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THE SUSTAINABILITY OF PACKAGING FOR E-COMMERCE: FROM SYSTEM TO PRODUCT.

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ABSTRACT

The e-commerce is a fast-growing sector, which has substantial impacts due to delocalisation, cost-effectiveness, rapidity and availability anywhere at any time. It implies not only a different logistic organisation but requires a radically different interaction between sellers and customers. This research aims at applying the concepts of local and sustainable development to the world of e-commerce, with particular attention to the role of packaging. The topic has been explored at two design levels: first, the methodology of Systemic Design was used to define innovative future scenarios for the logistic management of the e-commerce system; secondly, different eco-design methodologies have been used to focus on the development of packaging for different scenarios. The analysis allowed to establish the main guidelines for the definition of futuristic sustainable scenarios of logistics. Starting from these, six main trends for designing sustainable packaging have been identified and tested through real concepts.
Key Words: packaging design, systemic design, sustainable development, e-commerce

1. THE ENVIRONMENTAL CHALLENGES OF THE BOOMING E-COMMERCE INDUSTRY

The e-commerce represents a rapidly growing phenomenon, which interests almost all production sectors, and has substantial impacts at the global level. On-demand economy is booming and continues to expand into new businesses: although the future of this sector is still clouded, it will definitely change consumption patterns, supply chains, competitiveness, as well as local and global regulations (Kerrigan, 2018; Netcomm, 2018). Online marketplaces are able to offer product ranges broader than any store could offer, by providing real-time information and added value services to sellers and buyers (Kestenbaum, 2017): if businesses are getting closer to their consumers, e-commerce is also allowing people to come together through the use of information technology (Leonard & Jones, 2015). Both in Business-To-Consumer (B2C) and Consumer-To-Consumer (C2C) e-commerce, the relationship between sellers and buyers is mediated by digital infrastructures and aimed at buying and selling goods and services. However, the interaction with web 2.0 tools often brought to a more social and collaborative approach used in online marketplace (Parise & Guinan, 2008) to enhance users adding value by generating and sharing content (Huang & Benyoucef, 2013). This creative and, often, unpredictable way of communication represents a fresh social challenge. However, the way people interact with each other involves also environmental factors: in other words, the sustainability of the e-commerce system is deeply affected by how users behave by creating new relations and new information concerning each other and the products and services they buy. The Digital Age is reshaping our way of living towards a new "augmented reality" in which digital reality is inseparably linked with the physical one (Jurgenson, 2012); this leads to many consequences that we do not intend to address here. What we are concerned with is the importance of analysing the complex digital-physical system of e-commerce to understand the potentialities of sustainability.

The world of e-commerce marked a paradigm shift both in the logistic organisation and in the stakeholders' interactions. On the one hand, we are moving to a global scale that strengthens the trend towards delocalisation and cost-effectiveness but, on the other hand, e-commerce retailers need to be a regular presence at the local level to ensure rapidity and availability anywhere at any time, addressing different cultural and purchasing needs. Therefore, the design of products, packaging and services for e-commerce has to face pressing challenges: designers are required to deal with many different factors, from packaging materials and technologies to techniques for storage and delivery to data management and visualisation. At the same time, the widespread interest in sustainable development is bringing new requirements of sustainability to e-commerce, especially concerning consumption patterns.

This research contributes to the body of knowledge about this emerging sector, aiming at applying the concepts of local and sustainable development to the world of e-commerce, with particular attention to the role of packaging. Because of the complex and interconnected nature of an e-commerce system, the research has started from the analysis of the logistics systems, focusing on their criticalities and potentials towards sustainability. In the second phase, the study addressed the design of packaging for e-commerce, by analysing the current scenarios and identifying the main trends to follow to design sustainable packaging able to effectively dialogue with the e-commerce systems. The research project was carried out in collaboration with the National Consortium for the Recovery and Recycling of Cellulose-based Packaging (COMIECO) and has involved the students from the Design degrees at Politecnico di Torino. The joint work of academic researchers and students allowed to innovatively address the matter, leading to a combined perspective on the topic that was then discussed with local and international stakeholders working in the e-commerce sector.

