the rapid prototyping of tangible objects with a high level of quality. They make designing new, highly customizable, devices risk-free and low-cost. In the context of *JRC Thinkers 'N' Tinkers Makerspace*, personal fabrication opens new ways for personal expression and allows ideas and concepts to be easily transformed into tangible objects. They hold a transformative power and enable self- empowerment. In the remaining of this section we will provide a thoughtful sense of the makerspace as a physical structure by addressing tangible aspects related to the creation of a makerspace such as the physical space in itself, the prototyping/fabrication technologies, and foreseen activities.

2.1 Physical Space Structure

The *JRC Thinkers 'N' Tinkers Makerspace* is envisaged as a multi-faceted space capable to house a diverse array of functions and activities, from citizen engagement and deliberation sessions and training activities, inspiring workshops to prototyping events and DIY festivals (see section 2.3 for a detailed list). Such activities will be connected to policy files that are developed in different units at the JRC. Hence, the space in itself has to be easily adaptable and reconfigurable to multiple layouts in order to accommodate different working dynamics. Indeed, the physical infrastructure of the space must not only foster and support a variety of activities but also the "cross-pollination" of activities, a critical element to the making and exploration process. Hence, the space in itself is structured in two dynamic environments, one tailored for thinking and the other for tinkering:



- <u>Thinking Environment</u>: Creative environment designed to accommodate relaxed group discussions and collaborative design work. Can be adapted to accommodate group meetings, project presentations and short seminar talks.

- <u>Tinkering Environment</u>: Work environment tailored for hands-on (hardware) prototyping and for housing the digital fabrication equipment (see section 2.2). It is equipped as well for computer work (from research work to CAD modelling). Materials and tools become the means not only to enable creation but also make visible toughs, feelings and ideas (i.e. to enable expression).

2.2 Personal (Digital) Fabrication Technologies

Makerspaces are commonly known by having a set of personal digital fabrication technologies aimed at the creation of physical objects from a digital design. Personal fabrication technologies allow ideas and concepts, or at least the digital representation of these, to be prototyped and transformed into tangible objects. The table below lists a set of fabrication technologies that are anticipated to be needed in the *JRC Thinkers 'N' Tinkers Makerspace*:

3D Printer *	3D Printing is an additive manufacturing process that allows the creation of physical objects, layer by layer, usually through the extrusion of a thermoplastic material from a movable print nozzle. As the thermoplastic material is extruded, it hardens almost immediately, forming the various layers that compose the final physical object.
Laser cutter *	Laser cutting is a subtractive process, and uses a high intensity focused beam of light to engrave or cut out shapes in a wide variety of material, from wood to acrylic. Laser cutting can be so accurate that the cut shapes can be made to snap together, thus allowing the quick assembly of complex 3D structures.
Sign Cutter *	Sign cutters, also known as vinyl cutters, use a computer-controlled sharp blade to perform precise custom shape cuts out of thin sheets of materials like paper, cardstock, and vinyl. It is also possible to use them to cut thin copper sheets in order to quickly make functional flexible circuits.
Computer Numerical Control (CNC) Milling Machine	CNC milling is a subtractive process that uses a high speed rotating cutting tool similar to a drill bit to carve and cut precise three-dimensional shapes into a wide range of materials like non-ferrous metals, hardwoods, and plastics. CNC milling machines allow the rapid realisation of complex cuts with extremely high accuracy which otherwise could not be easily duplicated by hand.
Printed Circuit Board (PCB) Milling Machine	PCB milling machines are high-precision (micron resolution), two-dimensional, desktop size milling machines, and are used to create circuit traces in pre-clad copper boards by removing the undesired areas of copper.

* Essential equipment

The JRC has already some of these fabrication technologies in its premises (e.g. 3D printers), spread across various units. The makerspace could start by listing the location of the equipment available and whenever possible coordinate its use with the group responsible. If a machine is not in use anymore it could be repurposed to the makerspace. A preliminary list of equipment available and committed to the makerspace by the units collaborating in this endeavour is provided in Annex A.

