

# Foundry 4.0: Revolutionizing Casting Production with Computerized Systems

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## Abstract

*For a considerable amount of time, foundries used computers for handling inventory, waging, wages, accounting, personnel records, and quality control. Nearly all of the foundry's systems and machinery are computerized. Through the installation of computers in foundries, employees' workloads and levels of stress have reduced significantly, and the workplace feeling has greatly improved. This review paper explores the potential implications and functions of computers in foundries. A thorough explanation of foundry software programs and expert systems is provided for the metal casting industry. To assist with understanding each foundry software package's distinctive use, a table featuring software programs produced by the American Foundrymen's Society (AFS) is given.*

**Keywords:** Foundry mechanization, computer aided foundry model, numerical simulation, computerized foundry line, expert systems, AFS foundry software packages

## INTRODUCTION

Technology for metal casting constitutes one of the oldest methods of production. In foundries, a range of molding techniques and melting tools are available to cast a number of metals and alloys. Even while casting manufacturing processes and techniques have evolved significantly, the underlying ideas have remained mostly unchanged. A couple of features clearly identify the important role that castings play in contemporary machinery utilized in industry, agriculture, construction, transportation, and information. For creating tools and machines, which need to exist to satisfy the needs and comforts of life, cast metals are needed in a variety of forms, sizes, and enormous amounts. Yet, castings have some benefits over conventional manufacturing processes, including metallurgical and design advantages as well as perks in the casting process itself. Computers are now used in every business process, but they are especially prevalent in foundry expertise [1, 4].

## PROSPECTS

Quality and defect-free castings are regarded as crucial components. This meets the needs of the client in a variety of ways. Production process control is necessary to attain and maintain quality. All foundry process steps must be manually controlled in order to turn out castings of the desired quality. In order to efficiently monitor and regulate the process, computers are added. Utilizing computers has become crucial for managing all aspects of the casting process, such quality, metal composition, handling liquid metal, and casting fault diagnosis using professional software. Computers also assist in simulating the solidification of the casting during processing. This lays the path for properly planning the casting, avoiding significant flaws like hot spots, and

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identifying and locating the areas where stress is localized. It offers the temperature distribution throughout the solidifying casting, as well as comprehensive details on the temperature contours and casting temperature records [5]. There are several software programs accessible to do analyses on different topics. Among them, finite element analysis is a crucial technique for analyzing the distribution of stress and temperature as well as the evolution of microstructure. Modern foundries require very little assistance from humans and are fully automated and computer-controlled. Computers are used in foundries to monitor and regulate emissions and noise. Computers are used to do microstructural characterization and take microscope images with the help of imaging instruments and software [1, 3].

### **COMPUTER AIDED FOUNDRY MODELS DESIGN**

The conventional method of handling process and process planning problems, which is frequently employed at a foundry, is to give the designs to the professionals who specify and illustrate the processes needed to create the cast product. Based on the design necessities, the installations and operators that are available, and their expertise and knowledge, the designers create projects and procedures for the foundry product manufacturing process [1]. Experience and understanding of casting procedures is essential for consistent designing and organizing. As a result, computer-assisted process scheduling (CAPP) systems were created, and these days, they are crucial in this industry. As a bridge between design and manufacturing, CAPP systems are starting to close the current gap between CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing). With the use of CAPP, an integrated structure addressing information flow across CAD, CAPP, MRP, and numeric control (NC) operations inside the organization may be developed [2, 3]. Regarding computer-aided process planning, there are two methods. Using pre-existing standard process plans that are kept in the database, a new process plan is created using the variation technique, which is the first strategy. The second method is called the generative approach, and it involves creating a new process plan entirely from scratch without using any existing templates as a basis. A generative process planning system's fundamental prerequisite is its ability to translate a given component model drawing into features that may be produced. The primary goal is to implement a computer-assisted system that will aid in automatically choosing and ultimately defining the characteristics of foundry models. The phases in the applied approach are broken down into three categories: acquiring knowledge, changing the activity, and lastly building and implementing the tool [2–4]. A significant portion of the casting production sector is comprised of foundries. The design of the models and their accessories is among the most crucial elements. A foundry engineer's knowledge and experience are crucial for the proper casting of a pre-designed shape, and it takes a lot of time in a production setting for them to complete this phase. Therefore, the primary goal is to implement a computer-aided system that defines the specifications of the model, including feed head, flask, pouring system, radius, draft corner, and machining allowance. The primary functional parts of the prototype system were created utilising Visual Basic, an object-oriented programming language. The geometrical definition of the part serves as the foundation for the computer system. The application does the model parameter calculations based on the geometrical features to provide an accurate design. The outcome provides the model's parameters as well as an adjustable dimension recommendation. The provided integrated approach's primary characteristic is its capacity to manage a range of components and produce the foundry models for all [4].

