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APPLICATION OF STANDARDIZATION TO INCREASE THE COMPETITIVENESS OF TOOLS AND DIE MANUFACTURING FIRMS - A CASE STUDY

Ram Babu Verma[a*] and Sanjay Kumar Jha[b]

[a,b] Department of Production Engineering, Birla Institute of Technology, Mesra, Ranchi, India

Abstract

In order to survive and remains stay competitive in present business situation, tool and die making firms have to ensure consistency in their operational processes to minimize their manufacturing cost and lead-time. Firms to achieve a consistent manufacturing process sequence in tool and die production must implement standardization. Tooling firms have one hand pressure to reduce lead-time in other hand to minimize manufacturing cost by maintaining quality. It is observed that traditional tool costing have error almost in between +/- 30 percent, provided similar mold and die not manufactured. The paper investigates a sector-specific application of standardization in tool and dies manufacturing industry to improve their business performance. Conducted case study compares the difference between traditional and standardized tool manufacturing of different types of dies. Post study result revealed the saving in manufacturing time is 22.87 percentage and cost 18.56 percentage while standardization applied. The study carried out at various tool-manufacturing companies and obtained results clearly indicate that enterprises performance significantly improved. The firms benefitted in terms of lead-time reduction and overall cost saving after implementation of standardization.

Key words: Standardization, Process flow, MSME, Die and Mold, Conventional machining

INTRODUCTION

Tool and die manufacturing has long been considered a key industrial sector enjoys a worldwide reputation among manufacturing enterprises. Tools and dies are critical devices used in mass production to obtain various components quickly, accurately, and economically. Tool and die making firms are small and medium-sized firms struggle to get every order from the customers due to present hyperactive competition. Each mold and die manufactured uniquely because of different type and size of component and non-availability of its pre-defined process activities start from design to till manufacture. The estimate tool cost varies due to variances in tool design and manufacturing process, as a result die manufacturing cost and lead time are significant factors are difficult to control for any tooling firm. Several tool manufacturing companies including MSMEs implementing practices of standardization [i]. Standardization provides a wide scope and strict control on shop floor tool manufacturing activities.

In the event of over costing firm has pressure to lose customers order and in the situation of under costing firm suffers business loss. Most of the tool manufacturing enterprises are small in nature, hence no strict working processes to controls shop floor operations that causes delays in customer delivery time. Tools and dies manufacturing firms' competitiveness depends upon the shorter lead-time and

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reduced manufacturing cost without sacrifice of tool quality. The die and mold manufacturers suffers financial losses when the estimated tool cost goes lower than the actual expenses. The enterprises losses would eventually lead to bankrupt. On the other hand, when the estimated costs are too high the work order lost out from the customer [3]. As a result, tool cost accuracy minimizes the lead-time and manufacturing cost necessary for firm survival.

Standardization is important in all organization as it leads the better material flow, quality and productivity. The paper discusses the need for product and process standardization in the tool and die manufacturing industry, as well as the importance of improving the overall quality in situation of uncertainty and variability during manufacture.

Firm level Key problem Issues

Table 1 Key issues and Observation made in a tool and die-making firm

S.N.	Problem	Observation
1	Lack of proper Market Orientation	Lack of proper market oriented approach to get the potential Customers
2	Improper Quotation generation system	Products cost estimation done based of the personnel experiences / no scientific tool is used.
3	Over costing and Under costing of Product	It observed that manufacturing cost wrongly estimated. As a result, quite often, production cost unexpectedly goes up, resulting in losses for the company.
4	Lack of adaptation of standardized practices in Tools & Dies Designing	No such stringent Guidelines to adopt standardization in Designing
5	Improper Tools & Dies manufacturing Process Planning	More specifically, problems like faulty process planning- unplanned changes/ modifications in between running process-manufacturing schedule extend beyond estimated time.
6	No controls over alarming Rejections	Suitable Measures are not taken to minimize the process errors
7	No control on Product delivery Time	This is Observed that overall product making process chain is not in control
8	No Optimum utilization of machines and manpower	This happens due to improper over all planning of men and machines

9	Uncontrolled raw material and other Items purchase and procurement Process	It is found that no stringent Purchase and procurement Policy is being adopted
10	No latest Technology, tools, techniques and strategies for overall Quality enhancement.	It found that many of the machines are old and unable to get desired output and accuracy, leads delay in manufacturing.
11	Transportation Problem	Many of the Customers unable to come due to topographical location of the IDTR. It affects purchase and supply of materials and other activities.

These key issues are in accordance with the way firms' implemented standardization. The aim of this paper is to highlight the benefits of standardization after implantation in tool manufacturing firms. Conducted case study report is going to answer the following questions.

1. Standardization at product level in tool and die manufacturing
2. Standardization at process level in tool and die manufacturing
3. Comparison in between traditional and standardized manufacturing
4. Result analysis of major key issues i.e. manufacturing cost and lead-time after implementation of standardization in the firm

These key initiatives provides a basis and suggest MSMEs to adapt standardization in the tool-manufacturing firms. Standardization at product and process level provides a foundation for personnel training, through the standardized work tools.

Basic feature of standardization in Industries

Standardization improves product quality, reduces time and investment, significantly [ii] [iii]. For instance consider the case of a mold or die, standardized manufacturing promote to manage the inventory as less keep to carried in stock[iv]. Factors such as machining time and labor cost and inventory cost saved in buying and stock. [v].

i. *Process:* By process several consecutive activities creates an output from an input. It gives a helicopter view and determined standardization effort meets national and international safety and quality standards. Right tool for right job [vi].
ii. *Procedure:* It means the way standardization implemented to perform task effectively. Procedure divides in steps and their inputs and outputs.
iii. *Greater flexibility:* Standardization makes easier to rotate roster due to clear blue print to standardized product, process tools reduces activity time to repair when breaks.
iv. *Consistent quality:* Allows performing certain task exactly the same way to product. Output will be always consistent establishes an internal system of quality standards that keep completing

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v. *Easier compliance:* Most manufacturers have comply certain sector specific national and international standards like ISO 9000 in such a case standardization act as control mechanism to comply rules regulation & requirements.
vi. *Reduce Waste:* Performing task in same way make easier to spot bottle necks and source of waste and after rectification products become economical that may be related ,with man material and machine.

Literature Review

Integrated product design involves multiple functions for a single component as when required. Complex product functions result out of fully integrated products of prescribed dimensions [vii]. Several standardization methods are available depending on the product's specification. Traditional tool and die manufacturing produces waste, since additive manufacturing works on the principle of a digital layering process. It reduces material loss of tooling construction, eliminates burdensome tasks of machining. [viii]. Additive manufacturing achieve a product of desired shape and size, thus lowering the manufacturing cost [ix]. It considered as an opportunity for many SMEs to adapt technology and make their mark more prominent as compared to their competitors [x].These manufacturers provide range of tool and die types, thickness of plates, and length of guide pillars, spigotted guide bush, linear, cap screw, and steel types giving a wide range to choose from [xi].

The principle aim is to explore new possibility of product manufacturing and its services to receive the customer orders [xii]. Considering the factors standard practices developed and categorized based on area of application [xiii]. Factors like development of a standard plan, decrease of distinction in the component of standard parts, making devices for working on the machining interaction effortlessly adjusted when required [xiv]. It has to be clarified that maintenance of principles is just conceivable when it is perceived that the outcomes of not keeping to the process is more prominent than that of the results of keeping to it [xv].

Worldwide, industries have tremendous pressure to control the key rivals like cost, quality, manufacturing cycle lead time and delivery in tool and die manufacturing industries [xvi]. Provision for modification kept in the event of necessary changes. In order to verify the part correctness, the specification of the finished product validated [xvii]. The economic downturn in manufacturing sector looking for ways to do more with less, pushing the limits of optimization, efficiency, and cost effectiveness. The tool and mold making process notoriously adds time to pre-production and can be very costly, especially for shorter production runs. Modular molds and dies shorten the time to production, decrease the cost associated with no. of tools & dies making, and compress the die changeover time [xviii].

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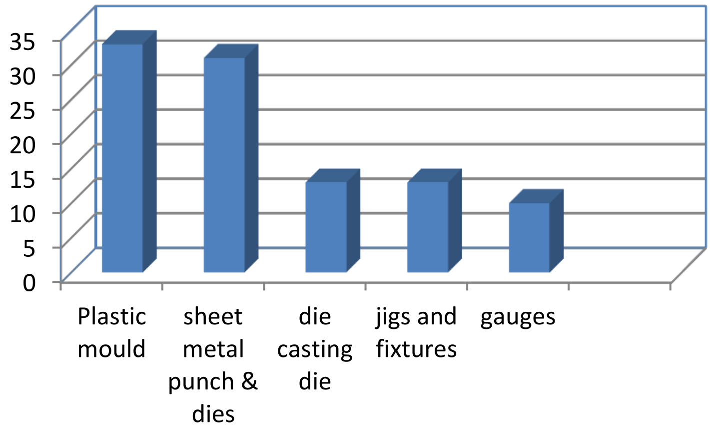

Fig. 1 share of different types of mold and dies demand in

Components need in all shape and sizes, and a large variation is required. Application of standardization has an ever-growing demand for process improvement to achieve the better quality of product. It enhances workflow of an organization boost effectiveness and efficiency [xix]. Many manufacturing companies including MSMEs are now initiating standardization practices [xx]. Developing standardization in tool and die manufacturing challenging task to sustain and update standards [xxi]. Tool manufacturing in small quantity additive manufacturing is a process of layering of material in order to produce the required component. [xxii] This process is also known as 3-D printing technique. There are mainly two advantages of this method.

i. Standardization refers to additive manufacturing provides the exact desired form of product, hence saves production costs. [xxiii].
ii. In product standardization, additive manufacturing technique provides an excellent opportunity for many MSMEs to develop standardized practices and make their mark more prominent as compared to their competitors [xxiv].