2. RESEARCH METHODOLOGY: FROM SYSTEM TO PRODUCT

The current investigation has been driven by two primary research questions: firstly, which is the role of Design concerning e-commerce, and how can designers cope with the material and immaterial complexity of this sector? Secondly, how can Design support the sustainable development of e-commerce, and how can designers deal with the environmental issues that new purchasing models are leading?

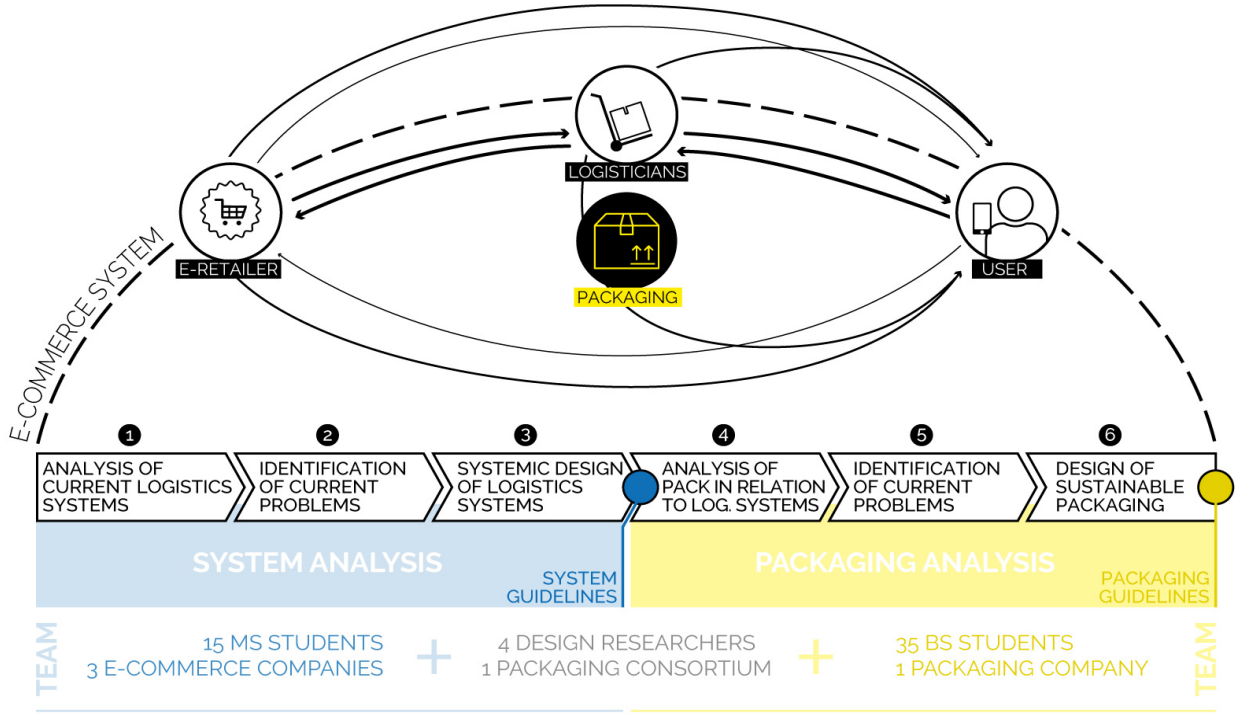
As outlined in the previous section, the complexity of the topic required to be approached at different design levels. The research project ran for one year and consisted of two phases: in the first one, a methodology based on the Systemic Design approach was used to define innovative future scenarios for the logistic management of e-commerce systems; in the second phase, different eco-design methodologies have been used to focus on the development of sustainable packaging.

Figure 1 illustrates in detail the six methodological steps that allowed to analyse e-commerce in depth, considering all the stakeholders involved and the two levels designers should act: the system and the product. Because in e-commerce we usually deal with retailers rather than manufacturers, the attention at the product level has focused on packaging, which represents a critical element as regards the environmental impact. Both in system and packaging, the analysis started from the current scenarios to identify the main existing problems from functional, communication and environmental points of view. After that, a design phase enabled us to give a response to the research questions through the definition of system and packaging concepts. The two levels of analysis are explained in detail in par. 2.1 and par. 2.2.