### **Role of Computers in Foundries**

A new cast product's profitable launch into the cutthroat market of today requires rapid, effective product development in addition to quick, adaptable methods of production. A few months of delay can cost a product market share and perhaps lead to a demise of a potentially successful product, thus timing is crucial. When launching new cast goods, foundries need to combine just-in-time manufacturing, concurrent engineering, and efficient design. The race is on to get a new cast product onto the market before the competition appears, once the prototype finishes market testing. The time it takes for new foundry goods to reach the market has been significantly reduced by computers. Casting directors of today build designs on-screen with sophisticated computer-aided design tools, which they may readily

update as necessary. Concurrently, assembly has grown more automated thanks to computerized inventory control systems and 24/7 human error-free assembly robots [4].

When it comes to labor rates and material consumption, casting is the most economical way to make metallic parts. Casting permits thinner walls, a greater range of alloys, less geometric restrictions, and more when compared to alternative manufacturing processes. The lengthy delay between purchase and acceptance, which results from the requirement for a pattern to be created for the mold, may, nonetheless, outweigh these benefits. Since gate design is frequently based on actual, mostly unrecorded experience, repeated trial and error prototypes is frequently required during the pattern creation process. By simulating solidification, computers might help the foundry guy with conceptual analysis and gating. In certain foundries, the CAD pattern design is created, then the pattern or die maker is instructed by the drawing. The crushing of the molten metal in the ceramic mold may be simulated in foundries using the same CAD data that was used to define the pattern or shape. Computer Aided Design has grown to be a vital tool for metal part design in recent years. By doing away with a requirement for manual drawing, computer-aided design (CAD) enables engineers to more precisely create complex elements. But the result of all that pricey software and processing power is a multifaceted sketch on paper. The part's design drawing must be interpreted by foundries into a pattern design, which calls for the inclusion of draft angles and parting lines, shrinkage a reimbursement, and the filleting of sharp comers. These changes often mean that the foundry must regenerate the CAD file, rendering the customer's CAD file useless. Instead of having to redraw the CAD, the foundry engineer may more easily mark the customer's drawing and send it to the pattern or molded maker [4, 5].

### **Computer Aided Foundry Die Design**

The goal of die casting die design is to create sound casting as quickly and inexpensively as feasible. Simultaneously, proper die size, gating system placement, and die-casting machine selection must be taken into account. Foundries frequently struggle to guarantee a shorter lead time when creating a new die for a new product. Numerous estimates that are mostly based on prior knowledge and the application of several mathematical and empirical equations must be made. The primary die components are estimated by computer programs using the casting shape's geometry as input. Following the initial inputs, the program does comprehensive computations, optimizes selections, and then offers a list of the primary die element sizes. Both die and casting machine characteristics may be shown in the software. The optimal die elements are selected based on both qualities. Among other die sections, the ideal filling time and gating ratios are established. Relationships between cooling time, cooling channel locations, and flow rates are determined [1–3].

### **Application of Computers in Foundries**

These days, computers are employed in every industry, and foundries are no exception. Castings have a significant failure rate in normal practice. Compared to manual production, computer simulation greatly reduces the failure rate. It takes a lot of time to manually examine cast items, and there's a risk a worker won't find a flaw. Quality inspection may be completed quickly and simply with the use of sensors, especially when castings are produced in large quantities. Therefore, human intervention could eventually be removed. The use of computers in foundries permits the direct development of a product from an existing one in situations when even more product data, such as a design drawing or the material used, is unavailable. Additionally, it lowers the incidence of rejection and waste and promotes continual research and development. Here is a list of some benefits of computer application [4].