Standardization is an outcome of the ever-growing demand of mass production and quality work [xxv].

Lead Time

The lead-time is an important factor considered in manufacturing that gives a clear idea about the time as well as the factors related to lead-time such as labor cost, energy usage of machines and miscellaneous expenses [xxvi]. Sheet metal dies manufacturing time is more as compared to injection molds it takes 4-8 weeks whereas die casting dies and injection molds require a lead time of 4-6 weeks to manufacture these types of dies and molds.

Fig. 2 Demonstrates the lead-time of different kinds of molds and dies manufactured during the financial year. The lead-time for press tool dies ranges from 4-8 weeks. In the manufacturing lead-time of plastic injection molds and casting dies, we cannot observe any significant difference.

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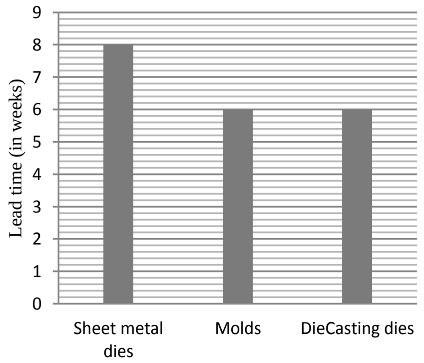

Fig. 2: Manufacturing Lead Time Comparison

Process Planning

Process planning is an important step in die and mold manufacturing as it defines the use of time and resources in a planned way [xxvii]. The time taken by the organizations in development of product design and its planning is on an average only includes 5% of the entire die manufacturing lead time that is considered essential for manufacturing die and mold under Collaborative Engineering[xxviii]

Computer enabled process planning have a rigid control on shop floor activities, save the tool manufacturing time and cost. Worldwide, industries have tremendous pressure to control the key rivals like cost, quality, manufacturing cycle lead time and delivery in tool and die manufacturing industries [xxix]. Provision for modification kept in the event of necessary changes. In order to verify the part correctness, the specification of the finished product validated [xxx]. Fig. 3; illustrates the amount of time consumed in the process planning activities.

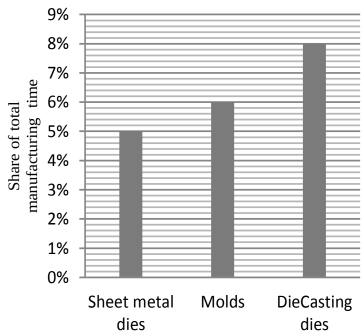

Fig. 3**:** Time taken in process planning (in percent)

Polishing is one of the concluding as well as critical steps of die and mold manufacturing. It is more important in injection molds than sheet metal dies and dies

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casting dies respectively. Fig. 4; quantifies the use of polishing in different types of dies. However, the article considers only the machining of the parts and assembly costing. Mold polishing, dispatch, and other limited secondary operations expenses are not included due to their low cost and reliance on local consumers.

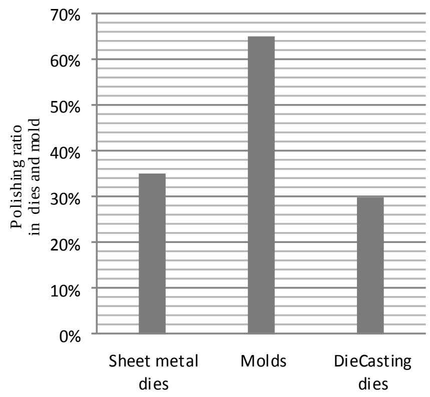

Fig. 4: Polishing ratio in dies and mold (in percent)

Tool Costing

Across the world, many tool-manufacturing industries restrain to follow standardization due their autocratic and own developed way of manufacturing. To facilitate and make industries used to mold base and die set producers supplies built sets. This leads to saving in manufacturing cost. The total cost model of a standard dies and molds calculated by considering the machining cost, cost of primary elements as well as secondary elements, various other factors such as assembly, inspection, die polishing as well as tool design and try out charges etc. Machining and other operations cost/ rate per hour is applied.

Product level Standardization in Tools & Dies Manufacturing

In most of the tools and dies parts similarity in structural build elements are common and it helps in designing. The suitable form of standardization adopted in both single piece and in mass production of similar dies manufacturing [1]. This can reduce the tool cost and die manufacturing time. Commercial the die sets are available in the market in those much of machining is already completed. These are the common parts consist many cylindrical parts like pins and flat plates in desired size. The complete mold and die bases are readily available in the market without containing its core & cavity or punch &die impression. Form. The standard mold & die bases have the verity like simple and master die set.

Level of standardization globally followed [2]:

These are common & preferred by most of manufacturers in present industrial

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practice; this practice adopted holistically in all the tool rooms. Mold core and cavity plate, ejector system, guide pillars & bushes, in sheet metal dies top and bottom bolsters, springs, knocked out rods, various intermediate plates, similarly in jigs and fixtures jig buttons, base plates, toggle clamps, and in pressure die casting plate products, ejector system, Sprue spreader, diffusers, cylindrical Pins, register ring etcetera readily available in the market.

1. Plate and Plate items
2. Standard die Assemblies
3. Unit Die set
4. Master Die set/ Master Kit

The level of standardization possible in MSME Tool Rooms is to be experimented and viability to be judged.

Categorically above product are readily available in the market, if tooling standardization becomes more rigid. Each above represents a higher degree of standardization. The highest standardization found in master die sets.

Features:

1. There is usually reduction in construction lead-time.
2. The cost of tool or mold assessed in much better way.
3. Turning, grinding, milling of many parts therefore fitting avoided.
4. Core cavity or Punch & die manufacturing started immediately.
5. Individual part replaced quickly in case of damage.
6. Tool & die delivery time may be reduced.
7. Highly paid toolmakers employed on important finishing work rather than relative rough bolster type plate.

Various standard Tool & Die Parts and Accessories

Fig 5. Represent various standard tool and die parts available in the market

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Standardization is the process of implementing and developing technical standards based on the consensus of different parties [xxxi] that include firm, users, interest groups, standards organization and government [xxxii] [xxxiii].

Application of standardization diminishes the tool cost and lead-time [xxxiv], thus reduces overall expenditure, for example, use of standard minimizes the inventory as less consumption of steel needs to carry the stock. The ejector plate is pre-positioned and located, factors such as machine time, labor time, buying, and stock control is simplified. Several international companies provide services in standard mold system [xxxv].

Die Mold Service Company Ltd. (DMS): British company.

i. Detroit Mold Engineering Co. (DME): European Company.
ii. Hasco Standards: West German Company.
iii. Uddform Sweden: Sweden, West Germany & Japanese Company.
iv. Desoutter Standards: British Company

Two plate-assembled system varies in three dimensions, i.e. in length, in width and in height. As the height of tool and die is dependent on the thickness of individual plates and on the length of ejector stroke(Figure 6).

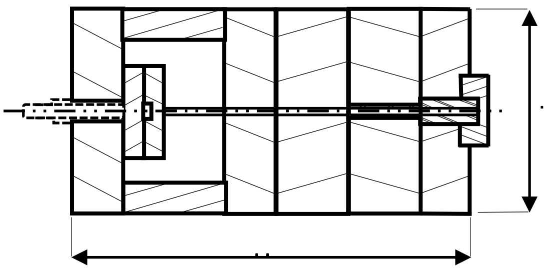

Fig 6: A Model for Representation of a standard mold system.

Tool and die are required in all shape and sizes, and a large variation in the number of impression is required in practice, so a tool and die system manufacturer provides the designer with a range of plate thickness and various length of ejector stroke. Size of tool and die is selected first as length x width (In this paper 500mm×500 mm is chosen), manufacturer i.e. DME, DMS, Hasco, Uddform, Desoutter or any other local manufacturer (In this paper DME is chosen). These manufacturers provide range of tool and die types, thickness of plates, and length of guide pillars, spigotted guide bush, linear, cap screw, and steel types giving a wide range to choose from.[xxxvi]

A standard tool has large number of parts that drains immense amount of time and energy to produce the same. As their price and delivery deadline are always a matter of prime concern in production planning and price negotiation in the sales and purchase area, however large number of parts have decisive effects on calculating the exact time and price. According to most studies the total time for making a mold is usually divided under these three sections a) Tool and die making, b) miscellaneous work c) contour parts [xxxvii].

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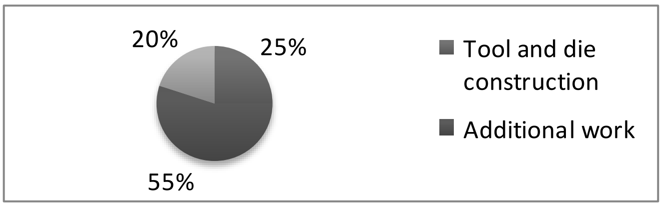

Fig. 7**.** Distribution of time involved in making a standard mold.

