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EFFICIENCY OF THE PRODUCT-DEVELOPMENT PROCESS AS A FACTOR DETERMINING THE EFFECTIVENESS OF IMPLEMENTATION FOR SUBSEQUENT PROJECT PHASES ACC APQP

UČINKOVITOST RAZVOJA PROCESA IZDELAVE KOT FAKTOR, KI DOLOČUJE USPEŠNOST IZVEDBE KASNEJŠIH PROJEKTNIH FAZ PLANIRANJA KAKOVOSTI NAPREDNIH IZDELKOV (PKNI)

Łukasz Rudolf*, Marek Roszak

Silesian University of Technology, School of Doctors, Faculty of Mechanical Engineering, Department of Engineering Materials and Biomaterials, Stanisława Konarskiego 18A St., 44-100 Gliwice

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This study presents a tool integrating PDCA Deming cycle and Design for Six Sigma principles to aid component development (especially dedicated for innovative projects). Designed for universal use across APQP (Advanced Product Quality Planning) phases, the tool guides through five key stages: Identify, Define, Design, Optimize, and Validate. Each stage involves specific actions and approvals, ensuring thorough development and risk assessment. Notably, the tool accommodates changing product requirements and validation challenges, allowing for adjustments without project delays. Its adaptability within the APQP framework is crucial for complex product development. The implementation at Tenneco demonstrates its effectiveness in structuring and overseeing development processes and improving project outcomes. Future analyses will delve into its impact and guide further research.

Keywords: product development, PDAC, quality planning tools, change management

Avtorja predstavljata študijo orodja za tako imenovano celovito načrtovanje z Demingovim krogom »Planiraj-Naredi-Kontroliraj-Ukrepaj« (PDCA; angl.: Plan-Do-Check-Act) in oblikovanjem s šestimi sigma temelji (DSSP; angl..: Dsign for Six Sigma principles) kot pomoč pri razvoju novih komponent (še posebej namenjenih za inovativne projekte). Orodje je oblikovano za univerzalno uporabo preko faz kvalitetnega planiranja naprednih izdelkov (APQP; Advanced Product Quality Planning) in orodij ki vodijo skozi pet ključnih stopenj ali faz: »Identificiraj, Definiraj, Oblikuj, Optimiziraj, Potrdi« (angl.: Identify, Define, Design, Optimize, and Validate). V vsako fazo so vključena specifična dejanja oziroma akcije in presoje, ki zagotavljajo natančen razvoj in oceno tveganja. Pomembno je, da je orodje prilagojeno eventualnim zahtevam po spremembi izdelka in izzivom njegove legalizacije, ne da bi pri tem prišlo do zamud pri realizaciji projekta. Njegova prilagodljivost v okviru faz kvalitetnega planiranja naprednih izdelkov je odločilna za razvoj kompliciranih izdelkov.Uporaba pričujočega orodja v firmi Tenneco je pokazala njegovo učinkovitost v strukturiranju in nadzoru razvojnih procesov ter izboljšanje rezultatov projekta. Prihodnje analize pa bodo pokazale njegov vpliv in vodilo za nadaljnje raziskave.

Ključne besede: razvoj izdelka, metoda »planiraj-naredi-kontroliraj-ukrepa«j (PNKU), orodja za kvalitetno planiranje, sprememba upravljanja

1 INTRODUCTION

Due to the high market demands for cars, manufacturers associated with the automotive industry are expected to minimize the time needed for product development and production, in parallel with the high expectations for reliability. In many cases, the correct implementation of the APQP methodology requires support with additional planning tools aimed at increasing the efficiency of implementing subsequent phases of the APQP; this is particularly important in the case of new, innovative, complex products.[1–3]

The result of the research conducted at Tenneco Automotive Eastern Europe for the department responsible for the development of a product, such as an electronically controlled shock absorber, is an original tool that systematizes actions and tasks that need to be taken to correctly define requirements, design, optimize and validate a new product. The fundamental goal was to design a universal planning tool regardless of the component or assembly being developed or modified. It was also essential to use the designed tool irrespective of the phase of the APQP in which the project is located.

2 EXPERIMENTAL PART

As part of the conducted research, a tool was created to support the development of a new component, assembly, or introducing changes to an existing one. The developed tool is based on the concepts of the PDCA Deming cycle (Plan-Do-Check-Act) and Design for Six Sigma. A key priority during the design of the new tool was to enable its universal and easy application, regardless of the

*Corresponding author's e-mail:
lukasz.rudolf@polsl.pl (Łukasz Rudolf)

type of component being developed and the phase of APQP in which the project is currently located.[4,5]

3 RESULTS

The proprietary tool (presented in a simplified version in **Figure 1**) divides developing or modifying a component or assembly into 5 phases (Identity, Define, Design, Optimize, and Validate). Transition to the next phase requires completion and approval of specific actions from the previous phase. The individual phases are characterized below:

1. IDENTIFY: A favourable decision to initiate the development process of a new component or introduce changes to an existing one.