- *Animation advantage:* Better imagination and presentation
- *Simulation advantage:* In a matter of milliseconds, proficient computations such as stress analysis and the flow of molten metal, potential barriers, stress and strain, solidification order of and defect probability may all be projected.
- *Database advantage:* Aids in the development of research. Leveraging its built-in information, the computer may provide substitute supplies and design alternatives to reduce costs due to weight, size, availability, and variation in properties.

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- *Communication and networking advantage:* Improved consumer service, easier team member interactions, easier history management, and order and feedback collect.

The machine advantage: Utilizing software packages for simulation in foundries. CAD/CAM/CAE tools are the broad terms used to describe simulation software. Catia (Computer Aided Three Dimensional Analysis) is one of them. It is an extremely flexible package that helps with nearly every type of design, including the creation of drawings, mechanical design, machine parts, sheet metal designing, free-style shaping, hybrid design, structural analysis, mold and die casting design, prismatic machining, layout of manufacturing plants, and more. Software packages like Unigraphics, Solid Edge, Pro E, and iDeas are already created. Early design optimization utilizing the iDeas package may significantly increase product quality while cutting costs and time. Solid Works is capable of producing illustrations, modeling cutting tool trajectories, developing numerical control, and creating geometry and fine-tuning component characteristics. For kinematics and motion analysis of mechanical systems, ADAMS is the ideal package. The behaviors of mechanical systems subjected to huge displacement initiatives can be predicted by it. Chain mechanisms and inversions, such as four bar confinement, employ it. Ansys is a finite element software it can handle a variety of analyses, including piezoelectric, acoustic, and linear and non-linear stress and heat issues. Ansys Flotrain and Ansys EMag are two more software that come with it that let the user figure out which stress, temperature, fluid flow, and magnetic phenomena interact. A collection of comprehensive CAE simulations for the plastic molding process, commonly referred to as C-MOLD, includes blow molding, thermoforming, co-injection molding, gas injected molding, reactive molding, post-filling and chilling, and injection molding filling. It also includes component shrinkage. The applications of fluid are most suitable for biological analysis, heat and mass transfer, fluid dynamics, and conveyance of fluids. With the aid of topology, topography, shape, and size, Altair Optistruct, a finite element analysis program, may maximize structures to reduce weight and increase performance. Pro CAST is a software suite that is specific to casting. Pro Weld specializes in welding software. Prodigy Plus is a machine that can create prototypes of any difficult material. It comes with accompanying software.

In today's world, computers are a critical instrument for all types of applications and in every profession. But in recent times, computers have been used more and more on a wide range of technological tasks, including designing and drawing, and choosing processes and methods, building tools, designing components, designing computers, planning and directing production, controlling processes, ensuring quality, and analyzing defects. In foundries, automation has also advanced significantly, and computers are now a crucial component of the control system for all autonomously controlling equipment. Further advances in robotics are made in several foundries, which likewise use computer programs that are pre-planned. In actuality, the introduction of computers entirely altered the structure of the foundry business, contributing to increased efficiency and casting output as well as quality control and cost management. Expert systems, artificial intelligence, CAD, CAM, CNC, and CAM have all boosted casting manufacturing. Currently, the foundry industry has no choice but to consider adopting new technological processes, new materials, and to go toward automation and computerization in order to accommodate the rapidly growing demand from sophisticated users, particularly the automobile, aeronautical, electrical, power plant, and machine tool industries, for castings developed in large quantities of superior metallurgical quality and close dimensional accuracy. Computers have the potential to guarantee better and consistent quality, larger yields, and cheaper prices, even if they are not necessary for use at every step of production. In the foundry sector, computers equipped with both standard and custom software have become widely used. More significantly, they are widely used in the following fields [4]:

- The design and development of molds for the best possible quality, dimensions, cost, and castability.
- Maintaining pattern designs.
- Sand control to achieve the appropriate qualities for mold and dust.
- Optimize and choose systems to guarantee product cost and quality.