By implementing standardization, tool and die construction including some additional work can be reduced significantly that can result to minimize the lead-time by 40% [xxxviii]. Standardization boosts the efficiency of these processes generates a scope for improving the lead-time, and minimizes manufacturing cost at the same time. [xxxix].

Research Gap Analysis:

i. In order to survive and grow in highly competitive business environment and to meet the global standards, the tool-manufacturing firms might take following highly concerned initiatives to get the expected positive results these are the trust areas.
ii. To develop and adopt best-standardized practices of tool & dies making of the world's most respected tool and die manufacturing companies to improve the quality, minimize lead-time and wastages from manufacturing process.
iii. To deliver cost competitive, sustainable and quality products to the customers, to get continuous business in long run.
iv. To control the production cost without compromising with the quality standards by developing an unmatched breadth and depth capability of manufacturing the tools and dies and required standardization of entire manufacturing process.
v. To compete in the global competitive market with w.r.t. quality, cost and delivery there is a need for offering integrated solution to the clients in his all the core and the value chain of related commercial operations, such as manufacturing, consulting, delivering trained human resources, and assisting with marketing, among others.
vi. Apart from these initiatives, there could be many more initiatives, need to be taken into account to address the problems mentioned earlier (a part of the proposed research work)

Applied Methodology

- Whether the MSME enterprises ready to follow the standardization practice in tools and dies manufacturing?
- Which level of above-mentioned standardization is suitable at what instance in tool rooms?
- Level of adaptation of standardization in structural, build elements and die sets divided in different category, for better selection?
- Do the MSME tool rooms have any policy and strategy regarding

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standardization and application in tools and dies manufacturing?
- Can the MSME enterprises evaluate the impact of standardization process on cost, quality customer satisfaction?
- How do the MSME firms standardize the products-criteria they use?
- Level of standardization applied in categorization of machines, dies and their accessories management.

Process level Standardization in tool and die manufacturing at firm

Process of standardization, improves product quality, reduce time and investment, significantly [xl] [xli] [xlii]. For instance consider the case of a mold or die, standardized manufacturing promote to manage the inventory as less keep to carried in stock. Factors such as machining time and labor cost and inventory cost saved in buying and stock. [xliii] [xliv]. In this stage, immense care taken for the time consumption in order to make the process of standardization commendable and the value added. To reduce the lead-time while manufacturing, minimize the tool, and die complexity certain factors are took into consideration. Factors like development of a standard plan, decrease of distinction in the component of standard parts, making devices for working on the machining interaction effortlessly adjusted when required [xlv].

Review of existing tool and die manufacturing process of firm

Table 2: Existing tool and die manufacturing Practices of Firm

Sl. No.	Step of activities	Old described procedure/ Task	Time taken (Old system)	Time Gap
1	Finding the prospective customers	Prepared a list of prospective clients and approach to get orders.	No time frame	Vast gap/ No limit
2	Receiving the Orders	Customer approaches based on its tooling need	No Time frame	2 week
3	Getting inputs from the customer	Old data base is used	Almost Informal way	1 week to visit
4	Die cost calculation	Inform the date customer will come for discussion and finalization	No time frame	Cost calculated in 2 weeks
5	Order finalization	Discussion with customer and order finalization.	No time frame	1 week
6	Quotation generation and Customer offering	Order finalized	No time frame	1 week

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7	Maintaining work order data	Customer order file creation, keeping relevant documents e.g. drawings, cost sheet, in accordance with the order	Within 1 week	1 week
8	Time bound process planning	Improper Process Planning schedule and its follow-up.	As soon as possible	No time frame
9	Change/modific ation ion in tool design or in manufacturing process	Approval from the competent authority taken, in case change in the part drawing at the customer's end.	Decision made at HOD level after consultation with the customer.	After getting the consent from the party
10	Pending Orders	Kept in the pending order file	Not specific	4 Weeks
11	Purchase of raw material and Bought out items	Traditional manual Purchasing procedure is followed	Lead time depends upon the type of item	3 weeks for consumables
12	Raw material cutting and distribution	Material is inspected and given for cutting	No time frame	No limit
13	Semi finishing / Finishing of die parts	Drawing and material is given in the shop floor for machining	No time frame	Depends on the type of work
14	Heat treatment	Traditional practice is adopted	Takes more time	Not specific
15	Final finishing of die parts	Final drawing and semi-finished parts given in CNC area	Allotted time is not very stringent	Depends on the type of work
16	Parts stage inspection	Finished material is sent to the inspection	Depends on the present	Operator inspects job
17	Assembly and trial/retrials of die	No system of time bound die assembly	No time frame	Time bound activity not followed.
18	Component Inspection and acceptance at customer end	Component is inspected as a final part, take a time in the inspection	Time lost due waiting in the inspection department	Die maker involve in part inspection
19	Dispatch of die	Die is sent to the party along with the ok component	As when die is ready	Lack of any report leads to a disagreement with the customer.

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20	Payment settlement	Invoiced bill sent to the customer	No time frame for payment settlement	Lack of follow-up, payment settlement takes a long time.
21	Customer support after sale and service	No such offering to the customer is available at present	Not specific	No sales and service terms defined

Traditional manufacturing process activities of the tool manufacturing firm

The standardized method of tool and die manufacturing validated by following the procedure of different in-house made Tools and Dies of the firm. Standardized practices developed with previous database of Die Shop of Indo Danish Tool Room, Jamshedpur. The study consisted of the following steps.

- Drawing development of the component
- Taken the necessary customer inputs required for mold Design
- Die design and its functional features provisions
- Estimation of mold cost – considering cost of various activities involved
- Development of final Tool Design and BOM Released
- PPC department raises the material Indent & prepare process Plan
- Purchase department: Release of purchase order to the suppliers
- Store department: Supplied items Inspection by the Indenter.
- PPC department makes the process planning to provide load in the machines in operational sequence.
- Pre Tooling Area: Semi Finished Parts returned to PPC for next Operation
- Precision Parts Finish machining done in CNC Area handed over to PPC
- Heat Treatment, Parts Finishing and Inspection
- Assembly dept.: All parts Assembly and making the Tool or Die Read
- Die Trial/retrial and Component inspection (To Check the functional fitment and Dimensional fitment of Die)
- Component Final Inspection and Acceptance from Customer
- Challan preparation and Final Billing of Die
- Die handover and Final Payment Settlement

Analysis of process activities

Tool and die companies' manufactures different kind of tools, dies and precision machining components for Micro Small Medium enterprises. All components of dies are manufactures in plant only except for basics i.e. nuts and bolts, screw. Efficient Part and Process design leads to a superior quality part at minimal cost in a short span of time [xlvi]. Tools and dies base pre machining manufacturing process sequences have no direct interface between the cutting tool and the piece part being made [xlvii].

Tool and die parts design is very crucial and technically challenging towards functionality of tool and die [xlviii]. Heat Treatment is required for certain parts those

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are prone to deterioration of functionality in a long period. Methods like carburizing, nitriding and plating or coatings of PVD and CVD applied to get the ideal hardness, finish and quality in the tools [xlix]. Inspection includes raw material stage to the final product stage in order to get best-desired results [l]. In all cases, CMM rely heavily on precise inspection of tool and component.

New developed standardized procedure for tool and die manufacturing firm

Table 3 : New system of tool and die manufacturing Practices of Firm

Sl. No.	Step of activities	New described Procedure/ Task	Time taken (New system)	Observation (New System)	Impact
1	Finding the prospective customers	Company Visit the companies and exhibitions for getting targeted customers	Done at regular basis in scheduled intervals	Companies' products and their tooling need identified.	Positive
2	Receiving the Orders	Representative visit the customers and invite to come to discuss about their tooling need	3 days for local, 1 weeks for national/ international customer	Tools Orders received timely	Positive
3	Getting inputs from the customer	Request the customer to fill out the requisite data/information either physically or online.	Formal way	Complete details available in record	Positive
4	Die cost estimation	Based on tool design QCD members do cost calculation based on the scope of work in the die	Within 2 days	Scientific way of cost calculation is adopted	positive
5	Order finalization	Firm presents a scientific calculated cost to the customer and placing the order at the same time.	Cost and time are determined on the same time mutually.	Micro level software based costing done rather experience based.	Costing accuracy improved
6	Quotation generation and handing over to the customer	Order copy is given to the customer with all the relevant details	Same day	The quotation is prepared and immediately sent to the client.	Clear, informative and agreeable terms.
7	Maintaining work order data	A customer order file created all related papers e.g. drawings, cost sheets, and other requirements that fit the customer order saved in soft copy.	Within 2 days	Activity time is saved due to computer application in new system	Customer information is accessed immediately

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8	Time bound process planning	Tool making process activities planning and follow up is possible up to macro level.	Software based process-planning sheet made. For timely follow up.	Unable to cope up the tool making activity.	A realistic time bound planning is possible
9	Any change/ modification in tool design or in process	Due to formal process changes are not possible without bearing the cost by customer	After formal consent from the customer	In the current situation, the company does not have any policy for customers to bear the cost.	Cost of alteration is taken from customer
10	Pending Orders	Follow-up is done with customer for finalizing the pending order	Orders are followed timely	Kept pending for future review.	Order follow up is easy in new system
11	Purchase of raw material and Bought out items	New computerized process is fast and reliable	Online process and time saving	Fast reliable and time saving	Improves the overall lead time
12	Raw material cutting and distribution	Time bound cutting diagram is followed	Time bound	Timely material cutting is possible	positive
13	Semi finishing / Finishing of die parts	Work is allotted time bound and Priority based	Time bound	Timely orders are completed	Work order is prioritized
14	Heat treatment	Time bound work is done	Takes less time	Time saving	positive
15	Final finishing of die parts	Priority based work is done through suitable process	Time bound work completion	Process alteration done in machining	Work order is prioritized
16	Parts stage inspection	Operator personally check the parts, if required assistance taken from the Inspection dept.	Time saved due waiting the inspection department	Self-inspection of operator is important to save time	positive
17	Assembly and trial/ retrials of die	Time bound die assembly is quite essential	Time bound die assembly save the huge time	Leads to improve the delivery time	Important activities time saved
18	Component Inspection, acceptance at customer end	Assembler can expedite the component inspection to save the time	Inspection depends on the present load condition in the department	Assembler has key role in part inspection and acceptance at customer end	Huge time saving is possible by assignment of assembler

