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## **Learning through co-configuration of a novel business model for sustainable innovation**

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**Abstract:** This paper analyses a network's learning through co-configuration. The co-configuration process of a novel business model – a cooperative – in a digital printing network demonstrates that the quest for sustainability in innovations sets the network participants a learning challenge. The study draws on the conceptualisation of object-oriented co-configuration and multi-level learning in the cultural-historical activity theory framework. It follows the network's object creation through six workshops by analysing the discursive breaks and turning points in the process of co-configuration. The key findings of the paper are the understanding that a sustainable business model is not a stable or final solution, but an adaptive process, which requires collective efforts from network participants on multiple levels. In order to become sustainable in various areas, including environmental, social and economic areas, novel business models should focus on learning. This study contributes to studies of work innovations by increasing the understanding and significance of learning through co-configuration for sustainable innovation in work life networks.

**Keywords:** co-configuration; consumer-involvement; digital printing; learning network; cultural-historical activity theory; sustainable innovation.

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## 1 Introduction

Sustainability and sustainable development are inextricable aspects of today's innovation activity in work organisations (Pinelli and Maiolini, 2017; Welford, 2016). This applies to the social sustainability of the results acquired in local development projects as well as the ecologic-environmental sustainability that drives long-term global development efforts. Both local and global targets are so demanding that they call for multidisciplinary cooperation, networking and collective learning (Zaman and Goshin, 2010; United Nations, 2015). This article argues for 'learning through co-configuration' as a promising approach to sustainable innovation activity (Engeström, 2004, 2007).

The sustainability of innovations is evaluated in terms of the progress it brings on ecological, social, and economic dimensions (Elkington, 1998; Rosca et al., 2017). For many enterprises, the combination of economic performance and ecological and social impact has become a specific challenge. This link may be effectively developed and studied through the notion and creation of novel business models (Boons et al., 2013; Rosca et al., 2017). Sustainable business models entail systemic solutions that enable balanced fulfilment of customer needs through dialogue between optimal production profitability and social-environmental effects (Boons and Lüdeke-Freund, 2013; Tukker et al., 2008). Workers' initiatives are also crucial for the sustainability of firm-level innovations, but genuine worker involvement requires time and agentic efforts from all the involved actors (Haapasaari et al., 2018). In networks, innovations happen in the boundaries between different stakeholders and require a certain objectual ground (Assudani, 2017).

In general, innovations do not necessarily refer to novel technology but to a creative and improved solution to a problem (Jorna, 2006; OECD/Eurostat, 2018). The solutions typically apply the extensive possibilities of digitalisation, virtual platforms, big databases, etc. and create expectations of sustainable development in comparison to mechanical industries and logistics. However, quite recently, electric energy consumption by smart technologies has entered the public discussion. The conditions of sustainable innovation are complex, and creating models that support sustainability calls for learning among all the stakeholders in and across organisations. Our notion of 'learning through co-configuration' is based on the cultural-historical activity theory (CHAT). This framework makes a distinction between the situated actions and societally durable activities that orient towards the production of meaningful objects (Leont'ev, 1978; Engeström, 2015). Single innovations created in developmental projects are at risk of remaining on the level of action, which makes them local and unsustainable in the long run. Long-term work to change basic assumptions and to model new activity can potentially lead to the creation of innovative work practices (Haapasaari et al., 2018; Schulz et al., 2015). Sustainable innovations require the construction of novel, durable object-oriented activity, which is an essential part of the co-configuration process among stakeholders. In this framework, business models emerge and can be studied as the object

of co-configuration in multi-stakeholder networks that pursue ecologically, socially and economically sustainable innovation activity. We further propose that productive co-configuration work implicates expansive learning on multiple levels (Toiviainen and Vetoshkina, 2018). Engeström (2015) formulated the theory of expansive learning to explain learning as a process of collective exploration and creation of activities in transformation, basically, learning about ‘what is not yet there’. In this frame of reference, the sustainability of innovation entails the mastery of expansive learning dynamics across the various levels that emerge in a given network (Toiviainen, 2003).

The analysed case deals with co-configuration for sustainable innovation in a public-private network in the field of digital printing. The rapidly developing digital printing industry provides fertile ground for developmental projects aiming for innovation activity (Paju et al., 2017). Direct printing of digital files on a variety of surfaces has expanded the use of this technology into the textile, clothing and interior industries to produce, for instance, digitally printed carpets, flags, banners and clothes. Digitalisation enables the printing of small batches and printing on demand, shortening production chains and applying just-in-time principles (Fenton and Romano, 1997; Fletcher, 2014; Tyler, 2005; Whitbread, 2009). These changes are contradictory. On the one hand, digital printing, networking and orientation towards local production are often regarded as a way towards sustainable development. On the other hand, the possibility of small batch production may increase consumption (Parsons and Campbell, 2004).

Digital printing technology expands the number of potential participants in the business ecosystems and changes their conventional roles, allowing early involvement of customers in design and printing processes. Printing houses and designers must adapt to new technologies and relations in business ecosystems with new business models and earning logics (Fenton and Romano, 1997; Tyler, 2005). Digitalisation enhances even students’ interactions with professionals and producers during their studies (Paju et al., 2017). All this creates a demand for the co-configuration of sustainable innovations, which we analyse in this article by directing attention to the object and the outcome on the one hand, and to the general conditions of the process on multiple levels on the other. The article discusses a unique case in a thus far under-researched area of networks’ learning through co-configuration in the face of digitalisation of work.

The research questions are:

- RQ1 How does the creation of a sustainable business model take shape in the constantly changing process of co-configuration?
- RQ2 What are the conditions of co-configuration and learning for sustainable innovation activity in the digital printing network?

The paper analyses data produced in a series of workshops held by the researchers and developers in order to encourage network stakeholders’ innovation activity. By ‘network stakeholders’ we refer to the participants of the prospective business model. The authors role among the stakeholders of the developmental project was that of facilitator with no business interests (see Section 3). The workshop method is based on dialogic interaction and equity of participation and is sometimes called ‘the Nordic model’ (Alasoini, et al, 2011; Gustavsen, 2011). Implemented in the textile, clothing and interior digital printing industry, the project’s aim was to create a consumer-customer-oriented service concept and a business model for networked activity based on sustainability (Paju et al., 2017). This service would materialise on an online platform, allowing consumers to design and

order products and the service providers to organise the production network from material supply to printing and a ready-made product. The original idea transformed into a web platform sustained by a cooperative model, in which students' learning dynamics were the core idea and motivating force for other stakeholders of education and work life.

The analysis traces the participants' learning through co-configuration on multiple levels in the process of the network's business model formation, during which the original idea of sustainable innovation was transformed through the subsequent co-configuration events. This process forms an empirical longitudinal trajectory of collaboration, which allows us to embed theoretical notions in the temporally unfolding and broadly unforeseen events. The concrete process is the focus, but the theoretical interest lies elsewhere than in the formulation of a process model of learning through co-configuration. This case highlights the dialectics of the levels of learning that the stakeholders create and work on in the process of co-configuration.