- Developing and establishing specific methods for designing patterns and other foundry tools, punches and molds, gates and risers, requiring exothermic and insulating materials, pouring, molding, relaxing fettling, and treating with heat.
- Controlling heat treatment cycles.
- Production planning and control.
- Purchasing and choosing goods, calculating the economic order quantity for several necessary goods, lead times, reserve stocks, and reorder points, ABC analysis, maintaining track of the stock positions of various stock items.
- Choosing the right blend of chemicals to provide the needed qualities, charge oversight, melting, and melt controls.
- Process control.
- Quality evaluation, records, inspection, and testing.
- Cost control at every stage of casting production.
- In order to ensure long-term product quality and easy identification and traceability, a computerized system containing all the information regarding production quantities, sand testing, casting manufacturing timelines, heat numbers, melt cycles, process controls, quality records, defect analysis reports, and heat treatment cycles must be argued.
- Preserving information on tool by gauge, instrument, and equipment calibrations; corrective procedures used to rescue goods; and quality records, which comprise work instructions, quality objectives, quality processes, and safety manuals.
- Documents pertaining to pay and benefits provided for employees and staff, labor inputs, instructions for employment, work evaluations, and merit grades.
- Maintaining data about daily, weekly, monthly production and productivity.

The following software requires installation to run computers for particular goals: [4, 5].

- The operating system, that enables the system to start, stop, and carry out a number of administrative tasks, including transferring et retrieving data, creating directories and editing, cutting, copying, and clipping, as well as printing or charting on a printed document.
- Standard software, containing programs for writing text, publishing, tabulating data, controlling databases, creating work sheets, sketching, drafting, and graphics, creating presentation slides, and conducting calculations using mathematics.

Software packages with particular purposes, like those made for risering and gating design, casting and pattern design, feeding systems, inventory control, melt calculations, warmth transfer, fluid flow and solidification studies, quality and soundness evaluation, are demonstrations.

There is no need to employ costly and proprietary software packages for many of these computer applications since they are so basic in nature. These can be created internally using appropriate computer languages like FORTRAN, Pascal, "C," and BASIC. For creating interior programs, standard applications like Excel, D-Base, AutoCAD, Harvard Graphics, Acrobat, and Coral may be utilized with its simplicity. The Internet has emerged as a major asset for expedient communication, be it domestically within the foundry sector or externally with foreign casting buyers, suppliers, or shoppers. An important amount of paperwork is saved, and messages that once required days or weeks to travel may now be sent and got back in a matter of seconds. Through the internet, it is able to send inquiries to potential clients, obtain quotations place purchase orders, record track of transactions, have discussions with individuals or groups of people, exchange information and data, drawings, or photos, and much more. In order to promote and popularize their cast products and amenities and investigate worldwide markets, foundries might establish their own site [6, 7].

### **Computer Simulation of Casting Solidification**

The process of metallurgical transformation of phase is essential to casting solidification. Casting the process of solidification is the process of releasing latent heat of fusion to convert a liquid phase into a

solid phase. This metallurgical action causes hot rips, porosity, and shrinkage in the casting. Accurate casting design and proper gating system design are required to completely alleviate such problems. Casting solidification may be calculated on a computer to forecast and design this. With the aid of the time-temperature contours that are acquired, it enables us to locate the hot spot location by helping us comprehend the temperature history of the solidifying casting. Likewise, by putting the aforementioned information from a computer-simulated process into practice, it will be utilized to obtain defect-free as cast goods. In many sectors, computers are readily available. Thus, scientists have started developing software that simulates the solidification of metals [8, 11]. The intricate process of creating solidification of metals and alloys is simulated by computer. The presumption and limitations that are employed in simulation are seen to be vital. By using computer software that had been developed domestically for the approach to casting that was chosen for inquiry, the solidification variables are simulated during the casting process. The information on the time-temperature profile and heat transfer coefficient values provided by software is crucial for the efficient design of castings [9, 11].

