

Izboljšanje kakovosti - krog PDCA v primerjavi z DMAIC in DFSS

Quality Improvement - PDCA Cycle vs. DMAIC and DFSS

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Za doseganje stalnih izboljšav kakovosti vsaka organizacija potrebuje ustrezno izbiro orodij in tehnik. Osnovne zahteve za uspeh v teh prizadevanjih so popolno razumevanje tako orodij in tehnik kakor tudi postopka, v katerem naj bi bili uporabljeni. Prispevek prinaša pregled in področja uporabe kroga PDCA, Šest Sigma in tehnik DFSS za stalno izboljšanje kakovosti izdelkov, postopkov in storitev. Krog PDCA je enostaven za razumevanje zasnove stalnih izboljšav kakovosti, Šest Sigma metodologija DMAIC je sistematičen pristop k vodenju projekta na osnovi dejstev, metoda DFSS pa je sistematični pristop k načrtovanju izdelka ali postopka, ki vključuje vse funkcije organizacije.

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(Ključne besede: kakovost izdelkov, izboljšanje kakovosti, krog PDCA, DMAIC metoda, Šest Sigma, DFSS)

To achieve continuous quality improvements every organization needs to use an appropriate selection of tools and techniques. The fundamental requirements for success are a clear understanding, both of the tools and techniques as well as the process by which they should be applied. In this paper we provide an overview and the fields of application of the PDCA, Six Sigma and DFSS techniques for the continuous quality improvement of products, processes and services. The PDCA cycle is a simple-to-understand concept of continuous quality improvement; the Six Sigma DMAIC methodology is a systematic and fact-based project-management approach; while DFSS methodology is a systematic approach to product or process design that includes all organization functions.

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(Keywords: product quality, quality improvement, PDCA cycle, DMAIC, Six Sigma, DFSS)

0 UVOD

Metodologija uvajanja upravljanja kakovosti in programa stalnega izboljšanja kakovosti je lahko različna. Program bo imel verjetno različno ime ali oznako, npr. TQM (Celovito obvladovanje kakovosti), Šest Sigma, BPR (Re-inženiring poslovnega postopka) ali proizvodna odličnost. Ne glede na metodologijo ali ime programa stalnih izboljšav bo vsaka organizacija verjetno potrebovala izbiro orodij in tehnik v svojem postopku izvajanja. Večina izmed teh orodij in tehnik je preprosta za razumevanje in bo lahko uporabna za večino ljudi v podjetju (npr. PDCA- ali Demingov krog). Vendar pa je nekaj tehnik na tem področju bolj zapletenih (Šest Sigma, Vitka Sigma ali načrtovanje za Šest Sigma - DFSS). Specialisti za reševanje specifičnih problemov uporabljajo prav te napredne tehnike. Zelo

0 INTRODUCTION

The methodology for implementing quality management and programmes for continuous quality improvement can be varied. The programme is likely to have a different name or label, such as TQM (Total Quality Management), Six Sigma, BPR (Business Process Re-engineering) or Operational Excellence. Regardless of the methodology or the name of the continuous improvement programmes, each organization will certainly need to use a selection of tools and techniques in its implementation process. Most of these tools and techniques are simple to understand and can be used by a large number of people in the company, e.g., the PDCA cycle or Deming's circle. However, some techniques in this area are more complex, e.g., Six Sigma, Lean Sigma, and Design for Six Sigma. Specialists for specific problem-solving applications use these advanced techniques. It is very important that tools and techniques should be

pomembno je, da so orodja in tehnike izbrani od ustrezne skupine ter pravilno uporabljeni v ustreznem postopku. Osnovni pogoji za uspeh pri tej nalogi so popolno razumevanje samih orodij in tehnik ter postopka, v katerem bi lahko bili ti uporabljeni.

Namen tega prispevka je seznaniti bralca z značilnostmi orodja PDCA in tehnik Šest Sigma in DFSS, ki jih je mogoče uporabiti za izboljšanje kakovosti izdelkov, postopkov in storitev.

1 KROG PDCA

1.1 Definicija

V osrednjem postopku se rezultati dejavnosti primerjajo s ciljem ali nastavitveno točko. Razlika med obema vrednostma se potem vzame za popravne ukrepe, če ta razlika postaja prevelika. Ponavljajoča se in nepretrgana narava stalnih izboljšav sledi tej običajni definiciji upravljanja in je predstavljena s PDCA-krogom (načrtuj-naredi-preveri-ukrepaj) [1].