First, we present the CHAT-based theoretical approach to co-configuration, focusing on the levels of learning. Then we describe the data and methods of analysis. The findings are reported in the analysis of six project workshops. In the Discussion section, we return to the research questions and reflect on the possibility of constructing sustainable innovations through the process of co-configuration. The conclusion provides an overview of the main ideas of the article and potential directions for future research.

## 2 Conceptual framework

### 2.1 Co-configuration

The historical evolution of work organisations presents a path through several types of work: craft, mass production, process enhancements, mass customisation and co-configuration (Victor and Boynton, 1998). The learning system that supports each type of work is specific and differs qualitatively from the previous type of knowledge creation (Pihlaja, 2005). In this framework, co-configuration emerges beyond mass customisation by making production and innovation continuous. Mass customisation entails designing products that meet the specified needs of clientele differentiated on a group level. Co-configuration takes relationships with the customer to the next level by creating an intelligent and adaptive product that responds to individual customers' needs and changing conditions. It builds a dynamic customer-product-company relationship throughout the product's life cycle (Victor and Boynton, 1998; Fuller et al., 2018). This type of production suggests that the process will not result in a finished product, as customers' needs constantly change. Products are created during constant interaction with the customer. The role of the customer changes from that of a mere customer to a partner and producer. The complex interaction within this system is the key to value creation (Victor and Boynton, 1998). Co-configuration may be seen as a solution to a contradiction between fixed products and constantly developing technologies and changing customer needs. This type of work enables crossing boundaries between product development and production, as well as between producers and users (Virkkunen, 2006).

The notion of co-configuration has been adopted and modified in activity-theoretical studies to enable the analysis of multi-stakeholder networks' innovation and development activities, particularly for understanding the emergence of new objects and tools in an

activity (Engeström, 2004; Toiviainen et al., 2009; Kerosuo et al., 2011). The CHAT approach was developed around the notion of activity. Activity is understood as a system of human ‘doing’, in which a subject acts upon an object to obtain a desired outcome by employing both external and internal tools. Activity is analysed as an object-oriented, culturally and socially mediated system with a division of labour and rules that regulate the interaction between participants (Engeström, 2015; Leont’ev, 1978).

Activity is by definition oriented towards a certain object (Leont’ev, 1978). The object defines activity (why, what for?) and embodies the meanings and motives that drive human actors (subjects) in their activities. In the analytical sense there is a distinction between the generalised object of the historically developed activity system and the specific object as it appears in various instantiations for a particular subject, at a specific time and place, in a given action (Engeström et al., 2003; Toiviainen and Vetoshkina, 2018; Vetoshkina, 2018).

Engeström (2004) sees co-configuration as a process of the construction of the object of an activity, shared by actors from different activity systems. This kind of cooperation has no fixed authorities (Engeström, 2004; Engeström and Nummijoki, 2010). In the age of digitalisation, the co-configured objects are increasingly heterogeneous, modifiable and virtual (Toiviainen and Vetoshkina, 2018). At the same time, digitalisation offers new means of customer engagement through interactive web portals (Mørch et al., 2010). Social media opens up further opportunities, even for lay consumers, do-it-yourself (DIY) customers and students, to join collaboration with professionals (Mohajer va Pesaran, 2018). This complexity creates challenges for co-configuration, but also makes co-configuration work possible. Exchanges and interactions between different stakeholders in the process of co-configuration call for continuous learning among all the members of the network. Learning at the boundaries of communities expands competence and expertise and provides new insights and radical innovations (Engeström, 2014; Wenger, 2000).

## *2.2 Levels of learning in networks*

Due to its complexity, learning through co-configuration typically happens over a long period of time and is largely dependent on the contributions of various actors. From the CHAT perspective, learning is an essential mediating factor of major transformations and innovations (Engeström, 2004).

Fenwick (2003) claims that innovative learning contains different dimensions such as rhythm (episodic or continuous), the magnitude of creative change (adaptive or generative), and levels (individual, group, organisation). Rhythm and magnitude are dimensions that may help identify critical events in the flow of co-configuration, whereas aggregate organisational levels in terms of who the learners are is less relevant in this context. Our definition of the levels of learning, based on the cultural-historical activity theory, is object-oriented seeking to answer what is learned and why. Toiviainen (2003) claimed that innovation-driven activity in a collaborative network creates multiple levels of network activities, each oriented to and motivated by a specific object of activity. Together, the levels with a complex object of activity can contribute to the ultimate innovation, such as a novel network-based business model. In this frame of reference, learning takes place in a dialectical movement across the levels of learning and across the various situational instantiations of the object. The instantiations mean various representations of the object as they appear to the different network participants

(Knorr Cetina, 2001) – designers, producers, consumers, students, teachers, researchers, etc.

Our previous study of this digital printing network identified four levels of learning (Toiviainen and Vetoshkina, 2018):

- 1 The project level was oriented to the creation of the network, writing the project plan, applying for resources and monitoring the project's implementation. For the participants, typical instantiations of the object were the project plan, the agenda for the next steps, and the constellation of the future service network: who should be involved?
- 2 The product level represented the design activity that envisions the products of digital printing for the consumer market. The instantiations of the object were, for example, a tangible piece of product, a prototype, a specific finished product, or a product idea, suggesting what is or might be possible to make.
- 3 The process level referred to production activity that pursues production and product development in the future digitalised operational environment. Participants worked on the instantiations of the object, i.e., a process model as an operational scheme, and a process model as a product development process. The leading question was how the future service on a digital platform would be organised and mastered.
- 4 The concept level emerged through the development activity to define: Customers and consumers, customised product and service concepts for the consumer market, and a business concept for the network. The instantiations were a customer concept, digital service as service concept, digital service as a business concept, and ecological and local digital printing. This was the level at which the reason why the novel business model would be needed to answer the challenges of digitalisation was conceptualised.

The levels were the outcome of the synchronic analysis of one workshop in a relatively early phase of the innovation process. The aim of the present study was to test the levels in a diachronic analysis – following the process through the series of workshops (see Section 3). The description of the levels hints at a progression model in which working on and learning from the questions of who, what and how (levels 1–3) leads to the fundamental question of why, on the highest conceptual level. The developmental dimension of the levels is relevant to the analytical framework. However, we are not taking this as a linear path model but as co-existing dialectical dimensions of learning.