There are a lot of computer simulation software programs available currently, but some demand processors with capacity that is typically beyond the reach of practical foundry personnel, and others take too long to produce useful results. The purpose of computer modeling is to forecast the solidification pattern, pointing out possible positions for shrinkage cavities and related flaws. An array of quality levels is its secondary goal. Additionally, it is utilized to mimic solidification by casting in several orientations, allowing the ideal position to be identified. This will assist with establishing the weights and volumes of various materials, including steel, non-ferrous metals and alloys, white cast iron, grey cast iron, ductile cast iron, and white iron cast ingots. Accurately determining the solidification time and behavior of many different substances is its intended purpose. As a result, it was used to ascertain the cooling rate that is impacted by the castings' grain structure. Castings' solidification simulation yields temperature contours, hot spot locations, degree of recalescence, latent heat of fusion, and solidification period of time. It also offers time-temperature data. The impact of undercooling solidify castings, which reflects more on the internal microstructures crucial to material qualities, is explained by the time-temperature plot that is generated [9–11]. Essentially, the solid modeling is done first by the casting the process of solidification simulation software program, followed by the heat analysis and solidification simulation. The best way to execute the casting may be anticipated by modeling the effects of changing the injection molding position, ingate position, mold materials, cooling, insulating, and exothermic materials during the process of simulation.

Aluminum, copper, iron, and steel foundries make use of casting solidification software for simulation on a daily basis for operations including investment and gravity die casting, green sand, resin and shell-bonded sand, and so on. Application include repeat castings like ductile iron crankshafts, large steel castings like heavy weighing engine housings, stern frames, critical high-pressure the button castings, and castings where modeling increases the likelihood of achieving "Right First Time" method, thereby cutting the lead time for new castings. Not only do foundry process engineers utilize solidification software to simulate, but casting designers and buyers also use it since they are seeing a noticeable improvement in quality from their providers of modeling software [10, 11].

### **Computerized and Automated Foundry Line**

A foundry has to reconstruct its automated sand casting line following a significant accident that drastically damaged or destroyed a great deal of the casting machinery and the management systems. The service needs to be restored as quickly as humanly feasible to keep customers from transferring to opponents and to allow furloughed employees to resume work. While they were rebuilding the casting line, the foundry workers wanted to make sure that the fresh control system didn't cause them the same problems as the old one. The programming and troubleshooting of previous systems was hindered by delayed reaction times due to network congestion [2, 3, 10].

Updating software or pursuing routine maintenance required slowing down the entire line while run under central control. a big annunciator panel that served as the line's main interface by installing.

Operators had to go through a sequence of decisions in order to start or stop the line. A few benefits are presented below [10].

- Operators are required to enter a few touch screen inputs to start the casting line.
- On graphical overview panels, color-coded indications act as alarm lamps by highlighting out the root cause of concerns.
- The primary dashboard can be customized by software modifications made to the Panel View monitors. Rewiring the annunciator panel is not recommended.
- Because the ladder logic software employs standard control code, maintenance and engineering staff can learn it more rapidly.
- Management and technical workers may use the Control Logic network to monitor, backup, and troubleshoot any PLC in the foundry from the comfort of their respective shop or office.
- Bottlenecks concerning networking have been resolved.
- Central management has eradicated the need to shut down the entire line for routine maintenance or improvements to the software.

### **Expert Systems for Foundries**

Expert systems in computer science are technologies that educate machines to think like people. In contemporary foundries, expert systems are mostly used for casting defect analysis. Expert systems are computer programs created to capture, store, and make available to the general public the knowledge and skills of one or more experts. Extracting the information or skills from the domain expert is a crucial step. A variety of sources, including papers, case studies, databases, textbooks, empirical data, and individual expertise, can add to the knowledge of an expert system. Because these systems let computers to think, reason, draw conclusions, and offer evaluations answers, and insights regarding problems, they may substantially assist persons in making decisions. These have a variety of technical applications, like fault finding, analysis of casting defects, manufacturing, quality control, and facility upkeep [4].

