ERC Starting Grant 2023
Research proposal [Part B1]

My project title

ACRO

- Principal investigator (PI): My Name
- Host institution: My University
- Full title: My project title
- Proposal short name: ACRO
- Proposal duration: 60 months

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Section a: Extended Synopsis of the scientific proposal [max. 5 pages]

DRAM in a nutshell

The main purpose of this project is to establish a blueprint methodology for the implementation of micro-chain values of distributed recycling at a urban territorial level. We seek to the achievement of a three-level target: (1) the establishment of a free-open source technical ecosystem that can be printed, 2) to establish a set of dashboard to possible
s to analyse, inform and develop a methodology that enables the implementation of community-based distributed recycling approach

Post-growth as economical logic for the urban settings

Plastic waste contamination is a stratigraphic indicator of what is recently considered the Anthropocene era Popularized by the chemist Paul Crutzen in 2000, the antropocene recognizes humans not only as biological but as geological force acknowledging the new status of humanity given the different markups in the ecosystems that are impacting the stability of the earth system. This impact is characterized by the exponential changes in demography and economic growth since the 19th century that have led to the current climate change and biodiversity collapse. The current manufacturing activities have played a major role as motor for the economic development but also also have multipled the impa.

Rethink the manufacturing approaches

The current ecological degradation demands to rethink the paradigms of the means of production. Indeed, the manufacturing approaches in a post-growth economy context need to integrate the related societal issues of resource scarcity and waste accumulation in the urban lives. The trend is reinforced by the fact that by 2050, it is expected that about 70% of the world's population will live in urban settlements[ref?]. Likewise, it is expected that urban cities will be responsible for non-negligible environmental impact, producing about 50% of global waste, and 75% of greenhouse gas emissions which affects the sustainability of cities and the quality of city life[1]. Therefore, reconciling urban development and industrial development is not an easy task. **Systemic design thinking is needed to identify major feedbacks in the strategic, the tactical and the operational decisions.** Thus, the type of information that decision-makers take into account is relevant at the moment to put in place informed decisions.

Design global / Manufacturing local approaches

A major trend in the development of production systems seeks to establish an urban production model with decentralized and distributed characteristics[2]. Free, Open source and P2P approaches have been seen as potential driver to propose a paradigm of manufacturing system. This novel approach aims to create a proximity with local stakeholders (suppliers, customers, workforce) creating a network of production sites in accordance with product demand and resource availability to promote 'local for local' or 'close-to-customer' concepts. This model aims for the the design global / manufacturing local which seems a proto-industrialization transition that is taking place given the major impact of the ICT technologies, and open source and commons approaches and the maker culture. There is a transition from DYI approaches towards what it can be called DIT together as a social manufacturing.

The purpose of this project is to give a blueprint methodology that enable to establish a distruted recycling approach in urban lives.

Open source as enabler of DRAM

Prior work has shown that open-source investment should result in an extremely high return on investment (ROI) in FOSH [29]. The funding would work as normal university or industry grants/contracts, with the exception that rather than fund researchers and allow them to gain a monopoly on the intellectual property, instead there would be an open-source license agreement mandate. In this way, the researchers are still funded, but the benefits of the research accrue to society more directly.

The reduction of the dependence of oil-based materials, as plastics, is a systemic endeavor challengue. However, there is an plastic waste stock of 70 years of accumulation of plastics materials. by the fact that the plastic development is there is .

This explain by the incredible demand of plastics materials for multiple usages.

One of the key factors of these transformations is the emergence of common-based additive manufacturing technologies that allows designers and the general public the production in small batch series in a more economical way, faster and on a local scale. Considering the different specificities of AM processes, a broad field of opportunity is emerging to develop more sustainable means of production at different levels of the value chain[3].

At the design stage of parts: the design is freer and shapes can be optimized over parts modeled for more traditional processes. At the production stage, by the main principle of additive manufacturing, which consists of layer-by-layer manufacturing, there is less waste produced during production than technologies based on the removal or deformation of material. In use, the service life of parts is increased by insitu repair techniques. Finally, having a production closer to the final consumer reduces the carbon footprint of the distribution.

Distributed (Re)recycled resources production

In that sense, the concept of urban factory is evolving as a disruptive approach and is the materialization of this manufacturing paradigm. The urban factory is defined as "*a factory located in an urban environment that is actively utilizing the unique characteristics of its surroundings*". It creates products with a focus on the local market and allows customer involvement during value creation. The Urban Factory has a minimal negative impact on its environment while positively influencing the local economy"[2,4]. Particularly, the recycled resources industry consists of a series of activities related to recycled resources – e.g., recycling, refining, remanufacturing, etc. – aspiring to mitigate the negative externality caused by the linear economy (Bokken et al., 2016; Wang et al., 2019). The sustainable development of the RRI has thus been highlighted on many countries' agendas to promote the circular society, as well as the goals of carbon peak and carbon neutralization (Türkeli et al., 2018).