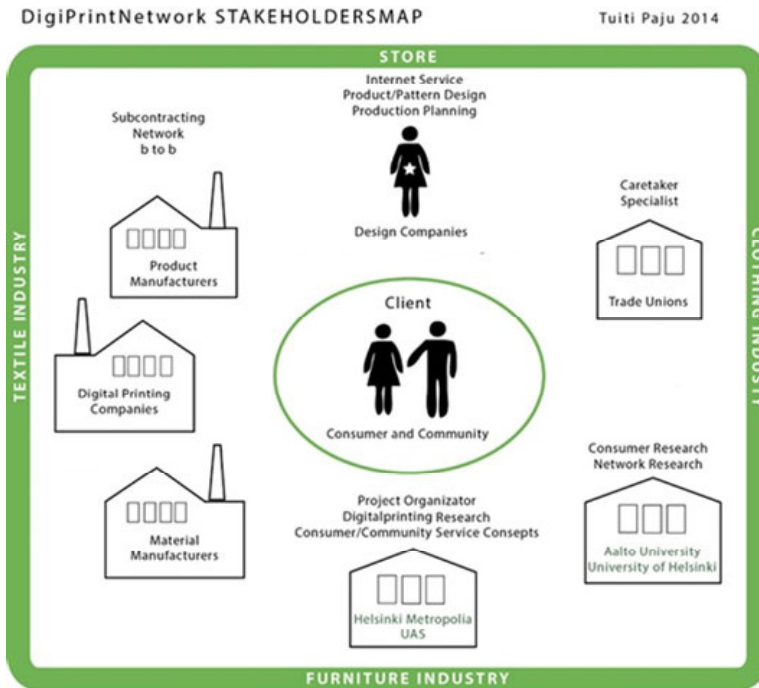
### **3 Data and methods**

#### *3.1 Data and data collection*

The data originated from a network in the digital printing industry, assembled for a public-private-funded research and development project, the DigiPrintNetwork (DPN) (Paju et al., 2017). Coordinated by Helsinki Metropolia University of Applied Sciences (UAS) the project brought together a network of professionals from design, printing and material production, and students, teachers, researchers and representatives of potential consumer-customers. Building on the previous history of collaboration between

educational institutions, designers and producers, the network started to search for novel and sustainable models in business and education. The original aim of the network was to create an online service for DIY customers (Hirscher et al., 2017). Figure 1 illustrates a map designed by the project coordinator for the project plan, which places the client (consumer and community) in the centre, circled by the key stakeholders of the network and framed by the agents of the industry (printing houses and material producers).

**Figure 1** DPN stakeholders' map at planning stage of project (DPN – project plan, tekes) (see online version for colours)



In collaboration with the project coordinator, researchers from two universities and the UAS held six workshops over 21 months, during which the network members developed a business model for an online service (Table 1). The focal data for this study consisted of video recordings of the workshops, memos, materials and the group work. The focus was on the workshops, because this was the only time during the project when all the stakeholders met and worked on the service concept and business model collaboratively. Time periods between the workshops were spent in active preparation, drafting and negotiating the concepts and models to be innovated. The outcomes of this work were brought to the discussions of the workshops, where the decisions concerning the business model were made. We argue that the series of workshops formed an integral process to be analysed in its own right, but we acknowledge that it only partially covered the whole project. Additional data collected during the project, primarily the interviews with stakeholders, the proceedings of project meetings and consumer research results, were used as additional contextual information but were not systematically analysed.

Table 1 Six DPN workshops

No	Workshop	Time and project month	Theme	Length of recording	Participants
1	Consumer workshop	April 2015, M2	Envisioning future service and customers.	3:09 h	Organised by consumer-researchers. <i>Present:</i> project coordinator and teacher, designers (3), digital-printing entrepreneurs (2) and consumer-researchers (2) <i>Absent:</i> learning-researcher. Another learning-researcher joined the project in January 2016.
2	Network learning workshop	December 2015, M10	Object, motives and values of network.	2:55 h	Organised by learning-researcher. <i>Present:</i> project coordinator, designers (3), digital-printing entrepreneurs (2), material producer, consumer-researchers (2), learning-researcher, consumer-users (3), teachers (2), students (2).
3	Consumer-user workshop	April 2016, M14	Concretising consumer-user.	3:06 h	Organised by consumer-researchers on basis of data collected from consumer-users. <i>Present:</i> project coordinator, designers, digital-printing entrepreneurs, material producer, consumer-researchers and learning-researchers, consumer-users, teachers, students. <i>New:</i> teacher of business in consultant role, learning-researcher 2 joined the project.
4	Business modelling workshop 1	May 2016, M15	Modelling network and roles of participants	1:39 h	<i>Absent:</i> one designer partner present only at end. Business modelling workshops 1–3 were organised by the project coordinator and business consultant. <i>Present:</i> project coordinator, designers, digital-printing entrepreneurs, teachers, students, teacher in business consulting role, learning -researcher 2 (recording). <i>Present:</i> project coordinator and administrative manager, designers, digital-printing entrepreneurs, material producer, teachers, teacher in business consulting role, learning-researcher 2 (recording)
5	Business modelling workshop 2	August 2016, M18	Alternative models of business activity	1:39 h	<i>Withdrawal:</i> one designer partner withdrew.
6	Business modelling workshop 3	December 2016, M22	Network structure, roles and responsibilities	2 h	<i>Present:</i> project coordinator, designers (who stayed), digital-printing entrepreneurs, students of design and digital communication, teacher in business consulting role, learning-researcher 2 (recording). Lawyer from UAS.



### 3.2 Analytical framework and data analysis procedure

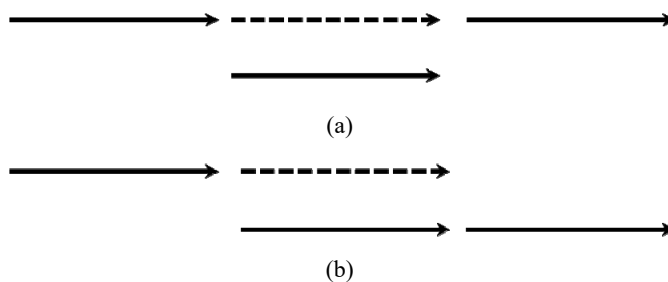
We analysed the workshops as a temporal process of co-configuration for sustainable innovation. The innovation process can be viewed as a temporal sequence of separate phases ‘to identify and compare developmental phases in the temporal sequence of data’ [Van de Ven and Poole, (1990), p.329]. We applied qualitative methodology, which sees content log creation and transcription as part of data analysis rather than mere actions to organise data for analysis (Green et al., 1997; Ravitch and Carl, 2015). In addition to these guidelines, we chose a set of CHAT-informed analytic intermediary concepts for our analysis: co-configuration event, object of co-configuration and levels of learning (Engeström, 2016; Toiviainen, 2003; Vetoshkina, 2018).

Co-configuration is an emerging temporal process, during which the object of co-configuration undergoes many changes. The critical analytical question is how to identify and seize these changes in the complex flow of activity in order to reveal the outcomes of co-configuration. In the discursive workshop data, we paid attention to particular moments in communication, the ‘turning points’ and ‘breaks’ that changed the course of action. In the activity-theoretical framework, breaks and turning points define the object-oriented co-configuration events that are the empirical units of analysis (Toiviainen, 2007).

It is not possible to trace the later effects of all interesting pieces of discussion, as these may be more or less indirect. Turning points and breaks highlight the critical issues that most likely require working and problem solving and are therefore worth following in the coming workshops. They are moments that carry expansive potential: either leading to creative solutions and innovation or otherwise energising collaboration, or remaining as manifest or latent tensions that cause friction until discussed and solved by partners. Turning points and breaks appear similarly in the data, as a disturbance – a stop in the flow of co-configuration and a transfer of the focus to another object of co-configuration. In Figure 2, the disturbance takes place when the thick line, depicting the focus on one object of co-configuration, turns into a dotted line, representing a change in the object (turning point, break). The difference between the turning point and the break is in what happens next:

- a in the break, the focus of co-configuration returns to the original object (dotted line turns into thick line), while at the
- b turning point, the flow of co-configuration continues focusing on the new object (thick lines beneath the dotted line).