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19	Dispatch of die	Finished die along with the component and tool completion report is sent to the party	Die dispatched with the check list and all other formalities	Computer based standardized process leads no error	Needs to follow the dispatch procedure
20	Payment settlement	Formal billing procedure is followed	Specific time framed payment settlement process adopted	A computer based formal procedure is to be made	Process improved for timely payment
21	Customer support after sale and service	A formal system of after sales service is required to address the customer issues	Time framed formal procedure is made	Feature based software take care of sales and service activities	positive

Expected Benefits:

i. Mold & die construction lead-time reduced drastically.
ii. The cost of tool or mold assessed realistically or in much better way.
iii. Pre-tooling operations like Turning, milling, grinding etc. can be avoided greatly way, which are time consuming & non-profitable work.
iv. Core-cavity or Punch & die manufacturing started immediately just component profile out line and housing planning...
v. Individual part replaced quickly in case of damage, as they are standard and available.
vi. Tool & die delivery time may be reduced.
vii. Highly paid toolmakers employed on important finishing work rather than relative bolster type plate manufacturing or deploying in rough and unimportant nature of work.

Industrial Illustration

The component produced through different dies made with use of standardization and conventional process implemented to manufacture the dies. Authorized suppliers provided the die set, ejectors, and fasteners. A comparison between traditional processes versus standardized approach seen in industrial illustration. Different kind of die manufacturing taken w.r.t. manufacturing cost and lead-time reduction in all three types of dies i.e. sheet metals, molds, and die casting die.

The customer has given the order to manufacture new die to the tool-manufacturing firm due to high demand of part. In the above case study, the initial dies made in-house with traditional process and the new dies built with using standard die base. The Die manufacturing firm constructed the similar dies to meet the time bound quality and quantity of piece parts production.

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Typical Tooling Industries

Table 4: Types of tool and die made for different component development.

S. N.	Type	Product component
1	Injection molds	Plastic components
2	Press tools	Sheet metal components
3	Pressure die Casting Dies	To cast non-ferrous material components

Validation of Standard and in-House manufactured Molds and Dies

Case -1: Plastic Injection Mold

Details of different cost heads and Time associated in Press tool manufacturing when using standard die set			
Sl. No	Breakup of different cost elements	Activity wise cost (in INR)	Activity wise Time (In Hour)
1	Raw material cost: Die and Punch Inserts, Pins	125280	74
2	Manufacturing cost: Machining, Assembly/ Other Treatment cost etc.	167040	184
3	Die Base cost (Die base set was Purchased from Vendor)	264480	332
4	Secondary elements cost (Screws, Dowels, springs etc.)	34800	37
5	Tool Design Cost (Based on the total manufacturing cost of the tool)	104400	111
Total		696000	737

Table 5: Different type of cost associated with standard Mould

Details of different cost heads and Time associated in Pressure Die Casting die manufacturing while using standard die set			
Sl. No.	Breakup of different cost elements	Activity wise cost (in INR)	Activity wise Time (In Hour)
1	Raw material cost: core and cavity Inserts, Pins etc.	22800	68
2	Manufacturing cost: Machining, Assembly/ Other Treatment cost etc.	91200	273
3	Die base cost (Die base set was Purchased from Vendor)	99750	299
4	Secondary elements cost (Screws, Dowels, springs and ejector pins)	14250	43
5	Tool Design Cost (Based on the total manufacturing cost of the tool)	57000	171
Total		285000	854

Case - 2: Pressure Die Casting Die:

Table 6: Different costs associated with Pressure Die Casting Die

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Case 3: Sheet Metal Die

Table7:Different costs associated with Sheet Metal Die

Details of different cost heads and Time associated in Press tool manufacturing when using standard die set			
Sl. No	Breakup of different cost elements	Activity wise cost (in INR)	Activity wise Time (In Hour)
1	Raw material cost: Die and Punch Inserts, Pins	125280	74
2	Manufacturing cost: Machining, Assembly/ Other Treatment cost etc.	167040	184
3	Die Base cost (Die base set was Purchased from Vendor)	264480	332
4	Secondary elements cost (Screws, Dowels, springs etc.)	34800	37
5	Tool Design Cost (Based on the total manufacturing cost of the tool)	104400	111
Total		696000	737

Machining Process Cost:

In order to calculate the cost, the features and processes identified. A Cad model of the component considered as an input of design the die and its corresponding parts. The following rates used in order to calculate the overall cost of the die manufacturing.

Table 8. Machining and other operational cost rate/hour:

Sl. No.	Name of The Machine	Rate/Hour
1	Gas cutting and power sawing	100
2	Conventional turning/drilling/boring	150
3	Pre machining/conventional milling	150
4	Assembly and misc. Bench work	150
5	Surface grinding/	200
6	Heat treatment(VaccumTreatment)	200/kg
7	CNC turning/drilling/boring	250
8	Cylinder grinding	350
9	Inspection	400
10	CNC milling/contour milling	500
11	EDM/Wire EDM	600
12	Final grinding/Jig grinding	800

Raw Material:

In order to increase the hardness wear resistance and die parts life premier alloys like Chromium, Nickel, Cobalt Tungsten, Molybdenum added with steel. Different kind of tool and die steel used to manufacture the different kind of tolls and dies

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elements. The material selection depends upon the parts functionality. Tolls and dies steels used for numerous tool manufacturing activities e.g. manufacture of Plastic Injection Moulds, Pressure die casting dies, Sheet metal dies, Jigs, Fixtures, inspection gauges for machining, welding and fabrication and for customized tool manufacturing work.

Table 9: Rate of raw material purchased

Sl.No.	Raw Material	Rate Per Kg (INR)
1	MS	35
2	EN 8	55
3	EN 24	60
4	EN 31	70
5	EN 353	80
6	HcHcr	200
7	H11	160
8	H13	180

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Cost estmation Details of inhouse manufactured Mould Base:

Sl. No.	Part Name	Material	Quanity	Size	Volume (in mm³)	Weight (in Kg)	material cost (in INR)	Gas cutting and power sawing: Total Hour	Gas cutting and power sawing: Cost (Rs. 100/- Hour)	Conventional turning/ drilling/ boring: Total Hour	Conventional turning/ drilling/ boring: Cost (Rs. 150/- Hour)	Pre machining/ conventional milling: Total Hour	Pre machining/ conventional milling: Cost (Rs. 150/- Hour)	Surface grinding/ cylindrical grinding: Total Hour	Surface grinding/ cylindrical grinding: Cost (Rs.200/- Hour)	CNC Milling/CNC Turning: Total Hour	CNC Milling/CNC Turning: Cost (Rs. 300/-Hr)	Heat Treatment: Cost (@Rs.200/kg.)	Jig Grinding/Final Grinding: Total Hour	Jig Grinding/Final Grinding: Cost (Rs.800)	EDM /Wire Cut: Total Hour	EDM /Wire Cut: Cost (Rs.600/-Hr)	Inspection: Total Hour	Inspection: Cost (Rs. 400/- Hour)	Assembly and misc. Bench work: Total Hour	Assembly and misc. Bench work: Cost (Rs. 150/- Hour)	Part wise cost (in INR)
1	Top Plate	MS	1	250×250×25	1562500	12.28	430	3	300	4	600	16	2400	9	1800	6	1800	0	0	0	0	0	1	400	2.5	375	8105
2	Bottom Plate	MS	1	250×250×35	2187500	17.19	602	4	400	4	600	16	2400	9	1800	6	1800	0	0	0	0	0	1	400	2.5	375	8377
3	Core plate	MS	1	250×200×30	1500000	11.79	413	3.5	350	10	1500	14	2100	7	1400	7.5	2250	0	6	4800	6	3600	1.5	600	3.5	525	17538
4	Cavity plate	MS	1	250×200×35	1750000	13.76	481	3	300	10	1500	14	2100	7	1400	8	2400	0	6	4800	6	3600	1.5	600	3.5	525	17706
5	locating ring	EN-8	1	Ø 120×15	169560	1.33	73	2	200	9	1350	0	0	3	600	4.5	1350	267	4	3200	0	0	0.5	200	1.5	225	7465
6	sprue bush	EN-8	1	Ø 60×112	316512	2.49	137	1	100	8	1200	0	0	5	1000	6	1800	498	5	4000	8	4800	0.5	200	1	150	13884
7	Spacer	MS	2	250×50×40	500000	7.86	275	4	400	1	150	12	1800	12	2400	3.5	1050	1572	0	0	0	0	1	400	1	150	8197
8	Ejection Plate	EN - 8	1	250×130×15	487500	3.83	211	2	200	2	300	8	1200	8	1600	4	1200	766	0	0	0	0	1.5	600	1.5	225	6302
9	Ejection Back Plate	EN - 8	1	250×130×20	650000	5.11	281	2	200	2	300	8	1200	12	2400	4	1200	1022	0	0	0	0	1.5	600	1.5	225	7428
10	Guide Pillar	EN-31	4	Ø 32×110	88422	2.78	195	3	300	12	1800	0	0	8	1600	9	2700	556	7	5600	0	0	2	800	2	300	13851
11	Guide Bush	EN-31	4	Ø 45×45	71533	2.25	157	3	300	11	1650	0	0	8	1600	8.5	2550	450	7	5600	0	0	2	800	2	300	13407
12	Cavity Insert	45C8	4	Ø 20×104	32656	1.03	82	2.5	250	6	900	0	0	12	2400	7	2100	205	5	4000	8	4800	4	1600	1	150	16487
13	Core Insert	45C8	4	Ø12×25	2826	0.09	7	2	200	6	900	0	0	8	1600	6.5	1950	18	5	4000	7	4200	4	1600	1	150	14625
14	Moving Inserts/Sliders	45C8	2	25x70x175	306250	4.81	385	3	300	2.5	375	20	3000	8	1600	16	4800	963	5	4000	24	14400	8	3200	6	900	33923
15	Support Pillar	MS	6	Ø29×90	59417	2.80	98	3	300	10	1500	0	0	9	1800	0	0	560	0	0	0	0	3	1200	2	300	5758
16	Push Back Pin	EN - 31	4	Ø14×120	18463	0.58	41	2.5	250	8	1200	0	0	8	1600	0	0	116	6	4800	0	0	1	400	1.5	225	8632
17	Wear Button	EN - 8	8	Ø12×22	2487	0.16	9	4	400	8	1200	0	0	8	1600	0	0	31	5	4000	0	0	2	800	2	300	8340
Total Manufacturing (in Hours)																											210025
Total Cost (in INR)																											699