2.3 Activities

The *JRC Thinkers 'N' Tinkers Makerspace* will have the dual function of collaborative tinkering and reflexive thinking practices. The aim is to attract both the community around the JRC and the JRC scientists who, by doing/making with the community, may reflect further on the issues they are delving in from a social and ethical perspective. In the makerspace, a number of events will be proposed which will be moderated by

JRC staff or invited well-known makers and artists. In particular, the JRC-STS team is in a unique position to facilitate these types of training activities and collaborations due to its expertise.

In an initial phase, the Makerspace should host a series of activities that foster STEAM capacities but other areas of "making" could be supported namely liaising with the existing JRC labs. Partnerships with schools and museums can also be sought. Below we present a preliminary list of foreseen activities to be organized and hosted in the *JRC Thinkers 'N' Tinkers Makerspace*.

List of activities	
Citizen engagement sessions: "Material Deliberation Tours"	Citizen dialogues, complemented with hands-on approaches, on societal impacts arising from current European technoscientific innovation. The work will be carried out using a mix of public participation methods and techniques. In the end of each year we propose an installation in this space resulting from these dialogues.
TNT talks: Talks about "Thinking 'N' Tinkering"	30 minutes seminar talks by leading scholars on topics related to Maker Culture, DIY Science and Biohacking. Similar format to the successful STS seminar series "Contro Corrente".[9]
"Learning by doing" prototyping events	Events where learning is focused on more experimental, hands-on approaches. The aim is to encourage a learning process driven by curiosity and desire to create new things as well as by an interest in sharing work and processes with others.
Hackathons	One day events where people with different technological background join different teams around a problem or idea, and collaboratively develop a unique solution from scratch. Hackathons provide a venue for self-expression and creativity through technology.
DIY Festival	Event aimed at celebrating and promoting the maker culture, with special emphasis on DIY Science. Envisaged as a show of crafts and skills, multimedia/interactive installations, and performance art.

[9] STS Contro Corrente Seminar Series:
https://www.youtube.com/playlist?list=PLGI5zHT2w7jDiax_QQ27hXaZbIGzmRbKE

3 Collaborations

The *JRC Thinkers 'N' Tinkers Makerspace* is currently a joint collaboration of the following units:

Unit	Contact Point
JRC.I.1	Paulo ROSA
JRC.E.3	Gianmarco BALDINI
JRC.B.6	Sven SCHADE

A number of case studies are already planned for 2017:

- Unit JRC.E.3 in collaboration with unit JRC.I.1 will make use of the makerspace as a space for conversations about smart cities, smart objects and the overall vision of the Internet of Things (including discussions about invasions of privacy, data and consumer protection, trust, accountability and security of systems, and loss of control). Other potential applications include:

    - Family well-being: Development of a set of applications, whose goal is to support the well-being of the member of the family (e.g. healthcare application for the monitoring of the health of the persons, especially elderly persons). The data from the sensors can be distributed only to authorized personnel like doctors or family people, who must be alerted by the conditions of the person under monitoring; or the monitoring of children for its position or abrupt changes (detected by sensors) or movements, which could indicate a fight with other children, a fall or something else.

    - New generation environment monitoring: Development of an application to monitor the environment, which works by collecting data from different sensors and by performing machine learning algorithms. Unit JRC.B.6 will facilitate a low-cost air quality monitoring framework that has been developed by the JRC (with Unit JRC.C.5), data from official air quality monitoring networks in Member States, data from existing Citizen Science initiatives, and data that can be gathered by using DYI air quality sensors. Machine learning algorithms (developed by unit JRC.E.3) will be applied on the self-collected data together with additional inputs of other volunteered initiatives and institutional sources in order to stimulate debates about data quality, validation and possible use of new data sources.

- Unit JRC.B.6 in collaboration with unit JRC.I.1 will use the makerspace to engage citizens on using sensors and apps to collect data that will feed into JRC.B.6 Citizen Science Platform. The platform is developed in order to support the JRC in the collection of Citizen Science data, their integration into policy-supporting processes and communications about the actual use of Citizens' contributions for evidence-informed policy making. The makerspace will operate as the physical counter part of the online citizen engagement platform, thereby helping to populate the platform with real Citizen Science data, but also to test possible usage scenarios for smartphone, web-based tools, and the platform in itself. We envisage three threads of activities:

- The development of the Citizen Science Platform will be directly supported by activities in the makerspace, including brainstorming and designing possibilities to inform citizen about the use of their contributions and related policy actions. Delated discussion rounds could be scheduled back-to back after hands-on experiences in the area of environmental monitoring or Invasive Alien Species (see below).