Moreover, the complexity of the topic required a multi-disciplinary team able to work and give feedbacks at different levels. A leading team of design researchers managed two groups of design students (enrolled in the op-

tional courses organised within the project) and kept regular contacts with different e-commerce stakeholders: the consortium COMIECO, three companies involved in the e-commerce logistics, and one packaging manufacturer. The stakeholders' involvement has been essential to give insights and get feedback on research achievements. Par. 2.3 provides a detailed description of the roles and tasks of the team.

[Figure 1] Visualisation of the methodological path of the research project



2.1. Analysis of the e-commerce system

The methodology adopted for the purposes of this research directly relates to the theoretical framework of Systemic Design (SD). Rather than a new discipline, we could define SD as a system-oriented design practice to tackle complex problems in complex systems. As Jones (2014) states, "Systemic Design is distinguished from service or experience design in terms of scale, social complexity and integration. SD is concerned with higher order systems that encompass multiple subsystems. By integrating systems thinking and its methods, SD brings human-centered design to complex, multi-stakeholder service systems [...]". The methodological approach to SD developed at Politecnico di Torino especially focuses on the environmental sustainability of the system, addressing social and economic issues from a holistic perspective. Particular emphasis is placed on the flows analysis, assessing the inputs and outputs of the system and the complex links they generate: material loops are open to decrease environmental impacts and resource depletion (Bistagnino, 2011; Barbero, 2019).

As described in the previous section, e-commerce systems have the distinctive features of complex socio-technical systems: they are widening the geography of markets, crossing different supply chains and combining both material and immaterial levels. They affect production, package, distribution and use of products, by changing the current purchasing patterns and involving different actors with radically new roles.

It was essential to distinguish between three main types of logistics systems:

- Horizontal marketplaces sell products from a large number of categories at national and global levels;
- Vertical marketplaces sell products from a particular industry sector;
- Small-scale retailers are small enterprises that usually sell niche products or local products (in the latter case it is called hyperlocal e-commerce).

Three steps of analysis have been applied to the categories listed above

1. Analysis of current logistics systems. The first step is based on the analysis of the different types of e-businesses. The analysis considered the interactions between stakeholders (retailers, logisticians, users) and the flows of matter (with particular attention to packaging) and information (both digital and physical).

2. Identification of problems. The analysis allowed identifying the main problems considering the environmental, functional and communication impacts of different systems. This step of analysis also highlighted the stakeholders affected by each issue.

3. Redesign of logistics systems. The final step focused on the redefinition of flows, thus identifying possible design solutions to apply to solve the issues highlighted in the previous step (see par. 3.1).

2.2. Analysis of packaging for e-commerce

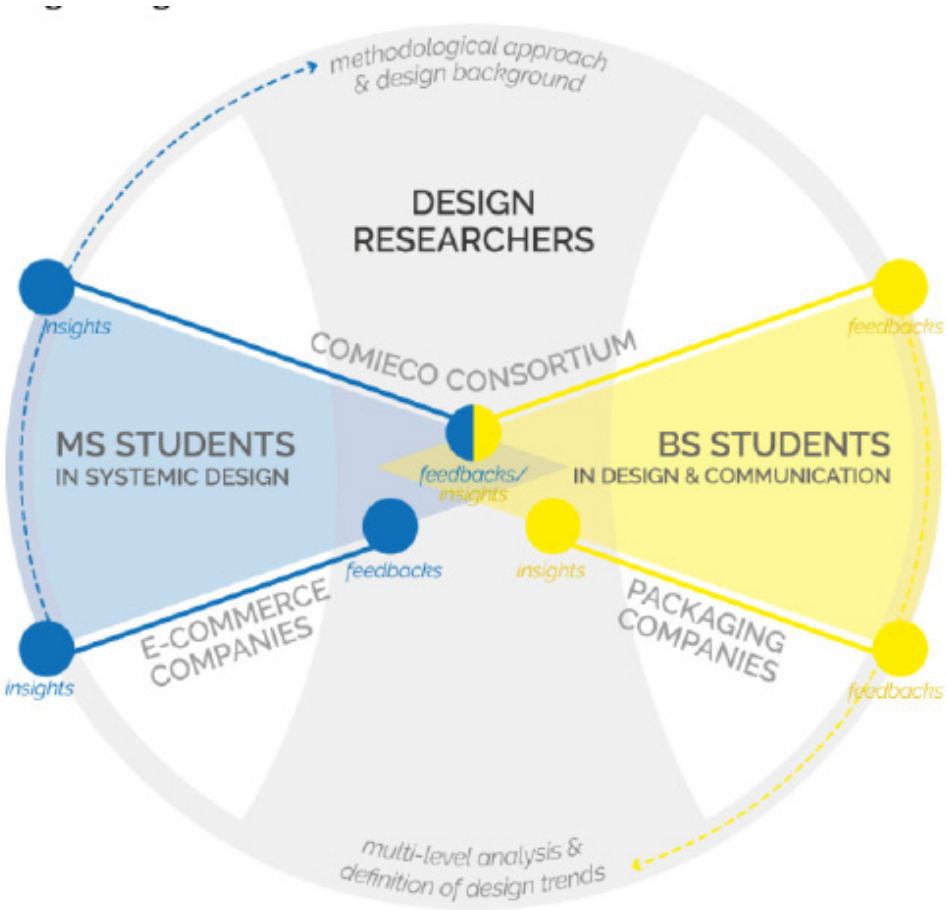
In e-commerce, packaging needs to meet new functional and logistics requirements, and it has to combine the func-