Note: In above Tool list most of the comman and major parts are taken into account.

Fig 8. In-house manufactured mould base costing

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Part wise cost sheet of In-house manufactured Pressure Die casting Die

Sl. No.	Part Name	Material	Quantity	Size	Volume (in mm^3)	Weight (in Kgs)	Material cost (in INR)	Gas cutting and power Sawing		Conventional Turning/ Drilling/ Boring		Pre machining/ conventional milling		Surface grinding/ cylindrical Grinding		CNC Milling/CNC Turning		Heat Treat-ment	Jig Grinding/ Final Grinding		EDM /Wire Cut		Inspection		Assembly and misc. Bench work		Part wise Cost (in INR)
								Total Hour	Cost (Rs. 100/Hr)	Total Hour	Cost (Rs. 150/Hr)	Total Hour	Cost (Rs. 150/Hr)	Total Hour	Cost (Rs. 300/Hr)	Total Hour	Cost (Rs. 300/Hr)	Cost (@ Rs. 200/kg.)	Total Hour	Cost (Rs. 800/Hr)	Total Hour	Cost (Rs. 600/Hr)	Total Hour	Cost (Rs. 400/Hr)	Total Hour	Cost (Rs. 150/Hr)	
1	Top Plate	M - S	1	350x300x35	3675000	28.9	1155	2	200	3	450	24	3600	14	4200	8	2400	0	0	0	0	0	2	800	2.5	375	13180
2	Bottom Plate	M - S	1	350x300x35	3675000	28.9	1155	2	200	3	450	24	3600	14	4200	8	2400	0	0	0	0	0	2	800	2.5	375	13180
3	Cavity Plate	H - 13	1	350x240x40	3360000	26.4	1056	1.5	150	4	600	20	3000	10	3000	24	7200	5282	8	6400	6	3600	3	1200	4	600	32088
4	Core Plate	H - 13	1	350×240×50	4200000	33.0	1320	1.5	150	4	600	20	3000	10	3000	24	7200	6602	9	7200	6.5	3900	3.5	1400	4	600	34973
5	Core Back Plate	EN - 8	1	350x280x30	2940000	23.1	924	1.5	150	3.5	525	20	3000	10	3000	7	2100	0	8	6400	0	0	3.5	1400	3	450	17949
6	Spacer	EN - 8	2	350x90x50	1575000	12.4	990	2	200	2	300	16	2400	12	3600	4	1200	0	5.5	4400	0	0	2	800	3	450	14340
7	Ejection Plate	EN - 8	1	350x150x15	787500	6.2	248	1.2	120	2.5	375	14	2100	8	2400	5	1500	0	6	4800	0	0	1.5	600	2	300	12443
8	Ejection Back Plate	EN - 8	1	350x150x25	1312500	10.3	413	1.2	120	2.5	375	14	2100	8	2400	4	1200	0	5	4000	0	0	4.5	1800	2	300	12708
9	Guide Pillar	EN - 31	4	Ø 24×128	57876	0.5	73	2.5	250	16	2400	0	0	12	3600	6	1800	90.98	6.5	5200	0	0	5	2000	4	600	16014
10	Guide Bush	EN - 31	4	Ø 32×52	41800	0.3	53	2.5	250	12	1800	0	0	12	3600	7	2100	65.71	6.5	5200	0	0	3.5	1400	6	900	15368
11	Cavity Insert	H - 13	1	Ø 140×42	646212	5.1	203	4	400	9	1350	0	0	9	2700	36	10800	1016	6	4800	42	25200	8	3200	12	1800	51469
12	Core Insert	H - 13	1	Ø 100×50	392500	3.1	123	3	300	8	1200	0	0	9	2700	36	10800	617	5.5	4400	38	22800	8.5	3400	12	1800	48140
13	Support Spacer	EN - 8	8	Ø24×110	49738	0.4	125	4	400	16	2400	0	0	16	4800	8	2400	78.19	9	7200	0	0	2	800	3	450	18653
14	Return Pin	EN - 31	4	Ø15×140	24728	0.2	31	2	200	8	1200	0	0	16	4800	8	2400	38.87	10	8000	0	0	1.5	600	1	150	17420
15	Diffuser Ejector Pin	EN - 31	1	Ø15×140	24728	0.2	8	0.3	30	3	450	0	0	4	1200	2	600	38.87	3	2400	0	0	0.5	200	1	150	5077
16	Ejector Pin	EN - 31	5	Ø4×140	1758	0.014	3	1.2	120	16	2400	0	0	20	6000	10	3000	2.764	12	9600	0	0	3	1200	2	300	22626
17	Ejector Pin	EN - 31	4	Ø7×140	5385	0.042	7	1	100	12	1800	0	0	16	4800	8	2400	8.465	10	8000	0	0	2	800	1.5	225	18140
18	Wear Button	EN - 31	8	Ø12×20	2261	0.018	6	1.5	150	10	1500	0	0	16	4800			3.554	11	8800	0	0	2	800	2	300	16359
Total Tool Cost (in INR)																											380128
Total Manufacturing (in Hours)																											1081

Note: In above Tool list most of the comman and major parts are taken into account.

Fig. 9. In-House manufactured die-casting die cot estimate

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Part wise cost sheet of In - house manufactured Press Tool