Pogosto se tudi omenja kot Demingov krog, imenovan po W.E. Demingu. Naslednja mogoča inačica PDCA je PDSA (načrtuj-naredi-študiraj-ukrepaj) [2].

1.2 Uporaba

Uporaba Kroga PDCA se je pokazala bolj učinkovita kot uporaba postopka "naredi prav prvič". Uporaba Kroga PDCA pomeni nenehno iskanje učinkovitejših metod izboljšanja. PDCA je učinkovit na obeh področjih: pri *opravljanju dela* in *vodenju programa*. Omogoča dva tipa popravnih ukrepov –časne in trajne.

Začasni ukrep se doseže kot rezultat praktične obravnave in poprave napake. Po drugi strani pa *trajni popravni ukrep* sestoji iz raziskave in odprave glavnega vzroka - cilj je vzdrževanje tako izboljšanega postopka.

Vidiki kroga PDCA, ki so uporabljeni za njegove notranje postopke zagotavljanja kakovosti:

- *Kaj bomo poskusili izpolniti?*
- *Kako bomo vedeli, da je sprememba izboljšanje?*
- *Katere spremembe lahko naredimo za izboljšanje?*

Slika 1 podrobno prikazuje krog PDCA ([3] in [4]).

selected for the appropriate team and applied correctly to the appropriate process. The fundamental requirements for success in this task are a clear understanding, both of the tools and techniques themselves and the process by which they can be applied.

The purpose of this paper is to introduce the reader to the characteristics of the PDCA tool and Six Sigma and DFSS techniques, which are possible to use for the quality improvement of products, processes and services.

1 THE PDCA CYCLE

1.1 Definition

In a central process, the actual results of an action are compared with a target or a set point. The difference between the two is then mentioned and corrective measures are adopted if the disparity becomes large. The repeated and continuous nature of continuous improvement follows this usual definition of control and is represented by the PDCA (Plan-Do-Check-Act) cycle [1].

This is also referred to as the Deming circle, named after W. E. Deming. Another variation of PDCA is PDSA (Plan, Do, Study, Act) [2].

1.2 Application

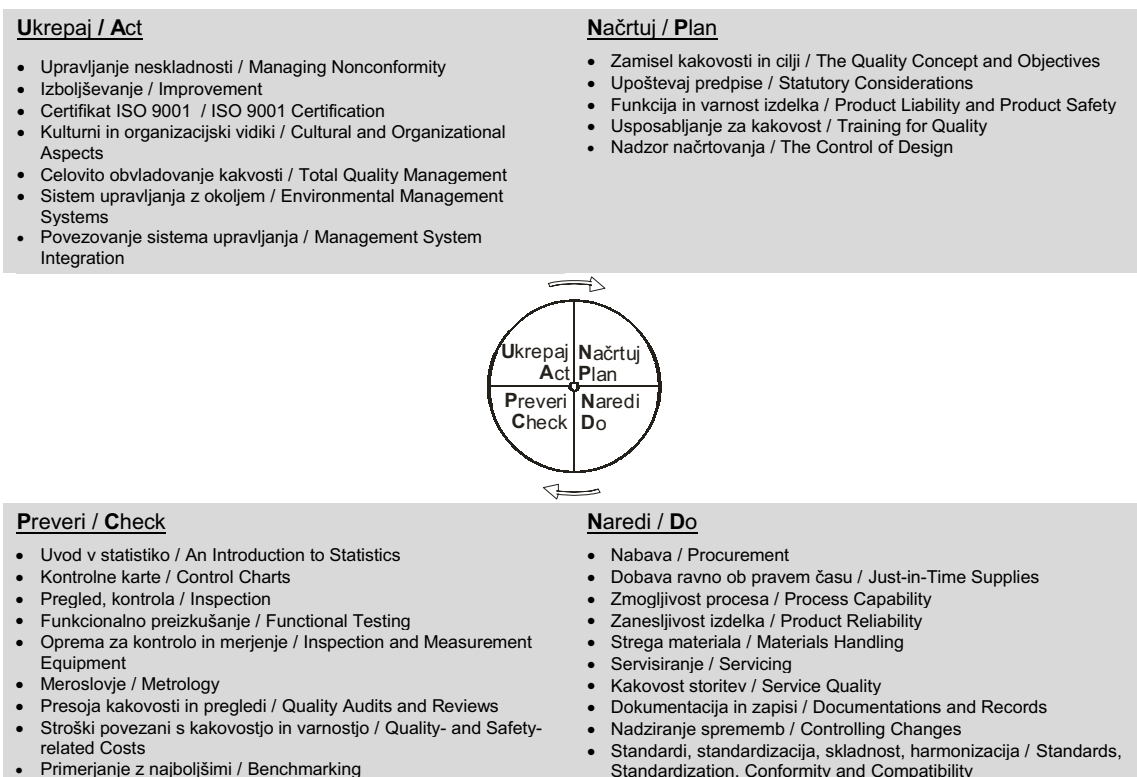
The application of the PDCA cycle has been found more effective than adopting "the right first time" approach. Using the PDCA cycle means continuously looking for better methods of improvement. The PDCA cycle is effective in both *doing a job* and *managing a programme*. The PDCA cycle enables two types of corrective action – temporary and permanent.