**Figure 2** Difference in flow of co-configuration between (a) a break and (b) a turning point



The analysis proceeded through the following steps. The first step was identification, for which we made a detailed content log of the workshops. The content logs named the theme and the participants of the workshop. These included a chronological description of what was happening during the course of the workshops and what discursive manifestations of the object of co-configuration could be identified. A customer-centric digitalised service concept was the general object of the network under construction, and in each workshop, the members of the network focused on the specific instantiations of this object (Toiviainen and Vetoshkina, 2018).

The second step was observation, which meant that we extracted the discursive episodes from the content log that represented the co-configuration events and included an observable disturbance in the data – a turning point or break, related to the object of co-configuration. These episodes were transcribed verbatim. When defining object-related disturbances – breaks and turning points – the researchers drew on culturally embedded meanings and conceptions to recognise the expressions of disagreement, uncertainty, innovation, etc. These moments create tensions among the participants. The focus of analysis is on whether these tensions lead to expansive solutions or to disintegration, and not on the expression of tensions as such. We specify our definition criteria and provide an authentic data excerpt from each episode in the presentation of our results.

Interpretation formed the third step of the analysis. We interpreted the observed co-configuration events by applying the framework of learning levels, which consisted of the project level, product level, process level and concept level (Toiviainen and Vetoshkina, 2018). We analysed what kind of change a particular co-configuration event brought about in the object of the digital printing network's activity. We further explored whether, and on which level of learning, the change in the object carried an expansive potential towards a sustainable innovation.

We define significant co-configuration events and their analysis as the following:

- All participants engaged in an ongoing flow of actions oriented towards the topical theme (identification)
- A turning point or break in the flow of co-configuration, which is related to the object of activity (observation)
- A change in the object at any of the levels of learning or a change in the levels resulting from the turning point or break (interpretation).

The aim of the analysis was to chronologically open up the unfolding process of co-configuration as a whole. Table 2 summarises the analytical setting that follows the process of learning through co-configuration. It directs us to follow the object of co-configuration in the innovation activity of the digital printing network (RQ1) and to interpret the findings through the interplay of the levels of learning (RQ2). Although RQ1 focuses on the co-configuration process leading to an 'outcome' – a sustainable business model, and RQ2 focuses on the 'conditions,' they are theoretically and analytically intertwined. The analysis of co-configuration events through breaks and turning points in the flow of the actions provide insights for both research questions.

The analysis below follows the process of co-configuration as a whole in the chain of six workshops. We return to the research questions in the discussion section and examine the analysis results to answer them.

**Table 2** Analytical setting

<i>RQ1</i>		<i>RQ2</i>
How does the creation of a sustainable business model take shape in the constantly changing process of co-configuration?		What are the conditions of co-configuration and learning for sustainable innovation activity in the digital printing network?
Following the object of co-configuration	Analysing co-configuration events through breaks and turning points	Interpreting co-configuration and learning on the levels of learning

### 3.2.1 Ethical considerations

The project participants signed a consortium agreement that contained the principles of data management and consent for the research use of the data. We are aware that total anonymisation of research participants cannot be secured, because the case is specific and the target group is small. We took this into consideration when deciding on the level of detail reported.

## 4 Analysis

### 4.1 Co-configuration in the network workshops

#### 4.1.1 Consumer workshop

##### 4.1.1.1 Identification

The first workshop of the project was called the ‘consumer workshop’ (Table 1). It was led by the consumer-researchers. Their aim was to collect the network members’ visions of the future digital world, ideas regarding the future service, and the definitions of the potential customer of the service. Based on this knowledge, the consumer-researchers carried out a lead user workshop, which in turn produced knowledge for the network’s development activity (e.g., consumer-user workshop 3). The participants worked in two small groups, then held a discussion. The aim of the workshop was to reach a shared understanding of the nature of the DPN’s service and its type of customer. What service, what kind of products and what types of customers – these were the intertwined questions that formed the object of co-configuration.

##### 4.1.1.2 Observation

The participants were explicitly asked to define the future customer. The project plan defined the ‘client’ as ‘consumer and community’ (Figure 1), which required further specification in order to identify the lead users – potential or pilot customers, crucial for identifying needs for the service. The workshop discussion, however, went beyond the consumer orientation and reflected on the possibility to reach business-to-business (B2B) customers as well as consumers. The designers had debated this in a series of meetings (data on the recordings of the designer meetings).

*Excerpt 1*

Designer A: When we designers have met up we've talked a lot about who our customer is and how big the proportions are of, for instance, company customers and consumer customers; this question is constantly an issue!

Designer B: Yeah

Designer C: (...) in general what these customers are, (...) company customers

Designer B: company customers

Designer D: Didn't we write something down last time?

Designer D's last question was inaudible to the others due to overlapping talk. Apart from this brief exchange among the designers (Excerpt 1), their previous debate (and what they had formulated in written form) was not brought up in the discussion with the wider network, and we see this as a break in the co-configuration of the service. The workshop participants seemed to reach an agreement that the users of the future service were both DIY customers and small and micro firms. The needs and interests of both groups were described, but it was also recognised that both groups were internally heterogeneous constellations of many subgroups.

#### *4.1.1.3 Interpretation*

We interpret that the object of co-configuration for the sustainable digital service emerged as an internally contradictory entity. The theory of expansive learning (Engeström, 2015) defines internal tensions as the primary contradictions that pull activity in diverse and mutually excluding directions. Resolving contradictions therefore has expansive learning potential – in this case – whether to prioritise DIY customers and the social ethos of the service, or to attract B2B customers and secure sufficient turnover for the DPN stakeholders. Because of the breaks in the co-configuration actions, we argue that the conceptual questions did not lead to concept-level learning in the early phase of the project. Discussion was productive, however, paving the way for the next steps of DPN and envisioning the digital service as collaboratively created. This progress suggests project-level learning in our framework.

### *4.1.2 Network-learning workshop*

#### *4.1.2.1 Identification*

The second workshop was a 'Network learning workshop' led by the learning-researcher (the co-author of this article). It gathered the key DPN parties and the representatives of the lead users. The programme was composed of presentations and discussion. The presenters were the project coordinator, the students of a concept design course, and the learning-researcher. The students' role in the DPN project was to produce prototypes of web-based service concepts, supervised by specialised teachers. The situated objects of co-configuration were the service concepts that the students (in the presence of the concept design teacher) presented in the workshop.

#### 4.1.2.2 *Observation*

The students presented two concepts, one for a DIY customer and the other for a semi-professional designer-consumer. These examples concretised what was possible and what problems existed in this kind of user-driven service. The students received positive feedback and encouragement to continue the technical specification of the concepts in the upcoming study course. A turning point was when the discussion turned to the economic realities and sharing of the risks in the network. How could customers' individual designs be produced in a profitable way?