My implication in the State-of-the-art advancement

Since 2014, I have been working on the validation of the open source additive manufacturing as a robust manufacturing system[5], but also as enabler of the mechanical recycling[6,7] of plastic waste material. From an energy and environmental perspective, the scientific literature[11] proves that the mechanical recycling strategy is the most suitable plastic waste management option for relatively clean and homogeneous plastic and bioplastic waste streams compared to landfilling or incineration alternatives.
THe main challengue remains to make affordable the use of new secondary material applicability[12].

Moreover, we proposed a closed-loop supply chain networks to possible implement distributed recycling[13,14],

This important input have a promised breakthrough in the

identifying the major . Using a systematic literature review, I realize that there a different maturity the technical value chain. In the context of a possible, we try to implement this approach in the context of an on-going European collaborative research project, INEDIT[ref?].

To appreciate the ground-breaking scientific nature of this idea, we can I like to highligth that current,

DRAM Goal

DRAM seeks to the achievement of a three-level target: the establishment of a open source technical ecosystem by means of opoen source hardware using In ordre to

A challenging task

Technical challengues in the recycling process

Historically, plastic recycling has been oriented to centralized facilities in order to take advantage of economies of scale through the production of low-value products. However, this approach must face the challenge of collection and transportation for high volume and low weight polymers, provoking that the recycling of plastic is not cost-efficient in this centralized context [8]. The use and disposal of plastics is a wicked problem characterized by high complexity and multifaceted feedback loops that calls for a systemic view of the entire plastics value chain from oil refinement to polymer production, conversion, retail, consumption, and recycling the material back into the value chain [9]. Transitioning to sustainable plastics in the manufacturing of plastic products, parts, and packaging is influenced by the complex interconnections between polymer producers - petrochemical companies- [10], converters [11], brand owners or manufacturers [12], retailers and consumers [13], and recycling operators [14], as well as the influences of policymakers in wider economic and societal changes [11]. Economic, social, political and technological barriers must be overcome for sustainable plastic management [9]. Kawecki et al in [15] developed a dynamic probabilistic material flow analysis of seven commodity TPs identifying nine product sectors and 35 product categories, across Europe from 1950 to 2016. Their model revealed that "the major final compartment for plastics was landfill (48%–60%)". Even for common consumer plastics such as polyethylene terephthalate (PET) and olefin plastics, achieving a circular economy is a major challenge [16]. If we currently consider the sources of plastic waste and more specifically those from food packaging, we are faced with various limitations related to the types of material and their shaping. More specifically, sorting centres find themselves with 3 material flows to manage. The first group (G1), namely that of bottles and flasks, is well controlled with relatively distributed sorting throughout the French territory (about 150 sites) and centralized mechanical recycling in a few specialized centres by type of plastic (polyethylene (PE), polypropylene (PP), high density PE (HDPE) PET, etc.). For the second group (G2: i.e. refusal of sorting PET, PP, PET/ HDPE mixture, polystyrene polyethylene (PS)), following the many actions carried out in recent years, we find ourselves with sorted plastics but due to a lack of circuit and value chain only residual energy value is considered although their properties are still high. Finally, the third group (G3: i.e. biopolymers, polylactic acid (PLA), Polyhydroxyalkanoate (PHA)) consists of unsorted plastics that end up in landfills and on which we have very little information [17]. In the GreenLocal3D project we will be focused on this two-last group ((G2) and (G3)) and we will for the plastics of (G3) evaluate the flows available at the sorting centres and for (G2), we will study the potential from these plastics for AM by primary or secondary recycling. Indeed, as explained in [18], these two categories are economically viable (in accordance with [Hypothesis3]). Thus, to conclude the GreenLocal3D project will concern the local mechanical recycling of plastic waste that are not yet revalorized due to lack of information about their availability or that didn't find a value chain with a sustainable business model.

The most common form of additive manufacturing is fused filament fabrication, which is a material extrusion process. 3-D printing filament can be manufactured economically using distributed means with a waste plastic extruder (often called a "recyclebot") (Baechler et al., 2013). Recycling is a well-known environmental benefit and performing distributed recycling of plastic waste into 3-D printing filament decreases the embodied energy of filament by 90% compared to traditional centralized filament manufacturing using fossil fuels as inputs (Kreiger et al., 2013; 2014; Zhong et al., 2017). Using distributed recycling fits into the circular economy paradigm (Unruh, 2018; Zhong and Pearce, 2018; Shonnard et al, 2019; Garmulewicz et al. 2018), as it eliminates most embodied energy and pollution from transportation between processing steps. This makes distributed recycling and additive manufacturing (DRAM) environmentally superior to other methods of plastic recycling.

