

Case Report

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THE NEW MILLENIUM – THE BEGINNING OF THE PORTUGUESE EV INDUSTRY FROM AN INDUSTRIAL DESIGN PERSPECTIVE?

O Novo Milénio – O arranque da indústria portuguesa de VEs numa perspectiva do design industrial?

RICARDO SANTOS¹

Writing - Original Draft

ORCID: 0000-0002-6249-3512

¹CIEBA-UL-Centro de Investigação e de Estudos em Belas-Artes

ABSTRACT

This study is grounded in the field of Industrial Design, examining how early electrification initiatives contributed to the development of automotive design capabilities in Portugal. It presents preliminary findings from postdoctoral research exploring the early stages of electrification in the Portuguese automotive industry during the beginning of the 21st century. It examines key initiatives such as the P3 Project, CEIIA (Centre for Excellence and Innovation in the Automotive Industry), and CEDP (Product Engineering and Development Centre), which aimed to position Portugal as a hub for niche small electric vehicles (SEVs) while developing local capabilities in product design, engineering, and R&D.

Although this work stems from a broader postdoctoral investigation, it represents a preliminary academic study focused on the development of design capabilities within educational contexts. These capabilities are intended to be transferred to the industrial ecosystem through the integration of trained professionals, reinforcing the long-term innovation capacity of the Portuguese mobility sector.

The paper also highlights the challenges faced, such as systemic lock-in effects and insufficient national support, which hindered the full potential of these initiatives. Nonetheless, the legacy of these projects continues, notably through CEIIA's role in developing multiple electric vehicles in recent years. This analysis concludes that the early 2000s marked the beginning of Portugal's engagement with the EV industry, fostering the development of product

RESUMO

Este estudo assenta no domínio do Design Industrial, examinando de que forma as primeiras iniciativas de electrificação contribuíram para o desenvolvimento das competências de design automóvel em Portugal. Apresentam-se resultados preliminares de uma investigação de pós-doutoramento que explora as primeiras fases da eletrificação da indústria automóvel portuguesa no início do século XXI. Analisa iniciativas-chave como o Projeto P3, o CEIIA (Centro para a Excelência e Inovação da Indústria Automóvel) e o CEDP (Centro de Engenharia e Desenvolvimento de Produto), que procuraram posicionar Portugal como um polo de desenvolvimento de pequenos veículos elétricos (SEVs), reforçando simultaneamente as competências em design do produto, engenharia e R&D.

Embora o trabalho se enquadre numa investigação de pós-doutoramento mais ampla, este artigo constitui um estudo académico preliminar centrado no desenvolvimento de competências de design em contexto educativo. Estas competências serão posteriormente transferidas para o tecido industrial através da integração dos estudantes no mercado de trabalho, contribuindo para a inovação e competitividade a longo prazo do setor da mobilidade em Portugal.

O artigo destaca também os desafios enfrentados, como o efeito de lock-in sistémico e o insuficiente apoio estatal, que limitaram o pleno potencial dessas iniciativas. No entanto, o legado destes projetos permanece, especialmente através do papel do CEIIA no desenvolvimento de vários veículos elétricos nos últimos anos. A análise conclui que os primeiros anos do novo milénio marcaram o início do envolvimento de Portugal com a indústria de VEs, fomentando

Correspondent Author:

Ricardo Santos, Largo da Academia Nacional de Belas-Artes, 1249-058 Lisboa, Portugal, r.santos@belasartes.ulisboa.pt

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design and engineering capabilities crucial for future advancements in electric mobility.

o desenvolvimento de competências em design de produto e engenharia cruciais para futuros avanços na mobilidade elétrica.

KEYWORDS

Industrial Design; Product Design; Automotive Design; Product Development; Design Education; Small Electric Vehicle.

PALAVRAS-CHAVE

Design Industrial; Design do Produto; Design Automóvel; Desenvolvimento do Produto; Educação em Design; Pequeno Veículo Elétrico.

1. INTRODUCTION

This investigation adopts an Industrial Design lens, positioning electric vehicle development as a driver for design culture, product ideation and capability-building within the Portuguese automotive ecosystem.