The *temporary action* is aimed at results by practically tackling and fixing the problem. The *permanent corrective action*, on the other hand, consists of investigation and eliminating the root causes and thus targets the sustainability of the improved process.

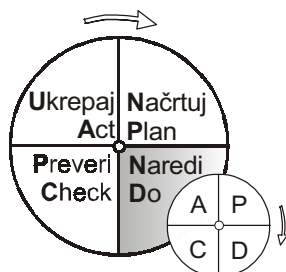
The aspects of the PDCA cycle were applied to internal quality-assurance procedures:

- *What are we trying to accomplish?*
- *How will we know that a change is an improvement?*
- *What changes can we make to improve?*

Figure 1 shows the PDCA cycle in detail ([3] and [4]).



Sl. 1. Krog PDCA
Fig. 1. PDCA cycle

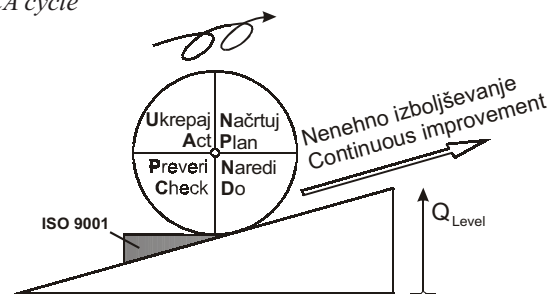


Sl. 2. Napredni krog PDCA [5]
Fig. 2. Advanced PDCA cycle [5]

V fazi *naredi* je mogoče vključiti *manjši* Krog PDCA (slika 2), dokler se problemi pri izvajanju ne razrešijo [5].

PDCA je več kakor samo orodje; je zasnova stalnega izboljšanja postopkov (sl. 3), ki je vgrajena v kulturo organizacije (podjetja). Najpomembnejši vidik PDCA leži v fazi *ukrepaj* po izpolnitvi projekta, ko celotni krog ponovno zaženemo za naslednje izboljšanje.

Krog PDCA prav tako lahko uporabimo znotraj zasnove Kaizen (sl. 4). V tem primeru govorimo o SDCA (standardiziraj, naredi, preveri, ukrepaj) in krogih PDCA [6].

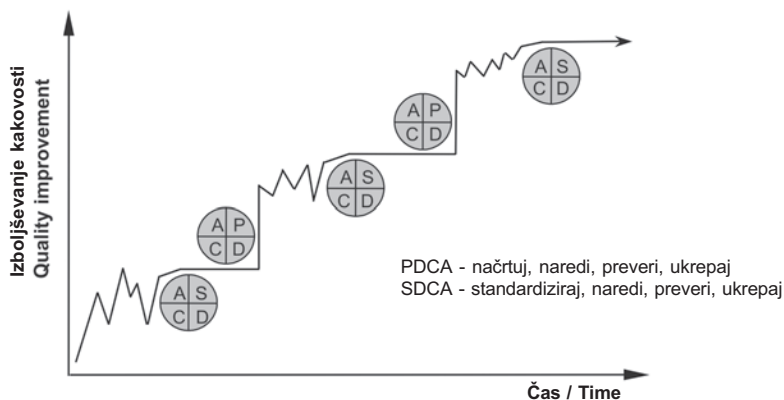


Sl. 3. Krog PDCA v procesu stalnih izboljšav
Fig. 3. PDCA cycle in continuous improvement process