Sl. No.	Parts Name	Material	Quantity	Size	Volume (in mm3)	Weight (in Kgs)	Material Cost (in INR)	Gas Cutting/ Multicut		Conventional Turning		Conventional Milling		Conventional Grinding		CNC Turning/ CNC Milling		Heat Treatment	Final Grd./ Jig Grinding		EDM/WEDM		Inspection		Assembly/ Bench Work		Elementwise Cost (in INR)
								Time (in Hrs.)	Cost (Rs.100/Hr.)	Time (in Hrs.)	Cost (Rs.150/Hr.)	Time (in Hrs.)	Cost (Rs.150/Hr.)	Time (in Hrs.)	Cost (Rs.200/Hr.)	Time (in Hrs.)	Cost (Rs.500/Hr.)	Cost (Rs.200/Kg.)	Time (in Hrs.)	Cost (Rs. 800/Hr.)	Time (in Hrs.)	Cost (Rs.600/Hr.)	Time (in Hrs.)	Cost (Rs.400/Hr.)	Time (in Hrs.)	Cost (Rs.150/Hr.)	
1	Top Base	MS	1	1400x1200x70	117600000	924.34	32352	6.0	600	0	0	6	900	3	600	6.5	3250	0	0	0	0	0	0.6	240	2	300	38242
2	Bottom Base	MS	1	1400x1200x70	117600000	924.34	32352	6.0	600	0	0	6	900	3	600	6.5	3250	0	0	0	0	0	0.6	240	2	300	38242
3	Top Plate	MS	1	1200x120x100	14400000	113.18	3961	6.0	600	0	0	7	1050	2.5	500	5.5	2750	0	0	0	0	0	0.6	240	2	300	9401
4	Bottom Plate	MS	1	1200x120x100	14400000	113.18	3961	6.0	600	0	0	7	1050	2.5	500	5.5	2750	0	0	0	0	0	0.6	240	2	300	9401
5	Split Top Die-A	D2	1	500x300x100	15000000	117.90	21222	6.0	600	0	0	5	750	2	400	10	5000	23580	6	4800	7.5	4500	0.5	200	3	450	61502
6	Split Top Die-B	D2	1	500x300x100	15000000	117.90	21222	6.0	600	0	0	5	750	2	400	10	5000	23580	6	4800	7	4200	0.5	200	3	450	61202
7	Split Top Die-C	D2	1	400x300x100	12000000	94.32	16978	6.0	600	0	0	4.5	675	2	400	9	4500	18864	4	3200	5.5	3300	0.5	200	3	450	49167
8	Split Top Die-D	D2	1	400x300x100	12000000	94.32	16978	6.0	600	0	0	4.5	675	2	400	9	4500	18864	4	3200	5.5	3300	0.5	200	3	450	49167
9	Split Bottom Die-A	D2	1	500x300x100	15000000	117.90	21222	6.0	600	0	0	5	750	2.5	500	9.5	4750	23580	5	4000	6	3600	0.5	200	3	450	59652
10	Split Bottom Die-B	D2	1	500x200x100	10000000	78.60	14148	6.0	600	0	0	5	750	2.5	500	9.5	4750	15720	5	4000	6	3600	0.5	200	3	450	44718
11	Split Bottom Die-C	D2	1	500x300x100	15000000	117.90	21222	6.0	600	0	0	5	750	2.5	500	9.5	4750	23580	5	4000	6	3600	0.5	200	3	450	59652
12	Split Bottom Die-D	D2	1	500x300x100	15000000	117.90	21222	6.0	600	0	0	5	750	2.5	500	9.5	4750	23580	5	4000	6	3600	0.5	200	3	450	59652
13	Split Bottom Die-E	D2	1	400x200x100	8000000	62.88	11318	6.0	600	0	0	4.5	675	2.5	500	8.5	4250	12576	4	3200	4	2400	0.5	200	3	450	36169
14	Split Bottom Die-F	D2	1	400x300x100	12000000	94.32	16978	6.0	600	0	0	4.5	675	0	0	8.5	4250	18864	4	3200	4	2400	0.5	200	3	450	47617
15	Bottom Die Suport-A	EN-8	1	900x70x60	3780000	29.71	1040	6.0	600	0	0	6	900	2	400	7	3500	5942.16	6	4800	5	3000	0.8	320	2	300	20802
16	Bottom Die Suport-B	EN-8	1	900x80x60	4320000	33.96	1188	6.0	600	0	0	6	900	2	400	7	3500	6791.04	6	4800	5	3000	0.8	320	2	300	21799
17	Bottom Die Suport-C	EN-8	2	700x60x40	1680000	13.20	924	6.0	600	0	0	5.5	825	2	400	7.5	3750	2640.96	5.5	4400	4.5	2700	0.8	320	2	300	16860
18	Top Die Support-A	EN-8	1	900x50x40	1800000	14.15	495	6.0	600	0	0	6	900	2.5	500	7.5	3750	2829.6	6	4800	5.5	3300	0.8	320	2	300	17795
19	Top Die Support-B	EN-8	1	900x50x40	1800000	14.15	495	6.0	600	0	0	6	900	2.5	500	7.5	3750	2829.6	6	4800	5.5	3300	0.8	320	2	300	17795
20	Top Die Support-C	EN-8	2	700x50x40	1400000	11.00	770	6.0	600	0	0	5	750	2	400	0	0	2200.8	5.5	4400	4.5	2700	0.8	320	2	300	12441
21	Bottom Rib	MS	12	50x50x40	100000	0.79	330	6.0	600	0	0	5	750	1	200	3	1500	0	0	0	0	0	0.5	200	4	600	4180
22	Top Rib	MS	12	50x50x40	100000	0.79	330	5.0	500	0	0	3.5	525	1	200	3	1500	0	0	0	0	0	0.5	200	4	600	3855
23	Gauge Support	EN-31	2	70x50x40	140000	1.10	154	5.0	500	0	0	3.5	525	1	200	6	3000	0	1.5	1200	0	0	1	400	2	300	6279
24	Reference Gauge	EN-31	2	100x40x30	120000	0.94	132	5.0	500	0	0	2.5	375	1	200	6	3000	188.64	1.5	1200	0	0	1	400	3	450	6446
25	Bush Set	STD	4	ø70x200	14000	0.11	31	0	0	12	1800	1.5	225	1.5	300	5	2500	0	4	3200	0	0	0.5	0	3	450	8506
26	Pillar Set	STD	4	ø70x200	14000	0.11	31	0	0	0	0	1.5	225	1.5	300	5	2500	0	4	3200	0	0	0.5	0	4	600	6856
27	Lifter M16	MS	8	ø50x100	5000	0.04	11	0.0	0	6	900	1.5	225	1.5	300	4	2000	0	0	0	0	0	0.3	120	3	450	4006
28	Pusher-MP50	EN-31	1	100x100x30	300000	2.36	165	6.0	600	0	0	2	300	1.5	300	3	1500	471.6	2.5	2000	0	0	0.3	120	3	450	5907
29	Pivot Pin-MP50	EN-31	1	ø30x70	2100	0.02	1	0.0	0	8	1200	1.5	1	1.5	300	4	2000	3.3012	2	1600	0	0	0.4	160	4	600	5865
30	Lever-MP50	EN-31	1	150x30x30	135000	1.06	74	6.0	600	0	0	2	300	2	400	4	2000	212.22	3	2400	0	0	0.4	160	3	450	6596
31	Handle-MP50	MS	1	900x25x10	225000	1.77	62	6.0	600	0	0	4	600	2.5	500	2	1000	0	0	0	0	0	0.2	80	2	300	3142
32	Guide Box-MP50	C-45	1	100x50x10	100000	0.79	28	6.0	600	0	0	3.5	525	1.5	300	6	3000	157.2	2.5	2000	0	0	0.2	80	3	450	7140
	Total Cost (in INR)																										**800054**
	Total Manufacturing (in Hours)																										896

Note: In above Tool list most of the comman and major parts are taken into account.

Fig. 10. In-house manufactured Press tool cost estimation

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Result Analysis

The standardized methodology for tool and die making validated by different ways in different quality, dimension of tools and dies produced. All the tools were made in the die shop of MSME Tool Room Jamshedpur in the year (2018-2019). The study consisted of;

- Identification of the component
- Die design
- Estimation of mold cost
- Comparison of estimated and actual cost of mold

Table 10: Comparative Analysis of Cost

		Total Cost (INR)		Cost Difference (INR)	Cost benefit (in %)
Sl. No.	Name Of The Tool	In-house Manufacturing Die Set	Standard Die Set		
1	Mold Base	210025	151200	58825	28.01
2	Die Casting Die Base	380128	285000	95128	25.03
3	Press Tool Base	800054	696000	104054	13.01
	Total	1390207	1132200	258007	18.56

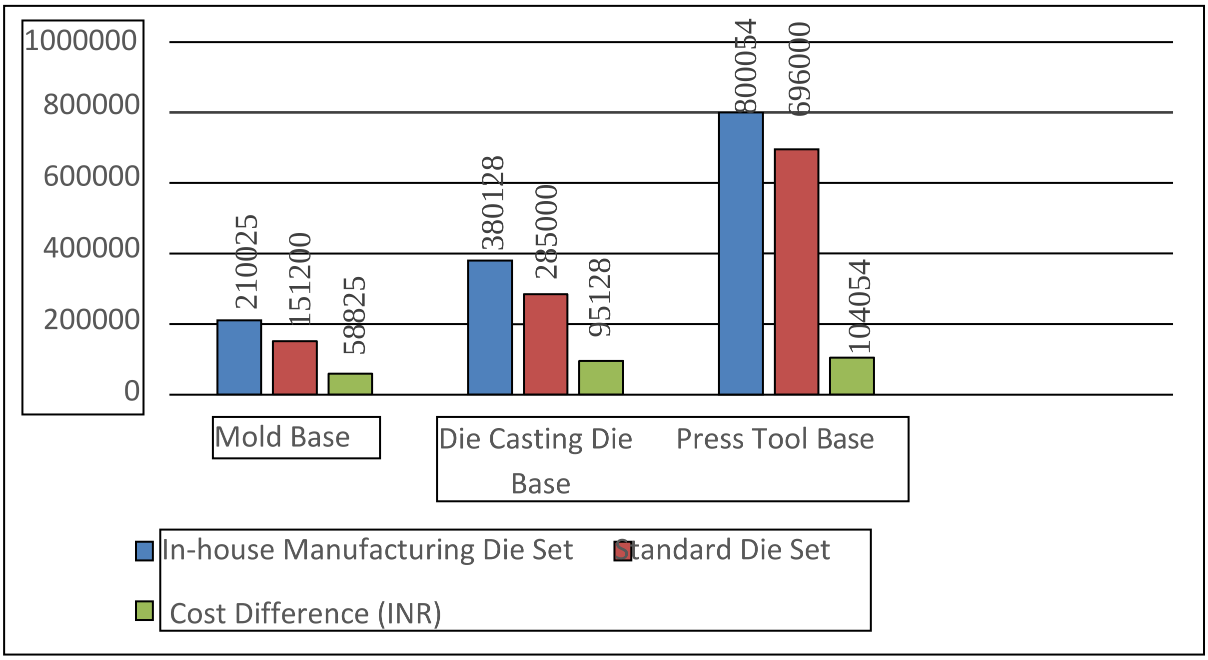

Fig. 11. Cost comparison of different type of dies

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Table 11: Comparative Analysis of Manufacturing Time

		Total Time (Hrs.)		Time Difference (Hrs.)	Time benefit (%)
Sl. No.	Name Of The Tool	In-house Manufacturing Die Set time	Standard Die Set manufacturing time		
1	Mold Base	699	475	224	32.05
2	Die Casting Die Base	1081	854	227	21.00
3	Press Tool Base	896	735	161	17.97
	Total	2676	2064	612	22.87