The early 2000s marked a turning point for Portugal's automotive industry, as emerging initiatives began to shift the country's role from a manufacturing base toward a center of product design, engineering, and innovation. This paper presents preliminary findings from postdoctoral research that investigates critical product design capabilities for Small Electric Vehicles (SEVs) in Portugal, based on the EcoCar — a symbiotic SEV concept developed in 2006 (Parra, 2021).

Although this research originates within a broader postdoctoral project, this paper represents a preliminary academic study rather than the beginning of that investigation. The postdoctoral project itself is primarily aimed at developing design competences among students — cultivating skills that can later be transferred to the industrial sector through professional practice. Consequently, while the direct focus is academic, the strategic implications extend to the industrial ecosystem, as future professionals trained within this framework will carry these advanced capabilities into the industry, fostering innovation and collaboration.

This study addresses the central question: Did early electrification initiatives in the Portuguese automotive industry aim to position Portugal as a hub for the development of niche SEVs and strengthen local suppliers' capabilities in product design, engineering, and R&D? By examining this question, this research explores how early projects sought to overcome systemic barriers within the Portuguese supply network—such as limited firm scale, weak R&D capacity, and insufficient integration into international value chains—while promoting technological and organizational transformation.

The P3 Project, developed in partnership with Pininfarina, serves as a key case study. Conceived as a modular, city-focused electric vehicle, it represented one of the first comprehensive efforts to embed design and engineering capabilities within Portugal's automotive ecosystem. Despite its premature termination, P3 established the groundwork for subsequent initiatives, particularly through CEIIA's continuing contributions to the design and engineering of electric mobility solutions.

Methodologically, this research combines historical analysis and case study approaches to trace the evolution and impact of these pioneering projects. Through this analytical framework, the paper highlights how early electrification efforts—though limited in duration—played a formative role in building the technological and design foundations necessary for Portugal's contemporary engagement with electric vehicle innovation. Ultimately, this study argues that the early 21st century marked the beginning of Portugal's transition from a peripheral manufacturing base to an emerging actor in the European electric mobility landscape. The legacy of these initiatives continues

to influence both academic formation and industrial practice, aligning educational objectives with national strategies for sustainable innovation capabilities.

2. DESIGN AS STRATEGIC CAPABILITY

In this study, design is understood not only as a styling or engineering support function, but as a strategic discipline structuring product innovation, capability development and cultural transformation. In countries with a weak industrial design matrix, such as Portugal, early EV initiatives represent critical moments in the emergence of design culture and professional practice.

3. HISTORICAL OVERVIEW

At the dawn of the new millennium, the internal and external reconfigurations of the international automotive industry network created a situation where many Portuguese suppliers found themselves stuck in what is known as a lock-in position (Camacho, 2001a).

The disconnect between market dynamics (inherent to industry restructuring) and company evolution revealed a systematic failure. The primary characteristics observed among Portuguese automotive suppliers in the early 2000s (which resulted in this failure) can be identified. (1) The limited scale of enterprises, insufficient product development and engineering activities (and the necessary organizational environment for expanding innovation processes), (2) inadequate R&D operations (along with disconnection from technological infrastructure and academic institutions), (3) internationalization and investment efforts not supported by advancement in strategic value chain areas, (4) inadequate corporate networking, (5) insufficient appropriately qualified personnel, a requirement that, (considering the existing local market) proved unsuitable for the industry standards demanded in the new millennium (Camacho, 2001a).

The systemic challenges faced by Portuguese suppliers, mirror those identified in recent studies on the conceptual design of new urban delivery vehicles (Hermann et al., 2023), which emphasize the need for integrated, flexible engineering practices to respond to shifting mobility demands.

As mentioned, these systemic failure indicators created a lock-in effect regarding the business advancement of Portuguese automotive suppliers. Consequently, there emerged a necessity to operate in upstream sections of the value chain (product development, engineering and R&D). However, developing these activities was only feasible under specific conditions determined by the size and clustering of these companies. Since the absence of crucial resources generates negative effects across upstream and downstream networks within the interdependent company system, the need for transformation to alleviate the described market constraint became evident (Camacho, 2001a).