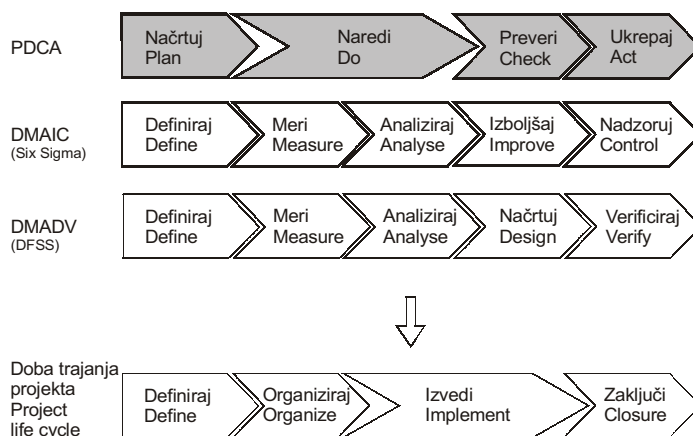
In the *Do* stage or implementation stage it is possible to involve a *mini-PDCA cycle* (Fig. 2) until the issues of implementation are resolved [5].

The PDCA cycle is more than just a tool; it is a concept of continuous improvement processes (Fig. 3) embedded in the organization's culture. The most important aspect of PDCA lies in the "*act*" stage after the completion of a project when the cycle starts again for the further improvement.

The PDCA cycle is also possible to use within the Kaizen concept, Figure 4. In this case we are talking about the SDCA–PDCA cycle [6].



Sl. 4. Krogi SDCA – PDCA za izboljševanje kakovosti v zasnovi Kaizen
 Fig. 4. SDCA–PDCA cycles for quality improvement in the Kaizen concept



Sl. 5. Krog PDCA nasproti DMAIC (Šest Sigma), DMADV (DFSS) in Dobi trajanja projekta (PLC)
 Fig. 5. The PDCA cycle vs. DMAIC (Six Sigma), DMADV (DFSS) and the Product Life-Cycle (PLC)

Medtem ko se Demingov Krog PDCA na veliko uporablja v razvoju in pri razširjanju politike kakovosti, sta DMAIC (Šest Sigma) in DMADV (DFSS) dodali natančnost dobi trajanja projekta (PLC) pri uvajanju in sklenitvi Šest Sigma projektov. Slika 5 kaže zvezo med PDCA-krogom, DMAIC, DMADV in tipično dobo trajanja projekta (PLC) ([1] in [2]).

While Deming’s PDCA cycle has been extensively used in the development and deployment of quality policies, DMAIC (Six Sigma) and DMADV (DFSS) have added the rigour of a project life-cycle (PLC) to the implementation and close-out of Six Sigma projects. Figure 5 shows the relationship between the PDCA cycle, DMAIC, DMADV and a typical project life-cycle ([1] and [2]).

2 DMAIC

2 DMAIC

2.1 Definicija

DMAIC izkorišča zasnovu s podatki upravljane dobe trajanja Šest Sigma projektov za izboljšanje postopka in je bistven del programa Šest Sigma v podjetju. DMAIC je kratica za pet medsebojno povezanih faz: definiraj, meri, analiziraj, izboljšaj in krmili (nadziraj). Preproste definicije posameznih faz so [1]:

2.1 Definition

DMAIC (Define, Measure, Analyse, Improve, and Control) refers to a data-driven life-cycle approach to Six Sigma projects for improving processes; it is an essential part of a company’s Six Sigma programme. DMAIC is an acronym for five interconnected phases: define, measure, analyse, improve and control. The simplified definitions of each phase are [1]:

- *Definiraj* pravi projekt z razpoznavo, prednostjo in izbiro.
- *Meri* ključne značilke postopka, pomembnost parametrov in njihovo izvajanje.
- *Analiziraj* postopek z določevanjem ključnih vzrokov in določb postopka.
- *Izboljšaj* postopek z njegovim spreminjanjem in optimiranjem izvajanja.
- *Krmili* postopek pri trajnostnih ciljih.

- *Define* by identifying, prioritizing and selecting the right project,
- *Measure* key process characteristic, the scope of parameters and their performances,
- *Analyse* by identifying key causes and process determinants,
- *Improve* by changing the process and optimizing performance,
- *Control* by sustaining the gain.

2.2 Uporaba

Orodji Šest Sigma in Proizvodna odličnost se uporabljata najbolj pogosto znotraj okvira DMAIC, ki pa je integralni del pobude Šest Sigma.