tions that in traditional scenarios are carried out by two different types of packaging (defined as primary and secondary packaging). In the e-commerce context, packaging has to complement the shopping experience, but it also has to answer the distribution requirements of an increasingly complex logistics.

The role of packaging is deeply interwoven within the e-commerce systems; therefore, the three-steps analysis started from the findings of the system analysis performed in the first phase:

- Analysis of packaging in current logistics systems. This step further expands the analysis of e-commerce systems focusing on the role of packaging within the system. It also assesses the interaction with intermediary users (in particular logistics operators) and final users.
- Identification of problems. The second step outlined the main problems affecting the environmental impact of packaging, but it also considered the functional and communication issues that may undermine packaging effectiveness concerning its logistics role and user interaction.
- Redesign of packaging. The last step set some key guidelines to advance the sustainability of packaging for e-commerce. The design of new concepts enabled to test the guidelines and start addressing the issues highlighted. The results achieved are presented in par. 3.2.

[Figure 2] The roles of teams and stakeholders involved in the project



2.3. Roles and tasks of the multidisciplinary team

As described in the introductory section, the complexity of the topic required a multi-disciplinary team able to work and give feedbacks at different levels (Figure 2). The leading research team was composed by four design researchers from Politecnico di Torino, that organised two training courses focused on Systemic and Packaging Design for e-commerce to enrol two groups of students from the Master Degree in Systemic Design and the Bachelor Degree in Design and Visual Communication at Politecnico di Torino. The leading team had regular contacts with the five stakeholders involved in the project:

- Consortium COMIECO: it represents hundreds of producers, importers and converters of cellulosic material and packaging. They are facing an increasing demand for cellulose-based packaging and are addressing the related problems of managing and recycling this type of waste.
- E-commerce companies: three companies working in e-commerce as retailers and logisticians are involved as direct stakeholders of the sector.
- Packaging companies: one manufacturer of packaging is involved as industrial stakeholder because of its interest in this emerging area.

The stakeholders provided valuable insights about e-commerce and gave technical and professional feedback on the students' work. The research team reinterpreted the stakeholders' observations to strengthen the design back-

ground of the project and included their feedback in the definition of the eco-guidelines.

3. RESULTS

In this work, we investigated the e-commerce sector from a design perspective, starting from the issues and potentials of different logistic systems to focus on the strategies to improve the sustainability of packaging. The analysis allowed to explore the two levels we examined (system and packaging): first, we set the leading design trends towards sustainable scenarios of logistics; secondly, we identified the main guidelines for designing sustainable packaging, that we tested through real concepts.

3.1. Results of the system analysis

The analysis was carried out on three different logistics systems (horizontal marketplace, vertical marketplace, small-scale retailers) and identified three critical points that are common to all the systems analysed. Table 1 reports these criticalities, the related issues and the design trends we defined.