2. DEFINE: Completing, analysing, and, where required, quantifying the requirements for the new product. In this phase, the level of risk associated with developing

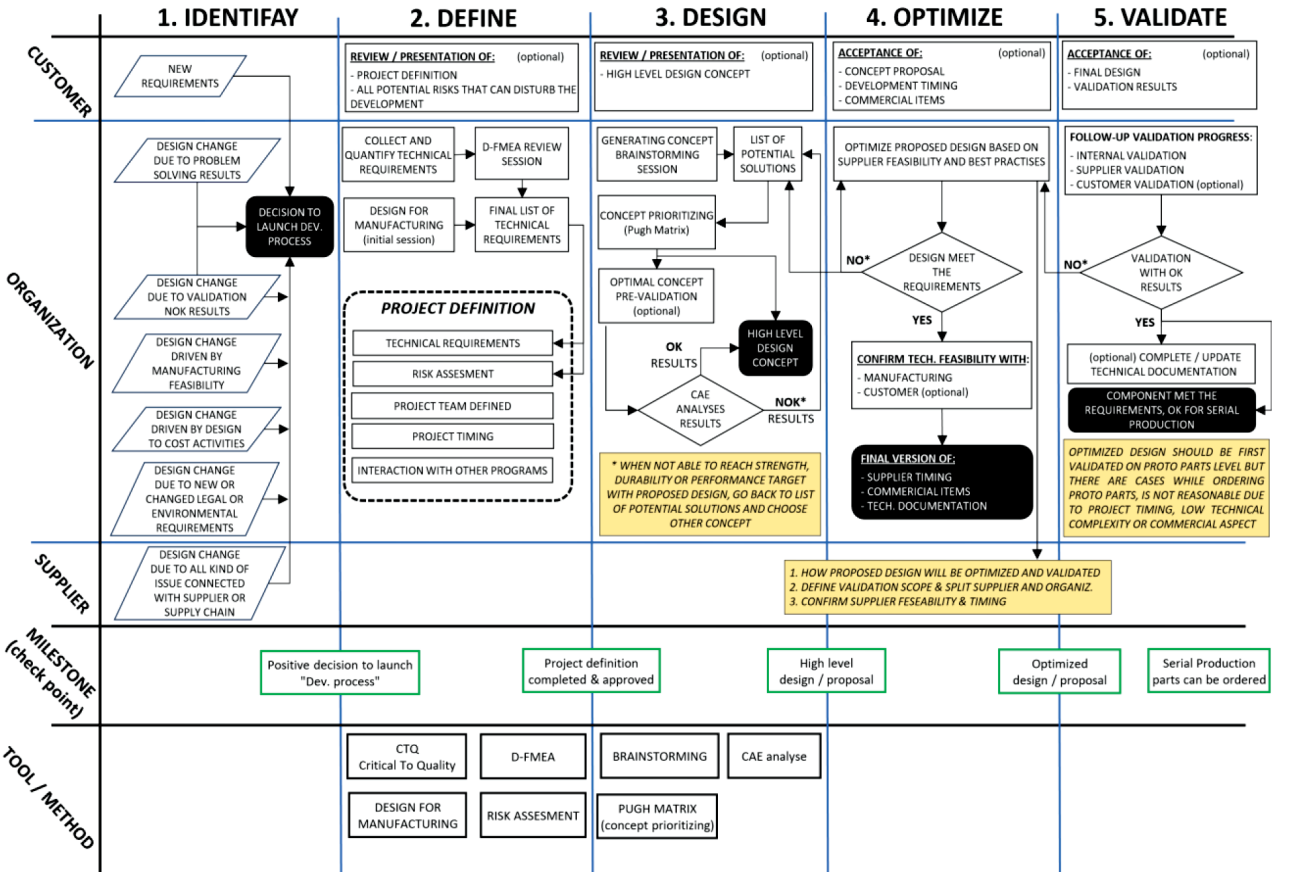

Figure 1: Structured process for product development (own elaboration)