One of the system's many widespread uses in foundries is casting flaw analysis. The entire system is comprised of an output device, a database, a knowledge base with inferential capabilities, and an input device like a keyboard. Concepts, facts, and procedures are included in the knowledge base, which is organized as a set of rules and may be saved, analyzed, and contrasted with the data in the database for a specific purpose. The data for the current problem is matched with the knowledge during inferencing using search and pattern-matching algorithms, and the option or solution, if appropriate, is shown on the result sheet. Foundries may purchase a knowledgeable system shell, which enables the creation, drafting, and amassing of any necessary knowledge, after which the application gets ready for use. An expert system could deliver relevant responses by simulating decision-making in a foundry, where many decisions are made on the basis of intuition. To begin with, in order to gather the data required to build the expert system, an expert with extensive knowledge of the pertinent technical field must be accessible. Once built, this technology may be employed whenever needed, obviating the requirement for continuous support from advisers or professionals with human expertise. Foundries are able to greatly profit from expert systems. Most decisions made in foundries, specially those on problem diagnosis, are based on common sense or heuristics. One such use case is the development of expert systems for diagnostics and monitoring in foundries. An expert method for examinations that looks at casting faults can be developed. It may also be used to identify a defect in any piece of foundry machinery. For example, expert systems for monitoring might be developed to monitor the properties of the sand mixture and offer corrective measures for effective upkeep of the sand structure [4].

### **Foundry Software Packages to Tackle Problems in Foundries**

Despite recent considerable developments in CAD, casting design, simulation, rapid tooling, intelligent advisory systems, and Internet-based foundries, most foundries remain caught between embracing change and staying in business. This is particularly significant for foundries operating in poor countries. However, businesses must remain current with the quickly advancing technological advances if they hope to remain in the global foundry industry. They can have both immediate,

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measurable benefits (such as shorter lead times, higher output, and fewer rejections) and long-term, intangible ones (which involves better marketing, greater communication, and enhanced company image) if properly submitted their application. [4, 5, 6]. Converting the tooling design from the component design and adding other elements such core boxes, pattern plates, gating and feeding systems, mold orientation, parting line, and draft allowances are all necessary steps in the casting design process. The designs of risering and gating systems may be modified through the use of casting solidification and mold full simulations, respectively. The casting model serves as the main input for the simulation. For casting design, three-dimensional computer-aided design (CAD) tools are used since the procedure essentially involves several geometric modifications to the component model. A few standalone tools are available for figuring out feeding and gating system dimensions, but they can't be connected to 3D casting design systems [4].

- Magmasoft
- CastCAE
- CastDESIGN
- CastCHECK
- AFS Solid 2000
- NovaFlow
- NovaSolid
- ProCAST
- MeshCAST
- AutoCAST

For casting and foundry improvement, Magmasoft software offers strong simulation tools, broad foundry knowledge, and professional support. It is a very popular simulation implementation that is used globally for cost-effective process architecture and casting quality prediction. Many foundries have accepted this as a way of tackling the difficulties in achieving directed solidification. The adoption of this package can enable both cost and quality saving by improving metal treatment and metallurgy, avoiding production risks, maximizing the strength qualities of cast iron, and reliably and optimally directing gating and risering. Additionally, a quantitative prediction of the microstructure distribution and local mechanical properties is earned.

CastCAE is a software application that simulates automated risering and casting solidification while monitoring proper mold filling. Filling patterns, cold closures, and shrinkage and porosity faults are all accurately predicted by it. It is fully based on physical representations and is compatible with all methods for casting and metals. It shows the filling sequence and temperature drop by simulating the pouring procedure. The next section illustrates how the casting hardens in the mold, where cooling causes shrinkage and the production of porosity. The user may share the findings with anybody who needs to see him without requiring more software since every output result will be issued as a separate file. Compared to the old modulus and Heuver's circle approaches, it computes the rate of feeding solution better since it is based on simulation and takes the effects of the alloy and mold into play.

CastDESIGN uses every single one of the dimensioning process methods to calculate the locations of necessary risers. The final findings include the yield, pouring and casting weights, and suggestions for more risers, if needed. CastCHECK has proven to be useful in several aspects such as initial component design, casting compatibility assessment, quality standard evaluation, inspection of design modifications for better castability, and customer inspection. Risering and gating design, piece test casting, and final test castings are among the applications for solidification simulation using Cast CHECKED [4].

AFS Solid 2000 software will be utilized to determine shrinkage porosity using a mix of volumetric and radiative calculations. It is possible to install the program on many workstations at once. The American Foundrymen's Society offers a variety of software applications intended specifically for use in foundries; they are shown in Table 1 below [4].