- Invasive alien species: Citizens are engaged in activities to identify, monitor, and act upon invasive plants. Here, we will exploit possible usage scenarios for a smart phone application, which has been developed at the JRC (under the DG RTD-funded MYGEOSS project, with Unit D.2).

▪ Unit JRC.F.1 in collaboration with unit JRC.I.1 is developing an engagement process about public food procurement for schools. The objective is to get insights, expectations and the imaginaries of involved social actors.

In addition, contacts for collaboration were already established with the following entities:

▪ FaberLab (Italy)
▪ FabLab Brussels (Belgium)
▪ OpenFab (Belgium)
▪ FabLab Factory (Belgium)
▪ Waag Society (Netherlands)
▪ Fablab Amersfoort (Netherlands)
▪ altlab: Lisbon's Hackerspace (Portugal)
▪ FabLab Lisboa (Portugal)
▪ London Biohackerspace (United Kingdom)

4 Support & Costs

Designation	Cost
JRC Thinkers 'N' Tinkers Makerspace space setup (implemented using in-house facilities)	4 000 EUR
1x 3D Printer (e.g. Ultimaker 2+)	2 500 EUR
1x Laser Cutter (e.g. Epilog Mini 24)	15 000 EUR
1x Sign Cutter (e.g. Roland CAMM-1 GS-24 desktop cutter)	2 000 EUR
Electronics Equipment (e.g. Arduino prototyping boards, sensors, soldering stations, power tools, etc.)	3 000 EUR
Consumables (e.g. 3D printing filaments, acrylic and wood sheets, cardboards, etc.)	3 000 EUR
Safety Equipment (e.g. googles, gloves, ear plugs, etc.)	500 EUR
TOTAL	30 000 EUR

5 Operationalization

The next steps in operationalizing the *JRC Thinkers 'N' Tinkers Makerspace* are:

Space	• Secure an appropriate physical location to host the makerspace (it is proposed at this stage the second floor of Building 51). • Secure the necessary conditions to open the makerspace to the local community.
People	• List of JRC staff interested in supporting and maintaining the operations of the makerspace.
Equipment	• Inventory of available equipment at the JRC that could be beneficial to the makerspace. • List of necessary furniture to support the makerspace activities. • List of tools and equipment required to purchase.
Partnerships	• Further explore possible partnerships and projects, both inside and outside the JRC.
Activities	• Define and plan the makerspace activities for the first year. • Establish contact with possible speakers and mentors.
Promotion	• Annoucement of makerspace in the community. • Setup an online presence.
Opening	• Setup a date for the "Grand Opening".

6 Contacts

For more information about the *JRC Thinkers 'N' Tinkers Makerspace*, please contact:

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Federico Ferretti	federico.ferretti@jrc.ec.europa.eu

Annex A: List of equipment committed to the makerspace

- 10 Arduino boards, which can be used to connect sensors and communication devices;
- Various IoT wireless communication devices including Bluetooth, zigbee, WiFi;
- 2 Sets of environmental sensors (each set includes: Humidity and temperature sensor, CO sensor, UV sensor, flame sensor, and soil moisture sensor);
- Diverse electronic components (e.g. resistors, LEDs, buttons, servos, jumper wires) that can be used to build electronic circuits;
- SecKit tool developed by Riccardo Neisse, which can be used to apply policies to the collection and processing of data to support protection of the privacy of the users or to implement specific policies (e.g., act on received data by a sensor and execute an action);
- Wireless indoor positioning system, which can be used to implement geo-fencing or act on change of the position (e.g., a child getting out from a fenced area and going to the street);
- Machine learning algorithms based on Support Vector Machine, which can be used to detect specific movements or actions from the sensor (e.g., a person falling down);
- Various smartphones;
- Digital photography camera;
- Balloon mapping kit (aerial photography);
- Desktop computer (old MAC Pro workstation).

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