ARTIFICIAL INTELLIGENCE (AI)

- Artificial intelligence refers to the ability of a computer or a computer-enabled robotic system to process information and produce outcomes in a manner similar to the thought process of humans in learning, decision making and solving problems. By extension, the goal of AI systems is to develop systems capable of tacking complex problems in ways similar to human logic and reasoning.
- Artificial intelligence – AI – is getting increasingly sophisticated at doing what humans do, albeit more efficiently, more quickly, and more cheaply. While AI and robotics are becoming a natural part of our everyday lives, their potential within healthcare is vast.

APPLICATIONS OF AI IN PHARMACEUTICALS

- AI have various applications in health care and pharmacy which are as follows.
- Disease Identification
- Personalize treartment
- Drug Discovery/Manufacturing
- Clinical Trial Research
- Radiology and Radiotherapy
- Smart electronic health record

DISEASE IDENTIFICATION

- 2015- Report by Pharmaceutical Research and Manufacturers of America- more than 800 drugs and vaccines are in trial phase to treat cancer.
- Google’s DeepMind Health, announced multiple partnerships including some eye hospitals in which they are developing technology to address macular degeneration in aging eyes.
- Oxford’s Pivital® Predicting Response to Depression Treatment (PReDicT) project is aiming to produce commercially-available emotional test battery for use in clinical setting.

PERSONALIZED TREATMENT

- Micro biosensors and devices, mobile apps with more sophisticated health-measurement and remote monitoring capabilities; these data can further be used for R&D.
- DermCheck; app available in Google play store in which images are sent to dermatologists(human not machines)

DRUG DISCOVERY/MANUFACTURING

- From initial screening of drug compounds to predicted success rate based on biological factors.
- R&D discovery technology; next-generation sequencing. Previous experiments are used to train the model
- Optimization softwares (example: FormRules) Designing of the processes

CLINICAL TRIAL RESEARCH

- Machine learning- to shape, direct clinical trials
- Advanced predictive analysis in identifying candidates for clinical trials
- Remote monitoring and real time data access for increased safety; biological and other signals for any sign of harm or death to participants.
- Finding best sample sizes for increased efficiency; addressing and adapting to differences in sites for patient recruitments; using electronic medical records to reduce data errors.

RADIOLOGY AND RADIOTHERAPY

- Google’s DeepMind Health is working with University College London Hospital (UCLH) to develop machine learning algorithms capable of detecting differences in healthy and cancerous tissues.

SMART ELECTRONIC HEALTH RECORDS

- AI to help diagnosis, clinical decisions, and personalized treatment suggestions.
- Handwriting recognition and transforming cursive or other sketched handwriting into digitized characters.

ADVANTAGES AND DISADVANTAGES

Advantage AI

- **1. Error Reduction:Artificial intelligence helps us in reducing the error and the chance of reaching accuracy with a greater degree of precision is a possibility.**
- **2. Difficult ExplorationArtificial intelligence and the science of robotics can be put to use in mining and other fuel exploration processes.**
- **3. Daily Application:Computed methods for automated reasoning, learning and perception have become a common phenomenon in our everyday live**
- **4. Digital Assistants:Highly advanced organizations use 'avatars' which are replicas or digital assistants who can actually interact with the users, thus saving the need of human resources.**
- **5. Repetitive Jobs:Repetitive jobs which are monotonous in nature can be carried out with the help of machine intelligence. Machines think faster than humans and can be put to multi-tasking. Machine intelligence can be employed to carry out dangerous tasks**
- **6. Medical Applications:In the medical field also, we will find the wide application of AI. Doctors assess the patients and their health risks with the help of artificial machine intelligence. It educates them about the side effects of various medicines.**

Disadvantage AI

- **1. High Cost:Creation of artificial intelligence requires huge costs as they are very complex machines. Their repair and maintenance require huge costs.**
- **2. No Replicating Humans:Intelligence is believed to be a gift of nature. An ethical argument continues, whether human intelligence is to be replicated or not.**
- **3. No Improvement with Experience:Unlike humans, artificial intelligence cannot be improved with experience. With time, it can lead to wear and tear. It stores a lot of data but the way it can be accessed and used is very different from human intelligence.**
- **4. No Original Creativity: These are not the forte of artificial intelligence. While they can help you design and create, they are no match for the power of thinking that the human brain has or even the originality of a creative mind.**
- **5. Unemployment: Unemployment is a socially undesirable phenomenon. People with nothing to do can lead to the destructive use of their creative minds.**

CURRENT **CHALLENGES/ FUTURE ASPECT**

- Many big Pharmaceutical companies began investing in AI in order to develop better diagnostics or biomarkers, to identify drug targets and to design new drugs and products.
- Merck partnership with Numerate in March 2012 focusing on generating novel small molecule drug leads for unnamed cardiovascular disease target.
- In december, 2016 Pfizer and IBM announced partnership to accelerate drug discovery in immunooncology.