##### Excerpt 2

Member A: It's good to think about the goal and the perfect service. But then we have to face the economic realities and [--] make dull compromises [--] The customer thinks they only need a little test print, but in production it may still go through a long process [--] One little piece may take half an hour while in the same time you could have printed five metres.

Member B: Or fifty

Member A: Exactly

Member C: When you start [the production line] it goes [in the blink of an eye]! That's the [difference between] mass and customised.

The idea of providing a service for semi-professional designer-customers, realised in the students' presentation as a tangible service, turned the discussion to the possible economic benefits and drawbacks of such a service.

#### 4.1.2.3 *Interpretation*

This workshop opened up the issues of sustainability, specifically its economic aspect. Economic sustainability was not discussed as pure profitability. It mostly appeared as the economic reasonability of providing such a service: how long can we sustain our business working with such customers?

The break and the inner contradiction in the first workshop between the DIY and business customers was not taken up in this meeting. The object of co-configuration – the students' models – was not worked on any further. The discussion left many questions unanswered without offering the companies realisable visions of the service concept. In this workshop, learning did not characteristically take place on a specific level; it took place in the clash between two levels of learning: product level versus process level: how to unite and simultaneously pursue a customised product and cost-effective mass production?

### 4.1.3 *Consumer-user workshop*

#### 4.1.3.1 *Identification*

The third workshop was again led by the consumer-researchers. The participants included the network members and visiting teachers and students. The theme of the workshop was the concretisation of the customer-user. First, the researchers presented the results of the lead user group interviews. Their data covered two groups of representatives of designer-users and two groups of DIY consumers who had been asked to give feedback on the same service prototypes as in the network-learning workshop (Workshop 2). Next,

the participants formed two groups and worked on service paths for two imaginary orders. The DPN members formed their own group (the students and teachers worked in another group) performing their ‘natural’ roles: designers, printers and material producer (the students and teachers formed another group). The project coordinator-designer played the customer’s role. The situational object constructed at this stage of co-configuration was a service path.

#### *4.1.3.2 Observation*

During this workshop, co-configuration oriented towards concretising the potential relationships in the network in the form of service paths. Having concrete service paths showed the network members the relationship between the costs of production, design and the price of the final product. The introduction of the idea of crowdsourcing (engaging a large group of people – or a ‘crowd’ – for solving a problem or achieving a goal) as a solution to simultaneous profitability and personalisation of production was a turning point.

##### Excerpt 3

Member 1: I think you’re thinking too small. Here’s ten people around an order and everybody should earn money. [--] Think, when you have 18 different Janes placing an order, how much workforce you’ve tied up [in production].

Member 2: Yes, we have talked-

Member 3: – Jane is not possible for us.

Member 4: – yes, that we don’t even offer Jane this kind of service, we have already excluded the possibility of [so much] customisation

Researcher 1: I think that crowdsourcing [formerly proposed by the designer-teachers and the students] is something you might consider, could it [be a solution]?

Member 2: We’ve considered it, yes, because if we bulk order material, then the bigger the group [of customers] we get involved, the more the prices will go down. And we could order large amounts at a time.

Working with individual DIY customers, as was planned at the beginning, appeared to be a challenging task, especially economically. The price of the final product would be too high, or the companies would get no profit. Crowdsourcing was seen as a possible way to overcome this.

#### *4.1.3.3 Interpretation*

The next workshop continued the economic sustainability discourse begun during the previous workshop. Co-configuration during this workshop concretised the relationships in the future network and made the threat to the sustainability of the whole network visible. The potential turning point appeared in the researcher’s re-introduction of crowdsourcing, which the designer-teachers and students had taken up previously. The learning at this stage took place on the process level, focusing on relationships in the network. However, the turning point led the co-configuration process a step towards concept-level learning, through the challenge of understanding the need to create a completely new business model, possibly based on crowdsourcing.

#### 4.1.4 Business modelling workshop 1

##### 4.1.4.1 Identification

The theme of the workshop was the modelling of the network and the roles, rights and responsibilities of the participants. Based on the outcomes of previous workshops, the digital communication students presented a specification and concretisation of the online shop concept. Their concept was ‘an online shop that sells products made of recycled materials and offers customisation through crowdsourcing campaigns’. The participants discussed the concept presented by the students. The business consultant gave an introduction, highlighting the decision-making concerning the ownership of the service. The participants had to jointly visualise the roles of each member of the network, following the frame provided by the business consultant. The object of co-configuration was the production of the network model and the commitment of the participants. The situational object constructed at this stage was the technically feasible ‘building block’ of the online service concept. The term ‘building block’ (in Finnish ‘palikka’) was a metaphor introduced by one of the members of the network to illustrate the mediating component in a technically complex whole.

##### 4.1.4.2 Observation

A turning point in the co-configuration discourse took place when the notion of the building block was introduced in the workshop discussion. This referred to the technical implementation of the online service. The participants discussed whether the building block would be a single software element that the partners could integrate into their own digital environments or an entire collectively shared online service composed of several building blocks (technical features). Member 1’s summary was followed by silence. The comments that ensued demonstrated that the dilemma continued. Views regarding both options were expressed. Thus, the turning point produced a break in co-configuration, as the decision concerning a single building block versus a shared technical system was not explicitly made.

###### Excerpt 4

Member 1: There are several building blocks [--] but I would proceed in designing them only after we’ve decided whether we’ll continue with [the service concept] or if everybody will utilise this in their own firms.

[Silence 4 s]

Member 2: It would be great to do this together, I didn’t mean [the contrary] even though I brought up-

Member 1: No, it’s good you brought it up, because now we have something concrete and I realise that it’s in everybody’s interest to get something out of this. [--]

Member 3: And if somebody doesn’t want to continue [in this project] they still get something [out of this project]: a building block! [Laugh]

##### 4.1.4.3 Interpretation

A strong effort to make the network sustainable was made by the attempt to consolidate through the outcome – a building block. Although the grounds of such consolidation and

commitments remained unclear, the co-configuration process was strong during this workshop. According to one digital printing entrepreneur: "...this was the most useful workshop, concrete discussion on the outcome of the project."

The learning in this case took place during the clash between the project level and the product level. The members pondered: what was actually written in the project plan? Was the product outcome meant to be a single, shareable building block or a comprehensive service of several interrelated building blocks? These required different types of consolidation and commitment in the network. The learning outcome resided in understanding the need for commitment to the network and its values in order to enable the creation of an innovative, sustainable business model.