DMAIC se tudi uporablja za oblikovanje "zaprtih postopkov" za nadzor projekta. Merila za posamezne faze so definirana, in če so ti pri posamezni fazi projekta doseženi, se lahko začne izvajanje naslednje faze, kakor to prikazuje slika 6 ([1] in [7]).

2.2 Application

The tools of Six Sigma and operational excellence are most often applied within the framework of DMAIC. As such, DMAIC is an integral part of a Six Sigma initiative.

DMAIC also used to create a "gated process" for project control. The criteria for a particular phase are defined and the project is reviewed, and if the criteria are met then the next phase starts, Figure 6, according to ([1] and [7]).



Sl. 6. Krog DMAIC kot osnova metodologije Šest Sigma
Fig. 6. The DMAIC cycle as a methodology for Six Sigma

Kot povzetek pri uporabi tehnike DMAIC lahko zapišemo: če *ne morete definirati* vašega postopka, ga tudi ne *morete meriti*. To tudi pomeni, če ne morete opisati podatkov ne boste sposobni upeljati DMAIC v vaše razvojne dejavnosti. Zaradi tega ne morete izboljšati ali vzdrževati kakovosti ([8] in [9]).

DMAIC je, kakor je že bilo omenjeno, sestavni del Šest Sigem. Je sistematičen in temelji na dejstvih ter zagotavlja strogi okvir za projektno vodenje, usmerjeno na rezultate. Metodologija naj bi se pojavila kot linearna in izrecno definirana, toda treba je opozoriti, da se najboljše rezultate z DMAIC doseže, če je postopek prilagodljiv, prav tako izločanje slabih korakov. Dober je kot iterativni postopek, če je potrebno, še posebej, ko so člani skupine še začetniki na področju uporabe orodij in tehnik.

3 DFSS

3.1 Definicija

DFSS (Načrtovanje za Šest Sigem) je sistematičen in strukturiran postopek načrtovanja novega izdelka ali postopka, ki se osredotoči na "*preprečevanje problema*". To opravi z namenom doseči ali preseči vse potrebe kupca ter *CTQ (kritične značilke kakovosti)* kot izhodne zahteve, ko se izdelek izdelava prvič. Osrednji cilj DFSS je "*oblikovati stvari pravilno prvič*".

Sistem sestoji iz vrste orodij za zbiranje potreb, inženirstva in statističnih metod, ki se uporabljajo med razvojem izdelka. DFSS zahteva natančno uporabo orodij in najboljših praks za izpolnjevanje zahtev kupca in prinaša finančne koristi pri zadovoljevanju zahtev kupca [10].

Temeljna značilka DFSS je preverjanje, ki jo razlikuje od Šest Sigem. Zagovorniki priporočajo DFSS bolj kot *celovit pristop* re-inženiringa in manj kot tehniko dopolnilno k Šest Sigemam.

3.2 Uporaba

Primarna uporaba DFSS kot tehnike je v stopnji načrtovanja in razvoja izdelka, postopka ali storitve. Načrtovanje novega izdelka ali postopka z uporabo postopka DFSS *ne nadomešča* sedanjih inženirskih metod, niti ne olajša organizaciji potrebo po skrbnem pregledovanju odličnosti v inženiringu in razvoju izdelka. To daje še dodatno vrednost pri razvoju izdelka. Pomaga v postopku inoviranja,

As a summary of the application of the DMAIC technique, if you *cannot define* your process you *cannot measure* it. This means if you cannot express the data you are not able to utilize DMAIC in your development actions. Therefore, you cannot improve and sustain the quality ([8] and [9]).

DMAIC is an integral part of Six Sigma. It is systematic and fact based and provides a rigorous framework of results-oriented project management. The methodology may appear to be linear and explicitly defined, but it should be noted that the best results from DMAIC are achieved when the process is flexible, thus eliminating unproductive steps. An iterative approach may be necessary as well, especially when the team members are new to the tools and techniques.

3 DFSS

3.1 Definition

DFSS (Design for Six Sigma) is a systematic and structured approach to new products or processes design that focuses on "*problem prevention*". This is done with the aim of meeting or exceeding all the needs of the customer and the *CTQ (critical to quality)* output requirements when the product is first released. The major objective of DFSS is to "*design things right the first time*".

The system consists of the set of tools, needs-gathering, engineering and statistical methods to be used during the product's development. DFSS requires the rigorous use of tools and best practices to fulfil customer requirements and brings financial benefits by satisfying customer requirements [10].