On the whole, there are many problems concerning the waste of material and packaging, the lack of communication and interaction, the environmental impacts due to transportation on a large-scale. In terms of sustainability, designers should work on the relations between the stakeholders, rethinking the system to enhance direct communications and greater attention to the local impact. Transparency and flexibility should characterise the new e-commerce systems to drive innovation from a systemic perspective and realise the potential of a sustainable digital economy.

[Table 1] The main criticalities highlighted in the system analysis and the related potentialities to address

CRITICALITIES OF E-COMMERCE SYSTEMS		POTENTIALITIES IN TERMS OF SUSTAINABILITY
Criticality	**Related issues**	**Trends**
Lack of a systemic perspective	> waste of material > use of multiple disposable packaging > anonym packaging	Design a PACKAGING that considers all the steps of logistics and the needs of the actors handling it. Re-think the PRODUCT DELIVERY to optimize transportation and packaging
Lack of relations between actors	> lack of users' feedback > reduced transparency of communication > communication limits imposed by the scale	Design a NETWORK OF RELATIONS between producers, retailers and users to enhance the transparency of the system
Lack of relation with the territory	> limited focus on local products > transportation impacts > disposal and reuse of packaging	Design MULTI-CENTERED SYSTEMS widespread on the territory to add value to local resources while reducing the impact of transportation

3.2. Results of the packaging analysis

The analysis concerned different types of packaging used in different logistic systems; the aim was to identify the common criticalities and the related issues. Table 2 summarises the main results and describes the six guidelines that we defined starting from the highlighted problems. The principal issues designers should address to improve the sustainability of packaging for e-commerce affect the functionality of use (flexibility, customisation), the interaction with the users (communication, awareness) and the management and disposal of the packaging (lifecycle and reuse, end of life).

[The team of bachelor students implemented these guidelines, testing them through different concepts of packaging that could fit the needs of horizontal marketplaces, vertical marketplaces or small-scale retailers (Figure 3). The industrial stakeholder gives periodical advice and feedback about the students' work: the resulting projects propose futuristic packaging that could be possible to produce on a medium-large scale.

4. CONCLUSIONS

The research contributes to the body of knowledge in the areas of Systemic Design and Packaging Design for sustainability, investigating the emerging topic of e-commerce that is raising concerns about the sustainability of future consumption patterns.

This study is an interesting case of a research project that jointly deals with the design of systems and products (packaging), also considering in the analysis the strong orientation of e-commerce towards service. It represented, therefore, a valuable opportunity to address complex problems that synergistically involve the three scales of design: system, service, product.

Table 2] The main criticalities highlighted in the packaging analysis and the related potentialities to address

CRITICALITIES OF E-COMMERCE PACKAGING		POTENTIALITIES IN TERMS OF SUSTAINABILITY
Criticality	**Related issues**	**Guidelines**
Non-joint design of product and packaging	> Use of multiple disposable packaging > Waste of material > Handling problems > Functional issues	1. LIFECYCLE AND REUSE: design new logistic strategies to adopt reusable packaging and/or to give a second life to single-use packaging. 2. COMMUNICATION: design the aesthetics together with the function; improve the "unboxing" experience.
Non-optimized shapes and volumes	> Oversized packaging > Waste of material > Higher impact for transport	3. FLEXIBILITY: design for variable amounts and typologies of goods. 4. CUSTOMISATION: design for creation of customized packaging.
Lack of attention towards the end of life of packaging	> Widespread use of single-use packaging > Waste of material > Difficulties in recycling	5. END OF LIFE: design for involving users in the management of the end of life of the packaging through the reuse or the recycling. 6. AWARENESS: design for increasing sustainable and informed purchasing behaviours.

The combination of academic research and training courses is an important means of achieving innovative results, facing the topic from different perspectives and free of technical constraints imposed by productive and organisational environments and structures. At the same time, the regular interaction with a National Consortium and several industrial partners allows to include the perspective of the stakeholders that are working at the coalface in the e-commerce sector. The results achieved have been thoroughly discussed within an interdisciplinary and cross-sectoral team; therefore, the findings of this multi-level analysis represent an effective design reflection and experimentation that set the trends to follow to bring e-commerce onto a sustainable path.

[Figure 3] Some packaging concepts designed by the team of bachelor students enrolled in the project

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