#### *4.1.5 Business modelling workshop 2*

##### *4.1.5.1 Identification*

The theme of this workshop was the evaluation of the alternative business models outlined during the project. First, one of the teachers presented three service models that summarised the discussions in the previous workshops. Each model implicated certain values and options and the next steps to be taken. The presenter emphasised that it was impossible to combine all the features – the network had to choose one model from among the alternatives. The fourth option had been modelled by the teachers between the fourth and the fifth workshops. This was called the ‘school model’ or a ‘business incubator’, in which students would be able to practise entrepreneur skills and sell their unique design products through crowdsourcing. We identify one stakeholder’s introduction of ‘the fourth model’, representing the discontinuation of the co-configuration process by all the network members. Nevertheless, the process continued, as the data of the fifth workshop shows, and produced a major turning point. The object of co-configuration was the chosen service model and its development beyond the building block – the minimal outcome, separate for the network members – which had been discussed in the previous workshop.

##### *4.1.5.2 Observation*

The major turning point in the second business modelling workshop was the withdrawal of one of the network members from the project. This was not completely surprising to the project management, as this partner had signalled that their expectations of the project deviated from the general discussion. In the light of this analysis, the co-configuration breaks observed in workshops 1 and 4 resurfaced: this partner was primarily oriented towards B2B customers and expected to obtain a building block to integrate into their customer service system. The crowdsourcing and the student-users seemed to have taken the project on a different course. After the turning point, the project coordinator proceeded to describe the value of the school-based model.

###### *Excerpt 5*

Project co-ordinator: ...we’ll commit ourselves to certain firms and subcontract everything from them. [The model] has the same values [as planned]; it’s ecological, [and] produces recycled materials. [--] We introduce the students to one kind of production chain; how they could launch their own collections and how they could function as enterprises.



The producers also supported the 'school model' based on the school's ownership, commitment to network partnership, and the value of offering a start-up platform for the school's students and graduates.

#### Excerpt 6

Material producer: This might work as a school building block. As an idea of a start-up and in this way an opportunity to make small batches and try to launch them already during the study phase, in the final stage, and to learn that way [design, marketing and selling].

### *4.5.1.3 Interpretation*

The members of the network decided to go along with the business incubator model as the most realistic and sustainable for the network model. The co-configuration of this stage was the specification of the business model as a business incubator and the following reorganisation of the network. The situational object of co-configuration was the service concept as the object of the project activity.

The learning happened during the clash between the project and the concept level. The acceptance of a new business model (concept) required expansive learning from the participants (Engeström, 2015) and led to a significant reorganisation of the project. The cycle of the withdrawing partner was deviating from the network's cycle. The students' role changed from that of the workforce to that of a client. The future step involved learning these new roles and their rights and responsibilities.

### *4.1.6 Business modelling workshop 3*

#### *4.1.6.1 Identification*

The theme of the final workshop was the concretisation of the network structure, roles and responsibilities. The digital communications students presented the technical implementation of the service portal, open first to the students of their school and later to other educational institutions. The discussion, involving mostly the producers and design students, revolved around the future development of the service and practical questions. The business consultant presented the form of the selected business model for the network – a cooperative, which is open for participants to join and leave whenever they wish, and which requires no starting capital.

The object of co-configuration at this final stage was the concretisation and realisation of the selected business model. The situational object under development was a cooperative-based service portal (Figure 3).

#### *4.1.6.2 Observation*

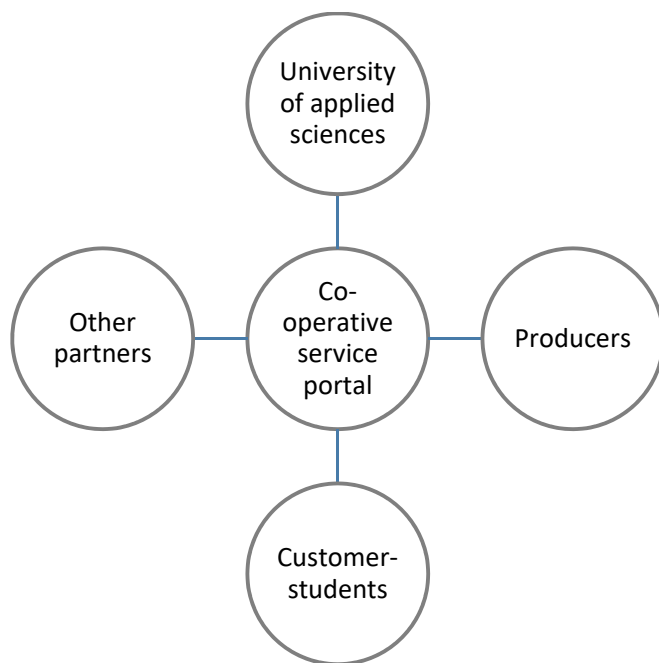
One of the producers characterised the cooperative model of the business incubator as a playground. At first sight, the playground metaphor seems to be a way of characterising the portal as something not serious. However, the idea of a playground also characterised this business model as a safe place for trying out new, unpredictable things and experimenting with novel ways of cooperation. The company members were concerned about the economic inputs and risks, but the consulting teacher saw that a cooperative in the planned form would not expose members to risks. The key concept at the outset was students' learning and proceeding under the teachers' guidance and supervision.

## Excerpt 7

Teacher: Students will not proceed further through my gate before I've controlled certain conditions and then they become your customers. [--]

Consultant: In general, you mustn't be worried about the trouble [students] bring. I think it's the other way around. We're talking about young adults who are learning – they are the implementers. The whole idea of cooperatives and enterprises in the context of higher education institutes is that it's the students who act and that they are guided by different people. The idea is not that suddenly 60 students pop in [to the companies] [--]. On the contrary, students cause less harm than a typical case, because their task is to find things out. They are learning and if they cannot do something [--] they inquire about it [--] until they end up with a solution. It's precisely about learning, and the movement and energy come from students.

**Figure 3** Network structure (see online version for colours)



#### 4.1.6.3 Interpretation

The sustainability of the chosen model was based on learning: primarily students' vocational learning, but also learning new ways of vocational teaching, and entrepreneurs learning new ways of collaborative working and experimenting at work. Ecological sustainability was an essential part of the crowdsourcing concept in terms of local production, the recycling of material and aiming for reasonable batch sizes. These ideas were in line with the goals of the original project plan. The co-configuration in the last workshop did not contain crucial turning points, but consolidation through the shared idea of enhancing the students' and graduates' learning by means of the cooperative's