The implementation of strategies promoting internationalization among Portuguese automotive industry suppliers significantly influenced the initial years of the century. The P3 Project, CEIIA (Centre for Excellence and Innovation in the Automotive Industry), CEDP (Product Engineering and Development Centre), and the INAUTO (Intelligence and Innovation for Automotive Industry Development) project represented efforts to enhance capabilities in product design, engineering and R&D.

4. THE P3 PROJECT

The P3 project formed part of a comprehensive strategy aiming to enhance capabilities in product design, engineering and R&D activities among Portuguese small-scale automotive industry suppliers.

The P3 Project originated from Pininfarina's Metrocubo concept vehicle. This compact urban car debuted as a concept at the Frankfurt Show in September 1999. According to Lorenzo Ramaciotti, general manager of Pininfarina's R&D operations, "The dream of fitting a lot of people into a small space has been pursued since the 'prehistory' of automotive design. Think of Dante Giacosa's Fiat 500 or Alec Issigoni's Mini" (Barufaldi, 1999, p. 16).

The foundation for developing this concept was Michelin's creation of its run-flat system (RFS) – the PAX System tires, which eliminated the need for space to accommodate a spare wheel, thereby freeing the entire floor area for alternative uses.

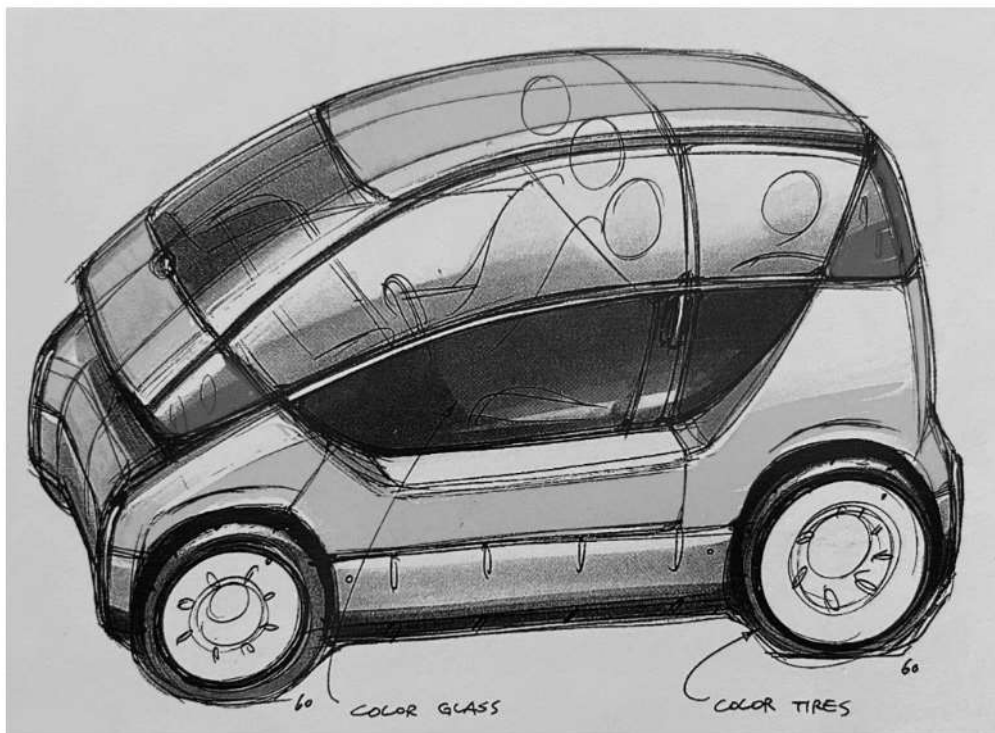


Fig. 1 - P3: Preliminary Sketch of Styling

Note. Source: Adapted from (Barufaldi, 1999, p. 17)

Since Michelin's PAX System tires were more compact than conventional types, designers could implement smaller wheel arches, facilitating vehicle entry and exit. This provided passengers with an additional 22% legroom. This design feature enabled the accommodation of three front seats. At the rear, also utilizing the possibilities offered by Michelin's Pax System tires, the P3 leveraged the additional space within the wheel to house suspension mounting points, minimizing the transverse dimensions of the rear suspension assembly. Furthermore, this approach allowed for a lower rear floor, thus enabling the design of a third rear passenger door.