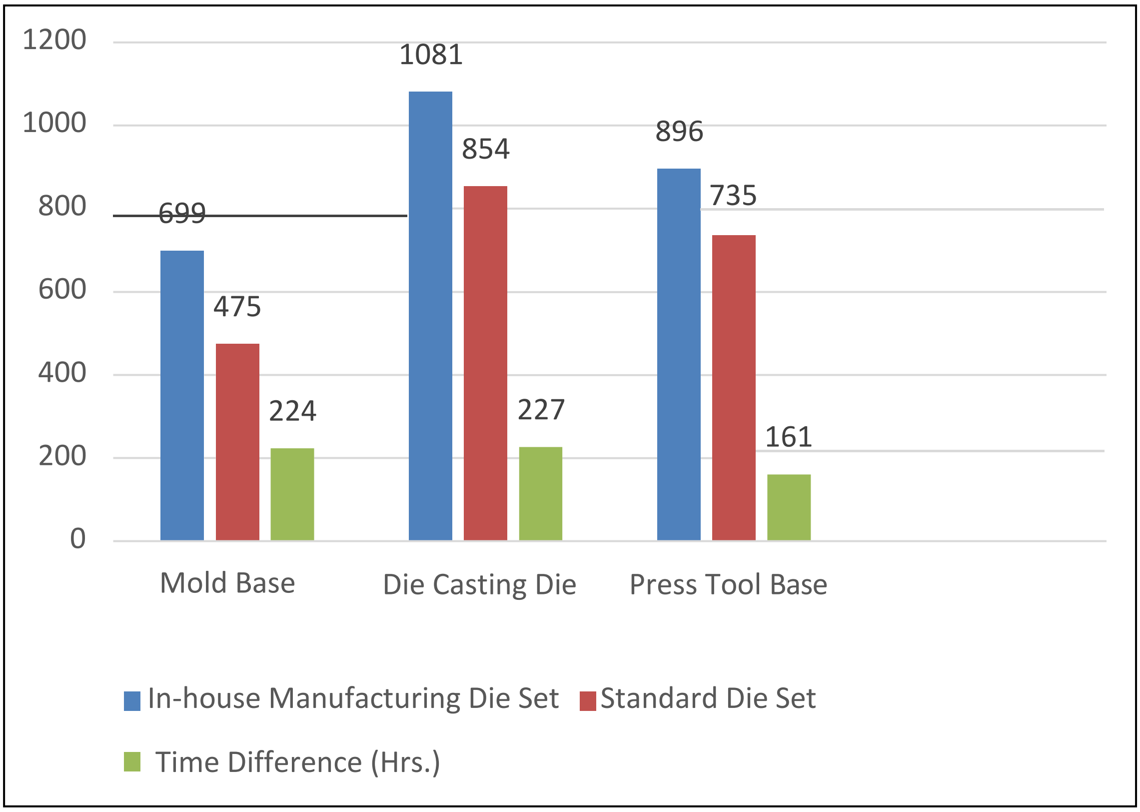

Fig. 12. Manufacturing time comparison of different type of dies

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Table 12: Cost benefit comparison between Standard die set and In-house manufactured Die (in Percentage)

Cost benefit (in percentage)	Time benefit (in Percentage
18.56	22.87

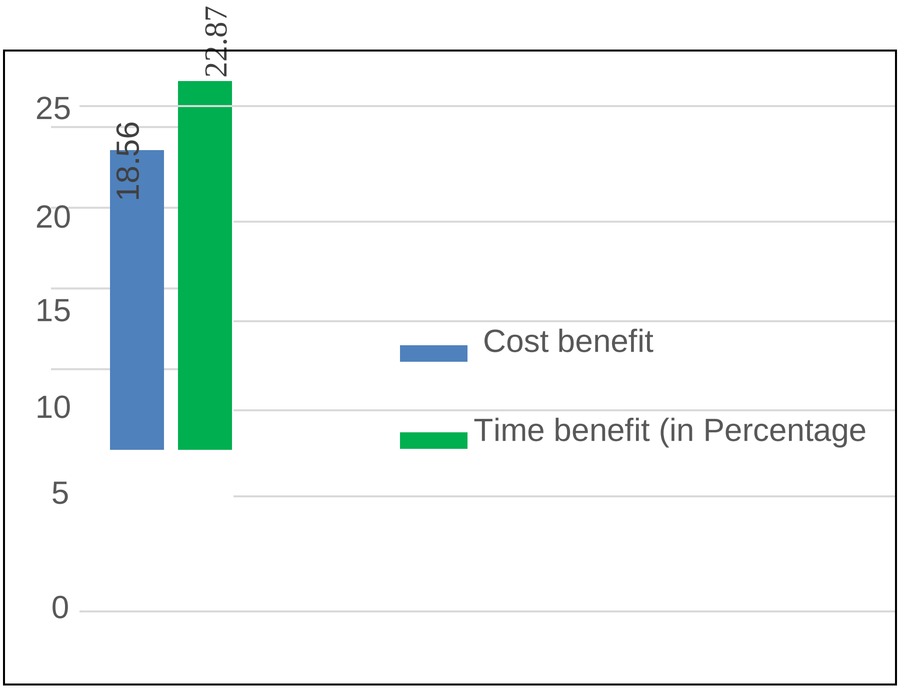

Fig. 13. Cost benefit and time benefit in standard die set

Result Analysis of process standardization

Taken following steps to standardize the entire tool and die manufacturing process chain of a general company

i. Formally describing the function of the entire existing task done in a general company during operation.
ii. Allotting Time frame for every task on the basis of historical data and discussion with the operators
iii. Comparing the time gap between previous and new time.
iv. Assessment of new system benefits.

Conclusion:

Tool and die making industry offers myriad complementary services to industries, especially to their local customers. The research paper deals with the various aspect of tool manufacturing e.g. adapted manufacturing process, Tool cost, and manufacturing lead-time. Various aspects of traditional manufacturing studied like manufactured tool quality, functionality, manufacturing process, surface finish die life etc. Result indicates that

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after implementation of standardization, cost saving in overall tool's manufacturing is 18.56 percent and manufacturing time saved up to 22.87 percent. Study revealed a pragmatic and significant change observed implementation of standardization. This made customer not only happy also delighted. Meanwhile saving in manufacturing time converted in the monetary term considered as an improvement to make organization profitable and sustainable in the present cutthroat competitive market resulted in the increase of plant efficiency.

Study showed the very significant improvement while standardization applied. Standardization applies in tool design, effective planning, manufacturing and inspection respectively. Apart from saving of manufacturing cost and manufacturing time, standardization improved the entire organizational manufacturing improved process flow, comfort and morale of the tool and die manufacturing companies. The aim of this article is to analyze the traditional tool making process with latest standardized process. Study revealed that application of standardization improved tool and die industry performance and its sustainability. Robust framework of standardized practices required to remove barriers of traditional manufacturing.

Future scope:

There are many other methods of manufacturing parts of a die or mold. Additive manufacturing is one such option. Many manufacturing companies including SMEs are now initiating E-manufacturing practices. It generates a wide scope for effective manufacturing as well as problem solving. It is not only an innovative approach but also more practical oriented and cost effective in long run. The new age practice successfully implemented in countries such as the USA and UK. This system of manufacturing opens the door for myriad opportunity and growth in the industrial sector.

Limitations:

The elucidated case study in research paper has its specific scope limited up to a tool and dies making organizations. Research study describes about the standardization practices in the form of an industrial illustration and has no financial obligations at all with any of the organization. The study was conducted as part of educational research work, obtained results are very promising, encouraging specially to micro, small, medium-sized tool making industries and advocates to adopt standardization their betterment in terms of productivity, lead-time and for overall sustainability of the organization.

Due to small nature of firms, worldwide Tool manufacturers face challenges, when it comes to the application of a systematic approach, mostly no single tool and die is exactly a replica of another. Standardization practices may not be economical at the initial stages but after a certain period start yielding several benefits to the organization.