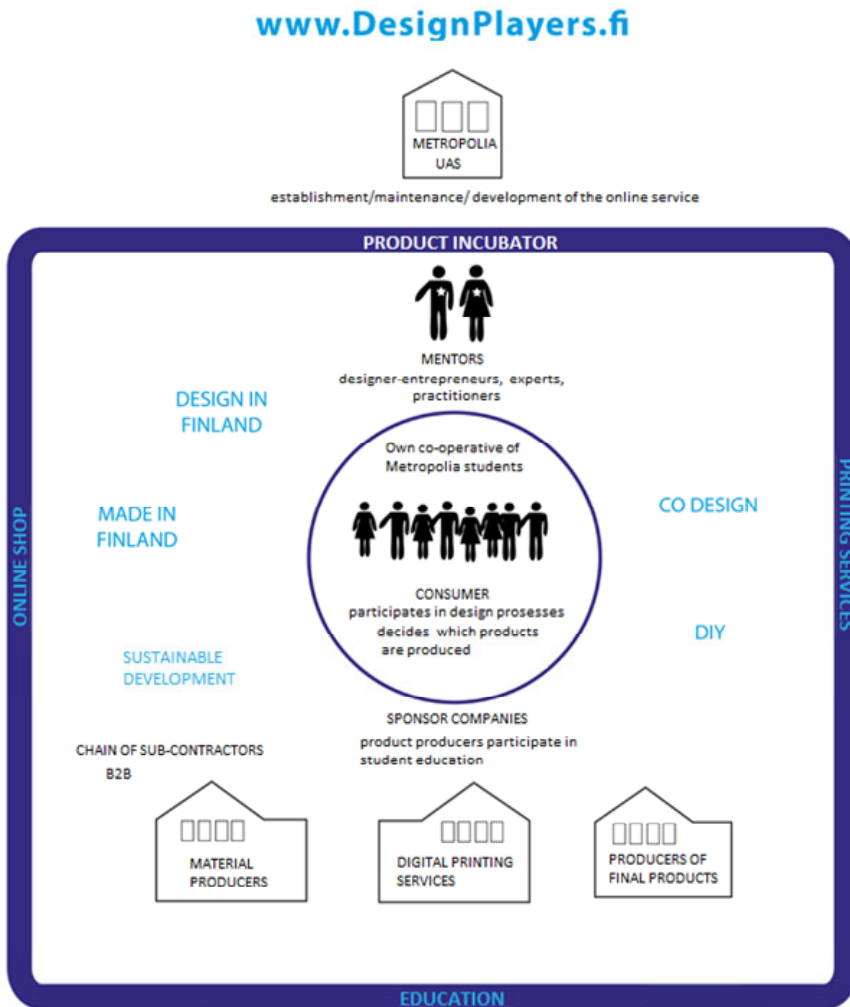
activity. Co-configuration appeared as the recognition of the innovativeness of the selected business model and as a commitment to the model.

**Table 3** Co-configuration process in the DPN

No.	Workshop (name and theme)	Object of co-configuration	Co-configuration event <i>B</i> = break, <i>T</i> = turning point	Levels of learning
1	<i>Consumer workshop</i> Envisioning future service and customer	What kind of products and for what types of customers?	B1: Both DIY customers and small and micro firms (B2B) as users of future service?	Project level
2	<i>Network learning workshop</i> Envisioning digital printing process and products	First service concept prototypes by students	T1: Economic realities and sharing of risks – profitability of customers' individual designs?	Product level and process level
3	<i>Consumer-user workshop</i> Concretisation of customer-user	Service path	T2: Crowdsourcing as a solution to simultaneous profitability and personalisation of production?	Process level
4	<i>Business modelling workshop 1</i> Modelling the network, roles, rights and responsibilities of the participants	Network model and commitment of participants	T3: Introduction of 'building block' in workshop discussion  B2: Both single building block and shared system as goal of project?	Project level vs. product level
5	<i>Business modelling workshop 2</i> Alternative models of business activity	Choice of service model	T4: Withdrawal of one network partner from project brought the breaks in co-configuration to the surface	Project level vs. concept level
6	<i>Business modelling workshop 3</i> Concretisation of network structure, roles and responsibilities	Selected business model and service portal	Innovation: Business model will be a cooperative, in which sustainability is based on students' learning, and profitability – on crowdsourcing (see Figure 4)	Project level + product level + concept level

The learning in this workshop was also about the consolidation of the levels. Learning happened in the interaction and intersection of the project, product and concept levels. The new service concept had the potential to bring these three levels together. The learning outcome was understanding that the network cooperation is complex and that to be sustainable it reaches beyond one single project.

Figure 4 DPN stakeholders map at end of project (see online version for colours)



Source: Paju et al. (2017)

#### 4.2 Summary of the findings

The analysis of the six workshops of the digital printing network highlighted the important co-configuration events and their effect on the change of the object of the network’s innovation activity. In the analysis, we referred to the object as the object of co-configuration, directing attention to both the common object, the customer-centred service concept; and its instantiations, the situational object, as it appeared to the participants in a given workshop; as well as the concept of customer, online service, cost-effectiveness, etc. Table 3 presents the whole co-configuration process.

The network began as a way to search for novel means of collaboration. During the co-configuration process, the original idea and the roles of network members changed entirely (compare Figures 1 and 4). By facing the challenges of implementing a service

for DIY customers and taking all the values into account, the network found completely new customers – design students. Figure 4 shows the changes in the network and the business model.

The result was a new, flexible business model for a cooperative in which customers are active members. It enables the network to temporarily rearrange itself according to how acute the needs of current and potential members are.

## **5 Discussion**

### *5.1 Results*

This study followed the creation process of a novel business model in a digital printing network. Digital printing offered a case in which to examine the conditions of sustainable innovation at work as learning through co-configuration, involving various stakeholders from education and work. The innovation analysed was a business model, first as a vision of a sustainable activity for digital printing and, finally, as a cooperative model achieved through co-configuration. As well as an innovative outcome, the co-configuration process can be seen as a process innovation (OECD/Eurostat, 2018), which we purposefully strived for in the project. We propose that this type of innovation process means that the network participants learn collectively across the levels of the network activities (Toviainen, 2003; Toiviainen and Vetoshkina, 2018). We formulated two research questions that guided our analysis:

- RQ1 How does the creation of a sustainable business model take shape in the constantly changing process of co-configuration?
- RQ2 What are the conditions of co-configuration and learning for sustainable innovation activity in the digital printing network?

To answer RQ1, we longitudinally followed the co-configuration of the object, which gradually transformed into the outcome of the process – a novel and sustainable business model. Our case demonstrated how, in the course of the workshops, the original idea of an online service for DIY and semi-professional designers transformed into an innovative solution of a students' cooperative at the University of Applied Sciences. The cooperative created functions as a business incubator for students – a path to future work life and a safe playground for testing design ideas and product collections.

The final business model was achieved through several phases of co-configuration events, empirically identified in the form of discursive breaks and turning points. These events took place in the workshops, made explorative and schismatic moments surface and led to a change in the focus of innovation activity. The analysis traced the constantly changing process of co-configuration. The application of the theory of expansive learning (Engeström, 2015) helped us realise and analyse the diversity of the co-configuration process. We also believe that the expansive learning potential of contradictions of activity is a fruitful approach to network research. Interpreted in this framework, the object-related discursive breaks and turning points are markers of learning. If not overcome, they become an obstacle to learning and development.

The analysis revealed that the creation of a sustainable business model took shape through the network members' problem-solving when dealing with the dilemma of

co-existing sustainability and profitability (De Vries, et al., 2015; Verburg and Wiegel, 1997). The breaks in the co-configuration process concerned the service for B2B customers and the building block model. Neither of these requirements were realised, which led to the withdrawal of one partner. We agree that innovations require a multiplicity of voices, which often rise in the face of a challenge or variety, even a crisis (Fenwick, 2003); sometimes even as nonsense (Sannino and Engeström, 2018). In Voltan's (2017) analysis relationship, diversity and network structure play a significant role in scaling social innovations.