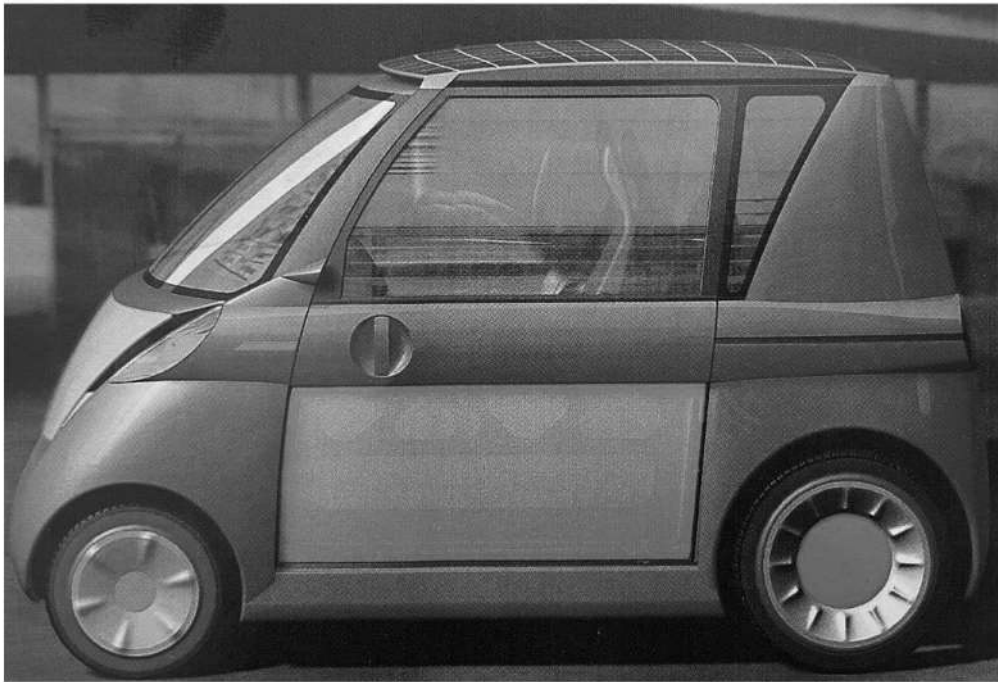


Fig. 2 - P3: A CAS Render
 Note. Source: Adapted from (Barufaldi, 1999, p. 18)

As Pininfarina's Metrocubo concept was a fully electric model, the floor structure employed extruded aluminum to accommodate the batteries. According to Lorenzo Ramaciotti, "The floor plan is about 20 cm deep and made of extra-thick extruded sections, so that the side members become bearing structures rounded off by the upper part of the body frame which supports the body-work panels and makes its own, albeit minor contribution to the rigidity of the floorplan" (Barufaldi, 1999, p. 17).

These mechanical design elements complemented the interior's modularity. In addition to the three front seats, two more could be positioned against the side walls facing inward. Alternatively, this space could serve various functions, such as a Sports Utility Vehicle (transporting sports equipment), a Professional Vehicle (carrying toolboxes or related materials), or for postal and logistics services (ideal for last-mile deliveries where fuel efficiency and space optimization are critical).