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References:

1. [i] Department of T`rade and Industry (DTI), E- Business in manufacturing case studies, October, 2001.
2. [ii] Martin, Timothy D., and Jeffrey T. Bell. New Horizons in Standardized Work: techniques for manufacturing and business process improvement. CRC Press, 2017.
3. [iii] Sherif, M. H. (2006). Standards for telecommunication services. In *Advanced Topics in Information Technology Standards and Standardization Research, Volume 1* (pp. 183-205). IGI Global.
4. [iv] Xie, Zongjie, Jeremy Hall, Ian P. McCarthy, Martin Skitmore, and Liyin Shen. "Standardization efforts: The relationship between knowledge dimensions, search processes and innovation outcomes." Technovation 48 (2016): 69-78.
5. [v] Kampker, A., Burggräf, P., Deutskens, C., Maue, A., & Förstmann, R. (2014). Integrated product and process development: Modular production architectures based on process requirements. *Procedia Cirp*, *20*, 109-114.
6. [vi] Zellner, P., & Laumann, M. (2013). Evaluation of business processes for business process standardization. *Evaluation*, *6*, 18-2013.
7. [vii] Pahl, Gerhard, Wolfgang Beitz, Jörg Feldhusen, and Karl-Heinrich Grote. "Methodisches Entwerfen." Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung Methoden und Anwendung (2007): 305-549.
8. [viii] Reinhardt, Thomas, and Gerd Witt. "Ansätze zur Qualitätsbewertung von generativen Fertigungsverfahren durch die Einführung eines Kennzahlensystems." In RTejournal-Forum für Rapid Technologie, vol. 2012, no. 1. 2012.
9. [ix] Klocke, Fritz. "Generative Fertigungsverfahren." In Fertigungsverfahren 5, pp. 127-170. Springer Vieweg, Berlin, Heidelberg, 2015.
10. [x] Schuh, Günther, Michael Salmen, Thomas Kuhlmann, and Jan Wiese. "Highly iterative product development within the tool and die making industry." Procedia CIRP 61 (2017): 576-581.
11. [xi] Pye, Ronald George William. "Injection Mould Design." Longman Group UK Limited, 1989, (1989): 754.
12. [xii] Boos, Wolfgang. Methodik zur Gestaltung und Bewertung von modularen Werkzeugen. Vol. 2001. BoD–Books on Demand, 2008.
13. [xiii] Kouzilos, Georgios N., Angelos P. Markopoulos, and Dimitrios E. Manolakos. "Manufacturing and modelling of an extrusion die spider head for the production of HDPE tubes." Journal of Manufacturing Technology Research 6, no. 1-2 (2015): 1-15.
14. [xiv] Sedchaicharn, Korkiat. "Eine rechnergestützte Methode zur Festlegung der Produktarchitektur mit integrierter Berücksichtigung von Funktion und Gestalt." Institut für Produktentwicklung IPEK, Karlsruhe (2010).

15. [xv] Sedchaicharn, K. (2010). Eine rechnergestützte Methode zur Festlegung der Produktarchitektur mit integrierter Berücksichtigung von Funktion und Gestalt. *Institut für Produktentwicklung IPEK, Karlsruhe*.
16. [xvi] Vazquez, V., & Altan, T. (2000). New concepts in die design—physical and computer modelling applications. *Journal of Materials Processing Technology*, *98*(2), 212-223.
17. [xvii] Romero, F., Rosado, P., & Bruscas, G. M. (2016). APPLICATION FEATURE MODELS FOR PRODUCT AND PROCESSES ANALYSIS BASED ON ASSEMBLY MODELS. *Journal of Manufacturing Technology Research*, *8*(3/4), 135-151.
18. [xviii] *Tool and Gauge Manufacturers Association (2000) Study on the Indian Tool Room Industry: 2000 Survey report, Tool and Gauge Manufacturers Association, Mumbai.*
19. [xix] Chan, Henry, Raymond Lee, Tharam Dillon, and Elizabeth Chang. E-commerce, fundamentals and applications. John Wiley & Sons, 2007.
20. [xx] Lee, Jay. "E-manufacturing—fundamental, tools, and transformation." Robotics and Computer-Integrated Manufacturing 19, no. 6 (2003): 501-507.
21. [xxi] Hepp, Martin, and Klaus Böhnlein. "Modellierung der pflege von standards mit hilfe höherer petri-netze." In Proc. 8. Symposium: Simulation als betriebliche Entscheidungshilfe, pp.3-13.
22. [xxii] Verein Deutscher Ingenieure (VDI): Richtlinie 3404 - Generative Fertigungsverfahren - Rapid-Technologien (Rapid Prototyping) - Grundlagen, Begriffe, Qualitätskenngrößen, Liefervereinbarungen, 2009.
23. [xxiii] Klocke, F. (2015). Generative Fertigungsverfahren. In *Fertigungsverfahren 5* (pp. 127-170). Springer Vieweg, Berlin, Heidelberg.
24. [xxiv] Schuh, G., Salmen, M., Kuhlmann, T., & Wiese, J. (2017). Highly iterative product development within the tool and die making industry. *Procedia CIRP*, *61*, 576-581.
25. [xxv] Chan, H.; Lee, R.; Dillon, T.; et al. E- Commerce: Fundamentals and applications; Chichester: John Willey& Sons Ltd; 2001.
26. [xxvi] Emmett, Stuart, and David Granville. Excellence in inventory management: How to minimise costs and maximise service. Cambridge Academic, 2007.
27. [xxvii] Chase, Richard B., Robert F. Jacobs, Nicholas J. Aquilano, Alberto Grando, and Andrea Sianesi. Operations Management nella produzione e nei servizi. McGraw-Hill, Publishing Group Italia, 2008.
28. [xxviii] Cheng, K., & Bateman, R. J. (2008). e-Manufacturing: Characteristics, applications and potentials. *Progress in Natural Science*, *18*(11), 1323-1328.
29. [xxix] Vazquez, V., & Altan, T. (2000). New concepts in die design—physical and computer modelling applications. *Journal of Materials Processing Technology*, *98*(2), 212-223.

ISSN：1671-5497
E-Publication： Online Open Access
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DOI 10.17605/OSF.IO/Y8HQM

30. [xxx] Romero, F., Rosado, P., & Bruscas, G. M. (2016). APPLICATION FEATURE MODELS FOR PRODUCT AND PROCESSES ANALYSIS BASED ON ASSEMBLY MODELS. *Journal of Manufacturing Technology Research*, *8*(3/4), 135-151.
31. [xxxi] Xie, Zongjie; Hall, Jeremy; McCarthy, Ian P.; Skitmore, Martin; Shen, Liyin (2016-02-01)."Standardization efforts: The relationship between knowledge dimensions, search processes and innovation outcomes”. Technovation. Innovation and Standardization. 48–49: 69–78. doi:10.1016/j.technovation.2015.12.002).
32. [xxxii] Martin, T. and Bell, J.; New Horizons in Standardized Work. 1st Edition ;CRC Press, New York; 2011.
33. [xxxiii] Sherif, M.H.; Standards for telecommunications services. In: Jakobs, K. (Ed.); Advanced Topics in Information Technology Standards and Standardization Research. Idea Group Publishing, Hershey, PA, pp. 183- 205; 2006.
34. [xxxiv] Kampker,A.; Burggräf,P.; Deutskens, Maue,A. and Förstmann,R.; Integrated Product and Process Development: the Modular Production Architectures Based on Process Requirements, in Procedia CIRP 20, PP 109-114,2014.
35. [xxxv] J. F. Camacho, ISTMA Statistical Year Book Edition 2014, Lisbon, 2014.
36. [xxxvi] R.G.W. PYE (1989)INJECTION MOLD DESIGN. Affiliated East-West Press Pvt. Ltd, New Delhi. pp.235.
37. [xxxvii] Boos, W.; Pitsch, M.; Kuhlmann, T.; Schippers, M.; Stark, M.; World of Tooling, Aachen, 2015.
38. [xxxviii] Klotzbach, Christoph. Gestaltungsmodell für den industriellen Werkzeugbau. Shaker, 2007.
39. [xxxix] MĺKva, Miroslava, Vanessa Prajová, Boris Yakimovich, Alexander Korshunov, and Ivan Tyurin. "Standardization–one of the tools of continuous improvement." Procedia Engineering 149 (2016): 329-332.
40. [xl] Martin, Timothy D., and Jeffrey T. Bell. New Horizons in Standardized Work: techniques for manufacturing and business process improvement. CRC Press, 2017.
41. [xli] Xie, Z., Hall, J., McCarthy, I. P., Skitmore, M., & Shen, L. (2016). Standardization efforts: The relationship between knowledge dimensions, search processes and innovation outcomes. *Technovation*, *48*, 69-78.
42. [xlii] Sherif, M. H. "Standards for telecommunication services." In Advanced Topics in Information Technology Standards and Standardization Research, Volume 1, pp. 183-205. IGI Global, 2006.
43. [xliii] Zellner, Philipp, and Marcus Laumann. "Evaluation of business processes for business process standardization." Evaluation 6 (2013): 18-2013.
44. [xliv] Kampker, Achim, Peter Burggräf, Christoph Deutskens, Andreas Maue, and Ruben Förstmann. "Integrated product and process development: Modular production architectures based on process requirements." Procedia Cirp 20 (2014): 109-114.

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E-Publication： Online Open Access
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DOI 10.17605/OSF.IO/Y8HQM

45. [xlv] Sedchaicharn, Korkiat. "Eine rechnergestützte Methode zur Festlegung der Produktarchitektur mit integrierter Berücksichtigung von Funktion und Gestalt." Institut für Produktentwicklung IPEK, Karlsruhe (2010).
46. [xlvi] Altan, Taylan, Blaine Lilly, and Y. C. Yen. "Manufacturing of dies and moulds." CIRP Annals 50, no. 2 (2001): 404-422.
47. [xlvii] Kovačević, Marko, Miloš Madić, Miroslav Radovanović, and Dejan Rančić. "Software prototype for solving multi-objective machining optimization problems: Application in non-conventional machining processes." Expert Systems with Applications 41, no. 13 (2014): 5657-5668.
48. [xlviii] Pessoles, Xavier, and Christophe Tournier. "Automatic polishing process of plastic injection moulds on a 5-axis milling centre." Journal of materials processing technology 209, no. 7 (2009): 3665-3673.
49. [xlix] Çalik, Adnan. "Effect of cooling rate on hardness and microstructure of AISI 1020, AISI 1040 and AISI 1060 Steels." International journal of Physical sciences 4, no. 9 (2009): 514-518.
50. [l] Evans, James Robert, and William M. Lindsay. The management and control of quality. Vol. 5. Cincinnati, OH: South-western, 2002.