One fundamental characteristic of DFSS is the verification, which differentiates it from Six Sigma. The proponents of DFSS are promoting it as a *holistic approach* to re-engineering rather than a technique to complement Six Sigma.

3.2 Application

The primary application of DFSS as a technique is in the design and development stage of a product, process or service. Designing new products or processes using DFSS approach does *not replace* current engineering methods, nor does it relieve an organization of the need to persevere excellence in engineering and product development. It adds another dimension to product development. It helps in the

razvijanja, optimiranja in prenosa nove tehnologije v program načrtovanja izdelka. Omogoča tudi zaporedje poddejavnosti zasnove razvoja, načrtovanja, optimiranja in ovrednotenja novega izdelka pred njegovim uvajanjem na zahteven trg ([11] in [12]). DFSS metodologija prinaša kakovostne in merljive rezultate pri obvladovanju kritičnih parametrov v nasprotju od tipične vrste zahtev za izdelek, ki temelji na *glasu kupca (VOC)*.

DFSS je primerna znotraj zamisli ključnega poslovnega postopka, a to je razvoj izdelka; zajema številna orodja in najboljše prakse, ki jih lahko selektivno razvija skozi faze postopka razvoja izdelka. Posebnost DFSS je v integraciji treh ključnih taktičnih elementov za doseg zahtevanih poslovnih ciljev - nizkih stroškov, visoke kakovosti in krajših časov v razvojnem krogu izdelka [10]:

- Jasen in prilagodljiv postopek razvoja izdelka.
- Uravnotežena zbirka orodij za razvoj in načrtovanje ter dobrih praks.
- Disciplinirana uporaba metod vodenja projektov.

DFSS se izogiba štetju napak in mest, na katerih se inženirski tim osredotoči na merjenje dejanskih delovanj. Dobljeni temeljni model se lahko preigra, analizira in ovrednoti statistično skozi simulacije Monte Carlo in načrtovanje poizkusov (DoE).

Napake in časi zastoja niso poglavitne metrike pri DFSS. DFSS uporablja zvezne spremenljivke, ki vodijo kazalnike nevarnosti za napake in poškodbe, meri in optimira kritične delovne odgovore ob določenih vzrokih za variacije v proizvodnji, dostavi in uporabi okolja. Preprečevati je treba probleme – ne čakati, da se ti pojavijo in se potem odzivati na njih.

Osnovni razlog za izvajanje DFSS je finančni. To ustvarja vrednost delničarjem, ki temelji na dobavni vrednosti za kupca na trgu. DFSS pomaga izpolniti *zahteve poslovanja* z izpolnjevanjem *glasu kupca*.

Najbolj pogosto omenjena metodologija za uvajanje DFSS v prakso sta **DMADV** (definiraj, meri, analiziraj, načrtuj in overi) in **IDOV** (identificiraj, načrtuj, optimiraj in validiraj). DMADV je pogosto opisana kot naslednja stopnja DMAIC (Šest Sigem) in tako lahko vodi k rodovnemu postopku [1]. Z namenom da bi poudarili določene značilke DFSS, smo vzeli postopek IDOV, da bi ponazorili osnovne korake postopka (sl. 7) [2].

Zagovorniki DFSS verjamejo, da bodo v nekaj naslednjih letih izkušnje naraščale, DFSS pa bo

process on inventing, developing, optimizing and transferring new technology into product design program. It also enables sub-subsequent conceptual development, design, optimization and verification of new products prior to launch into their respective market ([11] and [12]). DFSS methodology delivers qualitative and quantitative results by managing critical parameters against the clear set of product requirements based on *Voice of customer (VOC)*.

Design for Six Sigma fits within the context of the key business process, namely the product development process; encompasses many tools and best practices that can be selectively deployed during the phases of a product development process. Specifically, DFSS integrates three major tactical elements to help attain the ubiquitous business goals of low cost, high quality and rapid cycle-time from product development [10]:

- A clear and flexible product development process.
- A balanced portfolio of development and design tools and best practices.
- Disciplined use of project management methods.