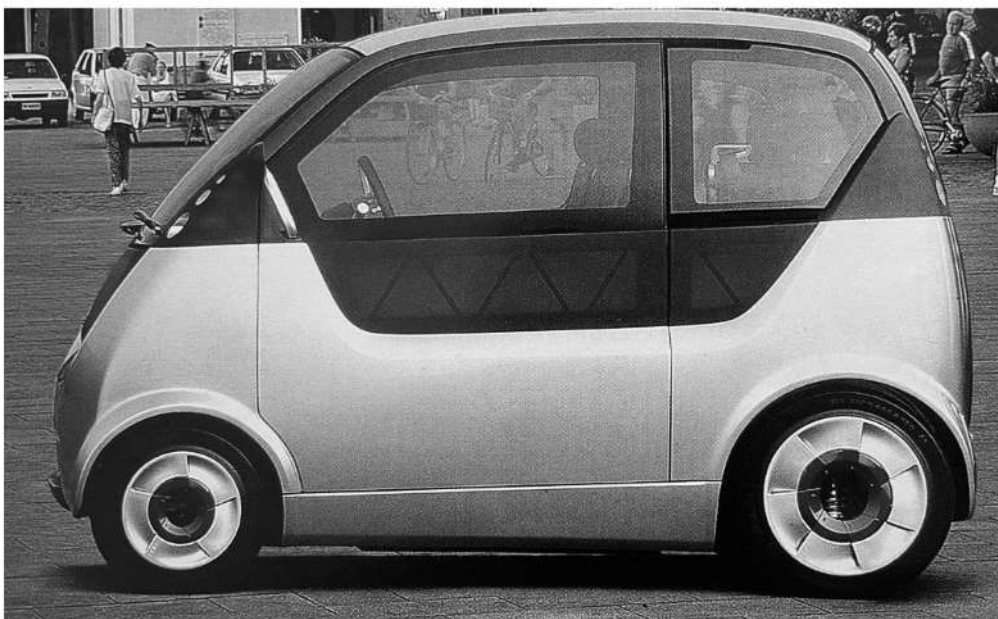


Fig. 3 - P3: Fully Functional Prototype
 Note. Source: Adapted from (Barufaldi, 1999, p. 22)

As Lorenzo Ramaciotti explains (as cited in Barufaldi, 1999, p. 18), “We designed the interior as an empty cube, in order to emphasize the spacious, modular character of the cabin (...) you can move all the seats so that nothing remains except the seat slides on the flat floor and a facia that we have made as simple as possible because we didn’t want to use complicated shapes interfering with the possible uses of the interior”. Metrocubo’s modularity was achieved through innovative seating. The completely foldable and sliding seats featured a straightforward deckchair-style aluminum framework covered with specialized plastic fiber with a soft underside, incorporating supportive cushions filled with specialized gel positioned at the seat’s lower-back level. Additionally, this padding absorbed and distributed pressure, ensuring proper passenger posture and enhancing comfort (Barufaldi, 1999).

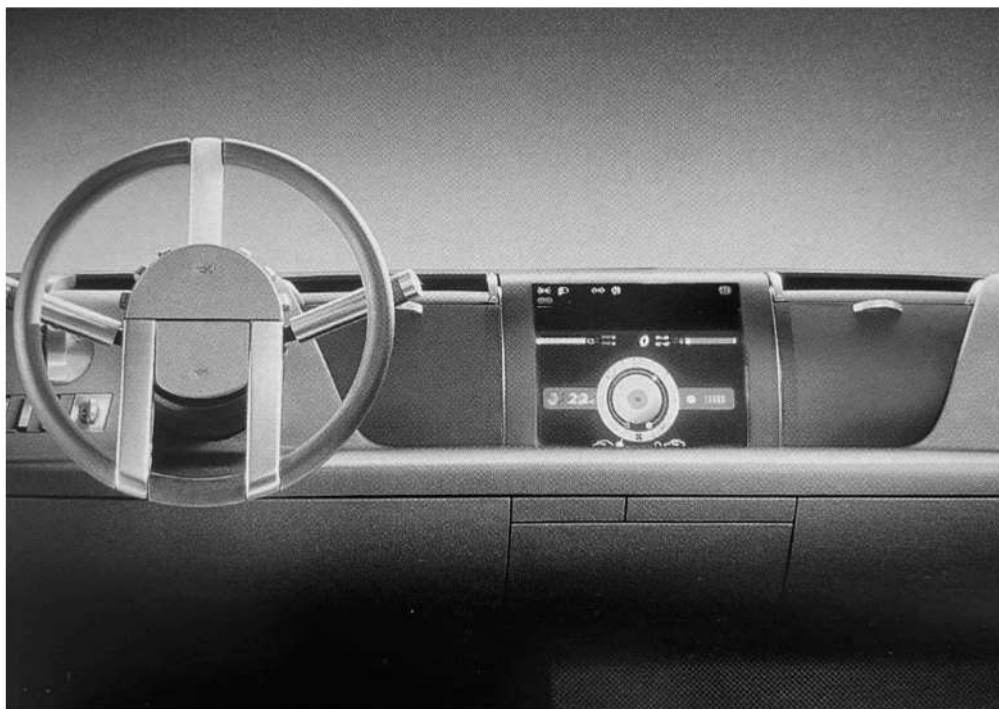


Fig. 4 - P3: Interior Trim
Dashboard detail

Note. Source: Adapted from
(Barufaldi, 1999, p. 23)