Logistical analysis in the

Systemic challengue to the deployment

towards the distributed recycling via additive manufacturing approach[15], validating the open source 3D printing as a reliable technique process. This validation of the process have also include the polymer recycling process as a possible industrial vector that enables can give possible uses to this abundant material.

Studies on the technical viability of recycled materials as substitutes for conventional virgin materials are still limited to particular applications[16]. We have proved that for prototyping is the case[ref?]. We need to imagine that the use of recycled assets becomes a norm and not a exception in the industrial process. This is important given that in a post-growth appproachs, the rarefication of virgin assets is a plausible scenario.

Preliminary studies on the use of rec

- The use of recycled materials like polymer waste is goindf to be one of the stock that we"ll nedd to use given the scarcity of
- Assitive manufacturing is a potential enabler of change for manufacturing
- the community-base recycling approach is a scale of the changes
- major efforts in the implementation of community-drien recycling approach is needed in the urban settlements
- the proposition of system dynamics as modelisation tool to understand the the main gap in ecosystems services are needed in the) like a bacterias, we need to develop a industrial infrastructure that stimulus the regenerative use of products
- Validation of open source as a means to foster the manufacturing conviviality
- Resilience as a major backtrack for industrial processes in the future
- Pluralism forom of evaluation needs to be developed to evaluate the implementation strategies of community-drivesn strategies of manufacturing.

- Mechanical recycling is leading a path in the transformation of waste-to-ressource atoms
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Section b: Curriculum vitae (max. 2 pages)

PERSONAL INFORMATION

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Education

2013 – 2016 Ph.D. in Industrial Engineeringat the Université de Lorraine
Title: ***Methodological proposition to evaluate polymer recycling in open-source additive manufacturing contexts***

- **Director:** Prof. Mauricio Camargo – ERPI, Nancy - France
- *Prof.* Hakim Boudaoud PERRY – ERPI, Nancy - France
- *Dr.* Sandrine Hoppe – LRGP, Nancy

The thesis is a result of a innovative collaboration between the Industrial Engineergin Laboratory and the Chemical . I participate in the Symposium congress at Texas University. This enables the collaboration with Prof. Joshua Pearce in the domaine of Distributed recycling via additive manufacturing. This enables me to co-create the open hardware approaches fostered with the innovation multi-scale at ERPI laboratory.

Current Position

2022 Research Associate at the ERPI Laboratory
École nationale supérieure en génie des systèmes et de l'innovation –ENSGSI-
Équipe de Recherche sur les Processus Innovatifs –ERPI-, Université de Lorraine, France

PREVIOUS POSITION

2020 - 2021 Post-Doctoral at Unievrsité Technologique de Troyes -UTT

Fellowships AND PRIZES

Main Teaching aactivities

Organisation of Scientific meeting

2022 Invited lecturer to the Workshop of Additive Manufacturing ". 300 Participants. ERPI - Nancy

2022 Member of the organization committee of the IEEE ICE / IAMOT joint conference on the topic of "*Technology, Engineering, andInnovation Management Communities as Enablers for Social-Ecological Transitions*". 300 Participants. ERPI - Nancy

INSTITUTIONAL RESPONSIBILITIES (if applicable)

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Country 201? – Editorial Board, Name of University/ Institution/ Country 200? – Scientific Advisory Board, Name of University/ Institution/ Country 200? – Reviewer, Name of University/ Institution/ Country 200? – Scientific Evaluation, Name of University/ Institution/ Country 200? – Evaluator, Name of University/ Institution/ Country

MEMBERSHIPS OF SCIENTIFIC SOCIETIES (if applicable)

201? – Member, Research Network "Name of Research Network" 200? – Associated Member, Name of Faculty/ Department/Centre, Name of University/ Institution/ Country 200? – Founding Member, Name of Faculty/ Department/Centre, Name of University/ Institution/ Country

MAJOR COLLABORATIONS (if applicable)

- Joshua Pearce, "Technical evaluation of the distributed recycling approach", Name of Faculty/ Department/Centre, Western University / Institution/ Canada.

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- urban waste market is not separated to the existing circuits of waste management [@]
- case-based empirical research looking at how waste markets are evolving in response to resource efficiency discourses

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