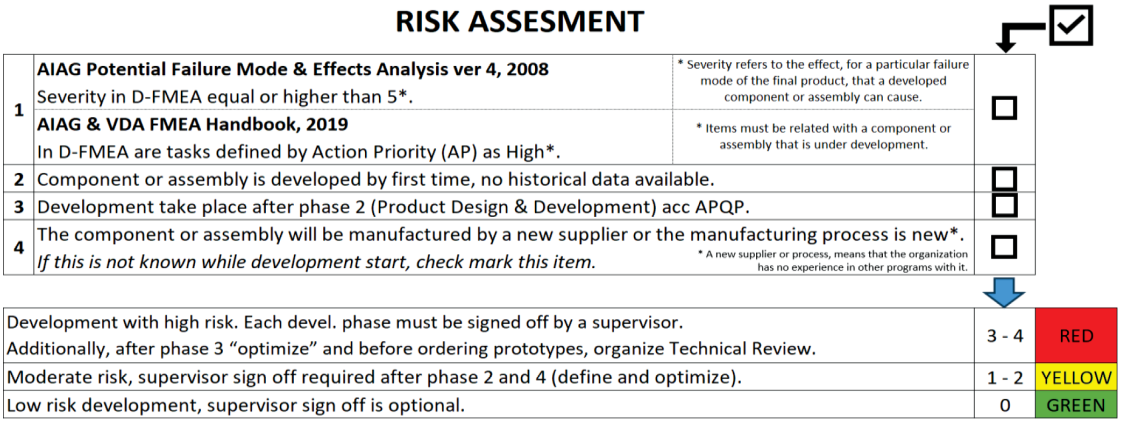

Figure 2: Risk-Assessment tool, part of the product development process. Assessing potential development risks with four questions (own elaboration)

a given part is also determined. The original Risk Assessment tool is presented in **Figure 2**.

3. DESIGN: In a multifunctional team, develop a list of possible solutions and select the optimal one for the developed requirements.

4. OPTIMIZE: Clarifying technical details with the selected contractor.

5. VALIDATE: Component validation by the planned and approved plan.

Using the new tool is particularly important when the product requirements change, or validation results are not acceptable; this requires changes to the product without affecting the accepted project schedule. The proposed solution aims to eliminate the possibility of omitting significant requirements and actions, which could negatively affect the project's further implementation (timeliness and profitability).[6,7]

4 DISCUSSION

Besides structuring the product-development process, the proprietary solutions presented above allow its use in any phase of APQP, if necessary. This is important for products where development often goes beyond the standard framework provided in the model approach, acc. to APQP. The tool is implemented and currently being tested. A detailed analysis of the results will constitute a separate study that will continue the solutions presented in this article.

5 CONCLUSIONS

The product-development process, implemented at Tenneco as an additional tool supporting the already-implemented APQP process, changes the effectiveness of the project's implementation (effectiveness of implementing subsequent phases acc. to APQP) by systematizing the type and sequence of activities related to the development or modification of the component. Additionally, it is possible to monitor the level of risk associated with individual product elements that are developed in a systematized way and/or modified during the APQP process.

Acknowledgment

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6 REFERENCES

[1] T. V. Tokmakova, V. I. Vysotskaya, E. N. Tokmakova, Improving Product Quality by APQP and PPAP. Russ. Engin. Res. 42 (**2022**) 286–287, doi:10.3103/S1068798X2203025X

[2] Automotive Industry Action Group Association. Advanced Product Quality Planning and Control Plan (APQP), Reference Manual. 2nd Edition. AIAG (**2008**)

[3] Ł. Rudolf, M. T. Roszak, Tools of product quality planning in the production part approval process. Archives of Materials Science and Engineering 118 (**2022**) 2: 67–74 doi:10.5604/01.3001.0016.2591

[4] A. C. Dzulinski, A. Braghini Junior, D. M. G. Chiroli. Design for Six Sigma: A Review of the Definitions, Objectives, Activities, and Tools, Engineering Management Journal, 35 (**2023**) 2, 161–180, doi:10.1080/10429247.2022.2041964

[5] V. Nguyen, N. Nguyen, B. Schumacher, T. Tran, Practical Application of Plan–Do–Check–Act Cycle for Quality Improvement of Sustainable Packaging: A Case Study. Applied Sciences 10 (**2020**) 6332. doi:10.3390/app10186332

[6] J. A. Doshi, D. Desai, Overview of Automotive Core Tools: Applications and Benefits. Journal of The Institution of Engineers India Ser. C 98 (**2017**) 515–526, doi:10.1007/s40032-016-0288-z

[7] E. A. Cudney, T. K. Agustiady, Design for six sigma: a practical approach through innovation. CRC Press, New York **(2016)**, 349