In May 2001, the Portuguese authorities and the Pininfarina group signed a contract to develop a new vehicle concept. This initiative aimed to create an innovative, flexible, modular hybrid powertrain and platform designed to target various market niches (Camacho, 2001b). The P3 project was divided into three stages: study and planning, engineering and development, and industrialization (Selada, 2002).

The multidisciplinary project team, coordinated by Pininfarina Studi e Ricerche S.p.a, initially involved collaboration with academic institutions including Massachusetts Institute of Technology (MIT, USA), Pennsylvania State University (PSU, USA), Instituto Superior Técnico (IST, Portugal), and INTELI – Intelligence in Innovation (Portugal). The team’s primary objective was to establish an integrated knowledge foundation covering areas such as spaceframes and flexible platform design, approaches to systemic urban challenges and innovative vehicle concepts, as well as environmental performance and regulatory considerations (Camacho, 2001b).



Fig. 5 - P3: Modular Seat Concept and Sliding Seats
 Note. Source: Adapted from (Barufaldi, 1999, p. 23)

In a pioneering initiative, engineering firms and domestic suppliers, supported by the Portuguese government, joined forces to usher in a new era for Portugal's automotive sector. This collaboration substantially increased their participation in automotive product design, development, and engineering processes (Camacho, 2001b). During the restructuring period, Portuguese suppliers struggled to compete with major European automotive suppliers due to their restricted size, limited technological capabilities, and insufficient supportive local networking environments. However, the AutoEuropa initiative enabled them to become competitive and attract diverse customers in both domestic and international markets. While Portuguese enterprises have successfully integrated into global supply networks, their position remains somewhat intermediate. The P3 Project constituted part of a broader, coordinated effort that included establishing institutional platforms to support commercial and R&D initiatives involving both Portuguese and multinational companies (Camacho, 2001b).

5. THE CEIIA AND CEPD PROJECTS

CEIIA was established in December 1999 with the objective of enhancing the competitiveness of Portugal's automotive sector by supporting companies' development of technical skills and strategic capabilities, establishing organizational, technological, and financial synergies enabling them to secure and maintain competitive advantages, thereby ensuring improved positioning in global markets. CEIIA's foundation involved a partnership with Pininfarina for the P3 project's development (CEDP, 2004). In December 2002, CEPD was established to provide the Portuguese automotive and aeronautical clusters with advanced technological capabilities in product development and innovation, aligned with global market trends, coordinated with a network of technological consortia, employing collaborative methodologies to foster new expertise in product engineering and design within companies (CEDP, 2004).

The establishment of CEIIA and CEDP formed part of a broader strategy to enhance Portugal's attractiveness for foreign direct investment by improving technological standards. These centers began operations before the P3 project's launch, though their principal aim was to fully support P3's second phase: development and engineering. The establishment of CEIIA and CEDP formed part of a broader strategy to enhance Portugal's attractiveness for foreign direct investment by improving technological standards. These centers began operations before the P3 project's launch, though their principal aim was to fully support P3's second phase: development and engineering. Following the P3 project's abrupt termination, CEIIA and CEDP merged and redirected their focus toward supporting comprehensive product development, from conceptualization and design through pre-production. Their project portfolio encompasses collaborations with OEMs, Tier 1 companies, Portuguese automotive suppliers, and various aeronautical clients.

6. THE INAUTO PROJECT

Around 2000, CEIIA and Portuguese authorities, through the Innovation Intelligence Center (INTELI), initiated a new undertaking – the INAUTO project. This initiative aimed to boost Portuguese automotive industry competitiveness by supporting companies' development of technical skills and strategic capabilities, fostering organizational, technological, and financial synergies enabling them to secure and maintain competitive advantages for improved international market positioning.

- The INAUTO project was structured around four domains:
- Technological advancement and management practice optimization.
- Human resource development.
- Technology and innovation management.
- National industry promotion.