**Table 1.** Foundry Software Packages from AFS (American Foundry men’s Society) [4].

Name of the AFS Foundry Software Package	Description and Application
AFS Gating System	Software for calculating dimensions for a step-down gating system using different types of sprues and runners.
DOEpack	Design of experimental software for optimal product quality.
GAGEpack	A powerful guage calibration tracking software that helps to maintain the history of gauges.
Least Cost Charge	Software used for calculating the least expensive charge mix for alloys with the correct chemistry requirements.
Process Plus	Software used for the creation of useful foundry process control sheets and technical reports.
AFS Risering System	Combines the best of the geometric and modulus risering techniques to predict the best risers for castings.
SQC Pack	Statistical Quality Control Package allows the turning data into useful information.
Weight / Order	A program will calculate the weight of casting based on a material density and casting volume. It also calculates a modulus value, so as to get an idea on the order of solidification.
AFS Modeling Solidification System 3-D	It is used to predict problems in castings and make changes to the part, risering or process to optimize part manufacture before the first part is made.
R & R Pack	Software designed to provide a complete statistical and graphical analysis of the measurement system.
Synchro-16	Synchro-16 is management software for foundries of all sizes covering all aspects of foundry management. It enables to choose and integrate with any leading accounting system.

Many casting processes, include high pressure die casting, permanent mold, magnesium, aluminum, zinc, and copper-based alloys, sand casting of grey cast iron, ductile cast iron, magnesium, lost wax, and shell molding, may be carried out using the metalworking packages NovaFlow and NovaSolid. Sophisticated algorithms that take flow and gravity into account during mold filling and settlement are among the essential features. Increasing yield, optimizing riser requirements, and reducing the time required to clean, polish, and machine moulds are examples of common use [4, 9].

ProCAST is used for automated melding, stress and distortion analysis, and micromodeling. It uses the finite elements methods. It may also be used with shell, sand, investment, die casting, permanent mold, and lost foam processes. By simulating the steps of solidification and refining techniques, foundries have used the software to generate radiography-quality castings. It may be used for copying each of the three primary modes of heat movement. It also accepts the thermal, hydrodynamic, mechanical, and electromagnetic properties of media as constants or functions of warmth. In addition to modeling gas flow other than Newtonian flow, drainage, turbulence, compressible flow, lost plastic, and particle tracking, it can supervise rotation for tilt pouring, which is solve the full three-dimensional Navier-Stokes fluid motion equations, and simulate any type of casting process. Airflow and trapped gas can also be recreated. It may also mimic the injection of gas into a liquid in low-pressure die casting, creating a pressure buildup that forces the flow into the cavity [4, 10].

MeshCAST is an extremely helpful tool for engineers since it creates 3-D models completely on by itself. It can handle complex shapes and create the mesh faster. It's a machine-learning three-dimensional tetrahedral mesh generator. In order to marry the three crucial tasks of making casting design decisions, creating casting models, and evaluating games, AutoCAST provides a large-eddy simulation-based knowledge-based system. This approach reduces the amount of time that must be spent importing and exporting data across systems for each layout iteration, which also lessens the threat of transferring data errors [4, 11].