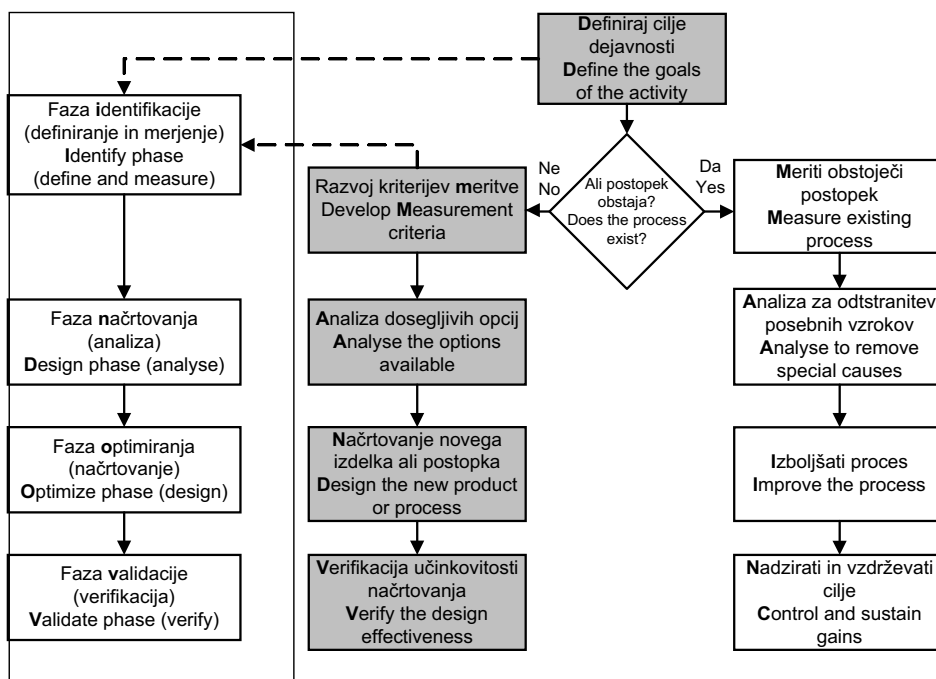
DFSS avoids counting failures and places the engineering team's focus on measuring real functions. The resulting fundamental model can be exercised, analyzed and verified statistically through Monte Carlo simulations and the sequential design of experiment (DoE).

Defects and time-to-failure are not the main metrics of DFSS. DFSS uses continuous variables that are leading indicators of impending defects and failures to measure and optimize critical functional responses against assignable causes of variation in the production, delivery and use environment. We need to prevent the problems – not wait until they occur and then react to them.

The reason for using DFSS is ultimately financial. It generates shareholder value based on delivering customer value in the marketplace. DFSS helps fulfil the *voice of the business* by fulfilling the *voice of the customer*.

Most frequently reported methodologies for putting DFSS into practice are **DMADV** (Define, Measure, Analyze, Design and Verify) and **IDOV** (Identify, Design, Optimise and Validate). DMADV is often described as the next stage of DMAIC (Six Sigma) and thus may lead to a generic approach [1]. In order to emphasize the distinctive characteristic of DFSS we have adapted IDOV to show the basic steps of the process, Figure 7 [2].

The proponents of DFSS believe that within the next few years, as experience grows, DFSS will



Sl. 7. Zveza med DMADV (DFSS) in običajnim DMAIC (Šest Sigem) - dodan je tudi novi postopek IDOV [2]
 Fig. 7. The relationship between DMADV (DFSS) and classical DMAIC (Six Sigma) - a new approach IDOV is also added [2]

uporabljena pri načrtovanju v podjetjih z enakim zaupanjem kakor v standarde ISO (ISO 9001, ISO 14001, ISO/TS 16949 in ISO OHSAS 18001).

DFSS je dolgotrajen in drag postopek, ki terja obsežne vire. Zato naj bi bil skrbno uporabljen samo na nekaj bistvenih projektih in še posebej usmerjen k razvoju novih izdelkov. Ne začenjajte projektov DFSS brez kupcev, vključevanja prodaje, zavezanosti vrhovnega vodstva in ustrezne skupine, po možnosti usposobljene za Šest Sigem. DFSS je močna tehnika in njena moč naj bi bila primerno uporabljena.

4 SKLEPNE UGOTOVITVE

Metodologija uvajanja nenehnih izboljšav kakovosti se lahko razlikuje v različnih organizacijah. Ne glede na metodologijo in program nenehnih izboljšav vsaka organizacija potrebuje izbiro orodij in tehnik kakovosti v svojem postopku izvajanja izboljšav. Pomembno je to, da so orodja in tehnike izbrane za ustrezno skupino in da se pravilno uporabljajo v ustreznem postopku.