As regards RQ2, the analysis provided knowledge on the conditions of co-configuration and learning for sustainable innovation activity in the digital printing network. We applied a conceptual framework of multiple levels of learning specified to this network from a previous analysis of the stakeholders' workshop in the starting phase of the project (Toiviainen and Vetoshkina, 2018). The preconception of the emerging levels thus functioned as a working hypothesis for this research. This differs from the approach of Toiviainen (2003), which explored the levels of learning in a process in which each step gave birth to a new level. In our case, these levels rather simultaneously developed in the process of co-configuration, although some of them became more visible in certain co-configuration events.

From our point of view, the conditions of learning are specific to each network or business ecosystem. Understanding learning as a multifaceted process means following it as a process of iterative cycles on different levels and through clashes between these levels, such as keeping to project routines instead of breaking out of originally defined roles to achieve unforeseen creative concepts. Pursuing a sustainable business model means that learning aims for concept-level transformation of the activity (Engeström et al., 2005; Virkkunen, 2007), which in this case materialised in the business model of a cooperative. However, instead of working directly on the concept level, the participants' co-figurative actions moved on and across the multiple levels of learning. Co-configuration was directed at various instantiations of the object of innovation activity. On the project level: What is the vision, who is committed? On the product level: what kind of products fulfil the requirements of sustainability, customer-centredness and economic feasibility? On the process level: What will the service paths look like, what are the qualities of an online service? (Table 3)

Before proceeding to the concept level, the clashes between the levels had to be iteratively faced and solved. We found that the participants had to work on the original business model given on the project level (Figure 1). This was based on a general idea of the sustainability of digital printing and local production. Through the process of co-configuration and learning on the product and process levels, the members came to understand that the initial goals of this project would not be achieved. The final concept of a cooperative model was unexpected, but it became the basis of sustainable innovation: it included students, and at the core of sustainability was learning.

Critical economic and Marxist studies often see cooperative forms of organisation as a new mode of production, alternative to the capitalist system (Jossa, 2012), or more recently, as a challenge to the corporate sharing economy (Sholz, 2012). Discussion on organising a cooperative in the specific context of DPN remains outside the scope of this study. The cooperative form of organisation of the network emerged as a sustainable business model, which implied novel and flexible organisation of the various stakeholders – from entrepreneurs to educational institutions. The role of the students in the network changed dramatically: from that of the project workforce to that of

customer-users, from assistants to active customers. This multi-level analysis leads us to suggest that the prerequisite for successful co-configuration and learning pursued in development projects is work on different levels, critical discussion and integration of the outcomes, as the sustainability of the conceptual-level innovation depends on the solutions and learning achieved on other levels.

## *5.2 Implications and limitations*

The answers to the research questions provided the grounds for formulating two points regarding innovation at work. We claimed that the sustainability of innovation requires learning across different levels of network activities. The innovation process is not only about learning on multiple levels; innovation is also a heterogeneous process in the sense that it generally blends different types of innovation. Discussion on the distinction between social and technological innovation has recently grown (Howaldt and Schwarz, 2010; Domanski and Kaletka, 2017). Innovations can be typologised in various ways, but from our point of view, classification is not necessarily fruitful. In the case of the digital printing network, the innovation was a new business model, a cooperative for active customer-students, which was embodied in an online service and involved local producers. This innovation had features of social, technological and economic innovations. In the modern world of work, it is often hard to distinguish between social and technological innovation, as objects in modern work with the presence of digitalisation are becoming more complex, with different instantiations (Toiviainen and Vetoshkina, 2018). Co-configuration allows the inclusion of all possible stakeholders and customers in the process of creating a sustainable business model. In this light it seems more productive to discuss innovations as a complex process rather than to distinguish between various types of innovations.

In our case of innovation creation, as in other cases (Nicolini et al., 2019), innovation was a longitudinal, adaptive and blended process, not a set of final solutions. Constant learning through co-configuration became the focus of the novel business model. This leads us to our second important point, as shown in our results: sustainable innovation does not mean a stable solution. Innovative solutions to complex problems at work cannot be final and stabilised, as these problems are in flux; constantly transforming, changing and expanding. Constantly changing and developing objects call for people's 'sustainability competences' (Wals and Schwarzin, 2012) and learning for the creation of adapting business models.

The network stakeholders expected a stable, final solution, as the co-configuration events illustrated: first, in following the initial project plan to address DIY customers; then, by revising the project plan to grasp the idea of a fixed building block. But none of these solutions led to a sustainable business model in the network. The sustainability of both the outcome innovation and the process innovation lay precisely in their instability and open-endedness – their ability to adapt to changing circumstances and take into account the needs of all the stakeholders in a business network. The cooperative being a flexible form of network organisation was a concrete materialisation of both process and outcome innovation. Process and outcome in the analysis of sustainable solutions are hard to separate. In CHAT, processes should be anchored in objects and outcomes of concrete activities when analysed (Vetoshkina, 2018).

Sustainable innovation should be understood as co-configuration of constant change, iterative recurring cycles of development, and the creation of an adaptive product (Wals and Shwartzin, 2012). Focus on learning and putting students in the centre of the network enabled support of sustainable values in the network: economic – businesswise rational joint activity of the network; social – opportunities for students to be part of the initially sustained network of stakeholders; and ecological – local producers using recycled products.

This study focuses on a single concrete case of the co-configuration of a sustainable innovation. This does not mean that concrete levels of learning and conditions of co-configuration can be directly transferred to similar networks between education and work. Our aim was not to create a general model, but to enrich the theoretical understanding of learning through co-configuration in a multi-level network (Engeström, 2015; Toiviainen, 2003). In our case, the potential transferability is in the principle (Pereira-Querol, 2011) of understanding the sustainable innovation created in the constantly changing process of co-configuration.

## **6 Conclusions**

Studies of sustainable work innovations to support a network's productive activity are still rare. This article has analysed one such case, namely the network of digital printing connecting higher vocational education and entrepreneurs in the textile, clothing and interior printing industry. The collaborative design activity during a development project was analysed as the process of learning through co-configuration. The methodology of the cultural-historical activity theory enables us to trace the object construction on multiple levels of network's learning, to identify the breaks and turning points, and to explore the final outcome – the cooperative – which radically deviated from the originally planned business model. The sustainability of the cooperative model was based on students' learning activity, which became the starting point for the entrepreneurs' commitment and willingness to learn. Placing the students in the centre made the ideas of ecological production, recycling and locality appear in the context of their vocational studies and resulted in a model that enabled experimentation and potentially professional growth.

Theoretically, sustainable innovations in networks require entering a long-term process of learning through co-configuration, during which the stakeholders together create activities on multiple levels and move creatively across the levels to reach models that leave pathways open to change and adaptation when the general understanding of sustainable development progresses. The understanding of sustainable work innovations may strongly benefit from studies that focus on the networks between vocational education institutions and entrepreneurs and small and medium-sized enterprises. This kind of collaboration in practice involves a wide range of innovation activities, whereas theories of innovation often focus on universities, larger organisations and companies.



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