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## DISCUSSION

These days, foundries are largely computer-controlled and automated, with very little human help. In foundries, computers are put to use for pollution control and output measurement. The process of microstructural characterization incorporates photomicrographing and software preparation using computers and imaging equipment. The correct casting of a pre-designed shape requires the skill and experience of a foundry engineer, and in a production setting, this procedure takes a long time to finish.. Hence, the initial objective should be to create a computer-aided system for defining the model's specifications, namely grinding allowance, draft corner, radius, size, feed head, flask, and pouring system. Computers might aid the foundry flesh in both design development and gating by modeling solidification. For recently created foundry items, it has greatly sped up time to market. Computer programs exist to predict the principal die components based on the dimensional input of the casting form. Certain die components—like the perfect filling time and gating diameter—are approximations. The cooling time, cooling channel locations, and flow rates are shown to be associated. Computer usage is increasing in many technical applications, such as design and design, process selection and methoding, tooling design, machine design, cast component design, which is production planning and oversight, process control, surveillance of quality, and casting defect analysis. Computer-assisted casting solidification modeling helps locate and detect hot spots and improves component design efficiency while eliminating errors like as shrinkage and porosity. It is also used to accurately determine the chemical makeup and solidification time of different materials. It is therefore used for estimating the extent to which the cooling rate is influenced by the grain structure of the castings. It provides solidification length of time, residual heat of fusion, temperature contours, degree of recalescence, and time-temperature characteristics. An automated and computerized furnace line allows the casting process to be activated with a few touch screen inputs. Alarm lamps are replaced by color-coded status messages on graphical monitoring displays that show the underlying cause of problems. The Control Logic gateway allows maintenance and engineer workers to monitor, backup, and troubleshoot any PLC in the foundry from the comfort of their offices or shops. There are no longer any networking bottlenecks. Thanks to decentralized control, routine maintenance and software updates no longer require suspending the entire line. The deployment of expert systems facilitates decision-making in foundries. It may be used substantially in foundry operations, quality assurance, fault detection, casting defect analysis, and casting creation... Before the foundry's software is ready for use, foundries may get a certified system shell, which gives them the ability to gather, produce, and program any data they need into it. Castings and foundry processes may be effectively simulated and upgraded with the use of software solutions for foundries. It is also a very helpful simulation tool for process architecture that is economical and for estimating casting quality. It may enable both cost and quality improvement through dependable and effective rising and gating methodologies, optimization of metal treatment and metallurgy, and mitigation of production dangers. In addition, a quantitative prediction of the microstructure distribution and local mechanical properties is made. It functions as a modeling tool for mold filling and solidification in addition to a digital riser.

## CONCLUSIONS

- Computers are used to track and oversee the modernization and mechanization of the manufacturing.
- In foundries, computerized process control might enhance production and casting consistency.
- The introduction of electronic devices into foundries has greatly improved work culture and dramatically reduced staff and worker dissatisfaction and pain.
- Utilizing computers is critical for managing the complete casting procedure, metal setup, liquid metal management, and casting fault analysis using specialized systems.
- Computers are used to recreate the solidification of castings during processing. This lays the path for correctly constructing the casting, avoiding major imperfections like hot spots, and locating the areas where stress is concentrated. It displays the temperature distribution throughout the solidifying casting, as well as complete information on the temperature contours and casting temperature a past.

- A variety of apps for foundries are available to do analyses on different topics. Among them, finite element analysis is an important tool for researching the distribution stresses and temperature as well as the evolution of morphology.
- Present-day foundries require hardly any human involvement as they are fully automated and run by computers.
- Computers operate in foundries to monitor and manage emissions and noise.
- Computer imaging equipment and software facilitate the task of microstructural differentiation and microscopy photograph capture.
- Compared to manual production, software simulation greatly reduces the reject rate.
- Expert systems have become prevalent in casting creation, quality control, troubleshooting, and plant maintenance within modern foundries, primarily for the discovery of casting defects.
- An expert system shell can be rented by foundries, allowing for the development, writing, and collection of any needed data, at which point the program is prepared for utilization.
- Through the use of robust and optimal methods for gating and risering, optimization of metal treatment and metallurgy, and minimization of production hazards, foundry software packages may facilitate both cost reduction and quality improvement. Further, filling patterns, cold chokes, shrinkage, and porosity problems are all accurately predicted by it.
- AFS Solid 2000 configure predicts shrinkage porosity through using volumetric and thermal analyses.
- ProCAST is a form of finite element modeling that has been used for automated meshing, micromodeling, stress, and distortion. Sand, shell, investment, die-casting, irreversible mold, and lost foam techniques can also use it. Radiography-quality castings have been made by foundries by using the program to model the solidification process and improve methoding.
- The fully automatic 3-D mesh produce tool, MeshCAST foundry software, is highly useful for designing projects. It produces the mesh with greater speed and can handle challenging geometry. It's a generator of automated 3-D tetrahedral texture.
- The AutoCAST foundry software product is a knowledge-based system that combines casting choices for design, casting model development, and process simulation into one coherent package using large-eddy simulation.

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