Among INAUTO's activities was the "Systemic Characterization of Product Development Processes in the Automotive Industry," an initiative within the project's third intervention axis aimed at creating a framework for strategy formulation, featuring quality information and forward-looking analysis that is usable by any company or group to define specific strategies, particularly regarding product development. The INAUTO project endeavored to establish a genuine automotive industry cluster in Portugal, stimulating growth in technological sector skills and capabilities. Unfortunately, due to insufficient national institutional support, the INAUTO project was discontinued in 2003.

7. CONCLUSIONS

The main goal of the P3 project was positioning Portugal as an ideal location for the development of complete automotive programs (design and production) for niche vehicles and small series, creating a necessary work frame for the direct integration of national companies along the entire value chain, thus promoting a new stage of development for the Portuguese suppliers, strongly empowered by the engineering, product development and R&D capabilities as well as fostering the growth of these companies (Selada, 2002).

These findings resonate with the current global trend toward modular and design-driven approaches to urban electric mobility (Frizziero et al., 2023; Srinivasan & Khare, 2022), demonstrating that the early Portuguese initiatives anticipated several of the design principles now central to contemporary electric vehicle innovation.

Unfortunately, due to insufficient national institutional backing, the P3 project was terminated. Nevertheless, it established foundations for CEIIA current operations center.

The P3 project, given its design characteristics, was conceived as a genuine urban electric vehicle. This represented an initial opportunity to develop local product design and engineering design capabilities focused on small electric city cars.

The P3 project's unexpected conclusion did not end this endeavor. Subsequently, the CEIIA project has become a Portuguese reference for sustainable mobility design, product development, and innovation capabilities. Since then, CEIIA has fully or partially developed the following vehicles: Vinci GT (2006), Futi (2008), Buddy (2009), Mobi.car (2010), Be (2014), and Ben (2017).

Did early electrification initiatives in the Portuguese automotive industry aim to position Portugal as a hub for niche small electric vehicle (SEV) development and strengthen local suppliers' capabilities in product design, engineering, and R&D? The research question should be answered affirmatively, as over the past fifteen years, CEIIA and other Portuguese enterprises have been developing small electric urban vehicles. The P3 project truly represented the initial endeavor for this vehicle category and consequently the development of product design and engineering design capabilities in Portugal.

Furthermore, the results discussed in this study highlight the strategic importance of fostering design capabilities within academic contexts as a means of strengthening the national mobility innovation ecosystem. By developing advanced skills in product design among students, higher education institutions contribute to the progressive diffusion of a design-oriented culture in industry. As these professionals enter the labor market, they carry with them methods, values and creative practices that expand the capacity of companies to innovate, particularly in sectors undergoing technological transition such as electric mobility. Therefore, the article contributes primarily to the field of Industrial Design by evidencing how early EV projects acted as catalysts for design culture, design education and national capability-building. In this sense, the impact of the initiatives examined extend beyond their historical and industrial context, demonstrating how educational and industrial strategies can be mutually reinforcing in shaping the evolution of design culture in Portugal.

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NOTES

- [1] CAS – Computer Aided Styling
- [2] CEDP - Centro de Engenharia e Desenvolvimento de Produto
- [3] CEIIA - Centro para Excelência e Inovação para a Indústria Automóvel
- [4] R&D – Research and Development
- [5] RFS – Run Flat System
- [6] SEV – Small Electric Vehicle

LIST OF ABBREVIATIONS

CAS – Computer-Aided Styling
 CEDP – Centro de Engenharia e Desenvolvimento de Produto
 CEIIA – Centro para Excelência e Inovação para a Indústria Automóvel
 R&D – Research and Development
 RFS – Run Flat System
 SEV – Small Electric Vehicle

NOTES ABOUT AUTHOR

Ricardo Santos

Senior Industrial Designer with demonstrated skills in Product Development, Product Design, Project Management and Industrial Processes and Materials. Bachelor of Science in Mechanical Engineer (BSc), Master of Science (MSc) in Product Design and PhD in Design. Currently assistant professor at University of Lisbon - Faculty of Fine-Arts and University of Economics and Human Sciences in Warsaw. Senior researcher at CIEBA-UL in Lisbon.

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