PDCA (Demingov) krog je več kakor le orodje kakovosti. PDCA je zasnova postopka nenehnih izboljšav, vgrajen v kulturo

be used in design houses with the same familiarity as the ISO standards (ISO 9001, ISO 14001, ISO/TS 16949, and ISO OHSAS 18001).

DFSS is a longer-term, resource-hungry process and it is expensive. Therefore, it should be deployed with care and on just a few vital projects, and specifically targeted towards the development of new products. Do not start a DFSS project without the customer, sales involvement, top-management commitment and a team, preferably one with Six Sigma training. DFSS is a powerful technique and its power should not be abused.

4 CONCLUSIONS

The methodology for implementing continuous quality improvement can be varied in different organizations. Regardless of the methodology of the continuous-improvement programmes, each organization needs to use a selection of quality tools and techniques in their implementation process. It is vital that the tools and techniques are selected for the appropriate team and applied correctly to the appropriate process.

The PDCA cycle (Deming's circle) is more than just a quality tool. The PDCA cycle is a concept of

organizacije. Je preprost za razumevanje in naj bi ga uporabljala širša skupina ljudi v podjetju (tudi skozi standard ISO 9001:2000). Najpomembnejši vidik PDCA leži v stopnji "ukrepaj" po izpolnitvi projekta, ko krog ponovno zavrtimo za nadaljnje izboljšanje.

Metodologija DMAIC (kot sestavni del Šest Sigem) je sistematična in temelji na dejstvih; zagotavlja natančen okvir za „na rezultate“ usmerjeno vodenje projekta. Pripomniti je treba, da so najboljše rezultate z DMAIC dosegli pri prilagodljivih postopkih in izločanju slabih korakov. Kot ponovitveni postopek je primeren zlasti, ko so člani skupine še začetniki na področju uporabe orodij in tehnik.

Metodologija DFSS je sistematičen in discipliniran postopek načrtovanja izdelka ali postopka, vključujoč vse funkcije organizacije od samega začetka, z namenom *oblikovati stvari pravilno že prvič*. Glas kupca (VOC) in Razvoj funkcije kakovosti (QFD) sta orodji za razpoznavo zahtev kupca, prevajanje le-teh v tehnične zahteve za načrtovanje izdelka in njihovo uvrstitev glede na pomembnost za izpolnitev temeljnih zahtev kupca. Ne začenjajte projektov DFSS brez kupcev, vključevanja prodaje, zavezanosti vrhovnega vodstva in ustrezne skupine, po možnosti usposobljene za Šest Sigem. DFSS je izjemno močna tehnika in njena moč naj ne bi bila zlorabljena. Vendar prav tako ne smemo pozabiti: DFSS je dolgotrajen in drag postopek, ki zahteva obsežne vire. Iz teh razlogov naj bi bil skrbno uporabljen samo na nekaj bistvenih projektih in še to usmerjen predvsem k razvoju novih izdelkov.

continuous-improvement processes embedded in the organization's culture. It is simple to understand and should be used by a large number of people in the company (also throughout standard ISO 9001:2000). The most important aspect of PDCA lies in the "act" stage after the completion of a project when the cycle starts again for the further improvement.

The methodology DMAIC (an integral part of Six Sigma) is systematic and fact based and provides a rigorous framework of results-oriented project management. It should be noted that the best results from DMAIC are achieved when the process is flexible, thus eliminating unproductive steps. An iterative approach may be necessary as well, especially when the team members are new to the tools and techniques.

DFSS methodology is a systematic and disciplined approach to product or process design, including all organizational functions from the early beginning, with the objective to *design things right from the first time*. Voice of the customer (VOC), to gather customer requirements, and Quality Function deployment (QFD) are tools to identify customer requirements, translate them into the product's technical design requirements and prioritize them according to weighted importance to meet customers' basic requirements. Do not start a DFSS project without the customer, sales involvement, top-management commitment and a team, preferably one with Six Sigma training. DFSS is a powerful technique and its power should not be abused, and do not forget: DFSS is a longer-term, resource-hungry process and it is very expensive. For this reason it should be deployed with care and on just a few vital projects, and specifically targeted towards the development of new products.

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Prejeto: 6.2.2007
Received:

Sprejeto: 25.4.2007
Accepted:

Odprto za diskusijo: 1 leto
Open for discussion: 1 year