ROBOTICS

- Robotics is defined to include intelligent machines and systems used in *space, exploration, human services* or manufacturing where as automation includes the use of automated methods in various applications, for example, system factory, office, home, or transportations to improve performance and productivity."
- Robots in laboratory, life science and pharmaceutical applications perform tasks at rates beyond human capability. These robots function in potentially hazardous settings in proximity to biological dangers, the threat of radioactive contamination and toxic chemotherapy compounds. Robotics is called upon to assemble and package a variety of medical devices and implants as well as preparing prescriptions for mail-order pharmacies or hospitals. Robots are doing assay analysis and automating the movement of test tubes in research laboratories. Because of the high number of samples that need analysis and the amount of data collection required, the process and costs are easily validated with robotics. In pharmaceutical applications, hospitals use robots to mix potentially hazardous cancer drugs and those associated with radiation.

ROBOTS USED IN PHARMACEUTICAL INDUSTRY

- **Pharmaceutical Container Replacement Robot**
- **Cylindrical Robot for High Throughput Screening**
- **Six-Axis Robots suit Class 1 Clean Room Applications**
- **Space Saving Ceiling Mounted Robot**
- **Metal Detector Targets Pharmaceutical Industry**

TYPES OF AUTOMATION

TYPES OF AUTOMATION

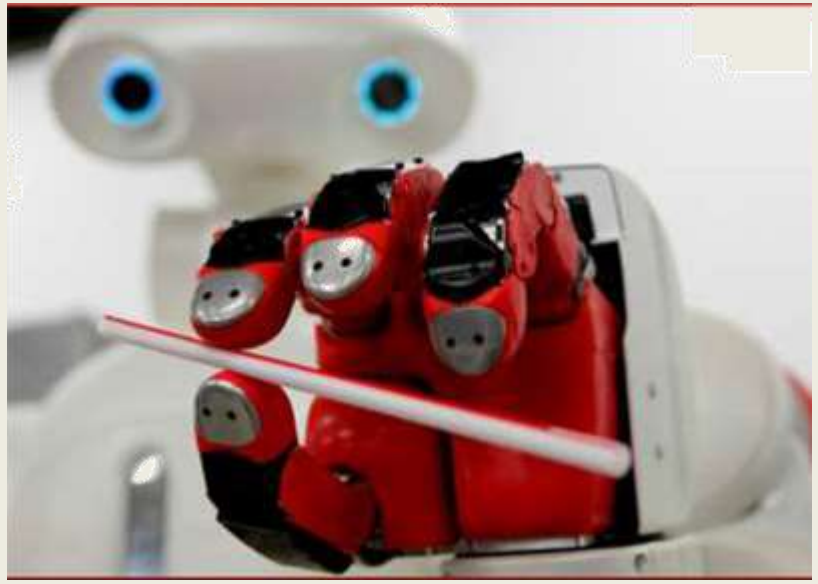
- **1.Feedback control**
- **2.Sequential control $ logical sequence control**
- **3. Computer control**

APPLICATIONS OF ROBOTS PHARMACEUTICAL INDUSTRY

- **Research and Development (R&D)**
- **Control Systems**
- **Sterilization and Clean Rooms**
- **Packaging Operations**
- **Flexible Feeding**
- **Vision Systems**
- **Grinding Applications**
- **Sterile Syringe Filling**

APPLICATION OF ROBOTICS IN PHARMACEUTICALS

LABORATORY ROBOT IN OPERATIONAL RESEARCH



LABORATORY ROBOT IN OPERATIONAL RESEARCH

- **Laboratory robotics** is the act of using robots in biology or chemistry labs. For example, pharmaceutical companies employ robots to move biological or chemical samples around to synthesize novel chemical entities or to test pharmaceutical value of existing chemical matter. Advanced laboratory robotics can be used to completely automate the process of science, as in the Robot Scientist project.
- Laboratory processes are suited for robotic automation as the processes are composed of repetitive movements (e.g. pick/place, liquid & solid additions, heating/cooling, mixing, shaking and testing).

COMBINATORIAL LIBRARY SYNTHESIS

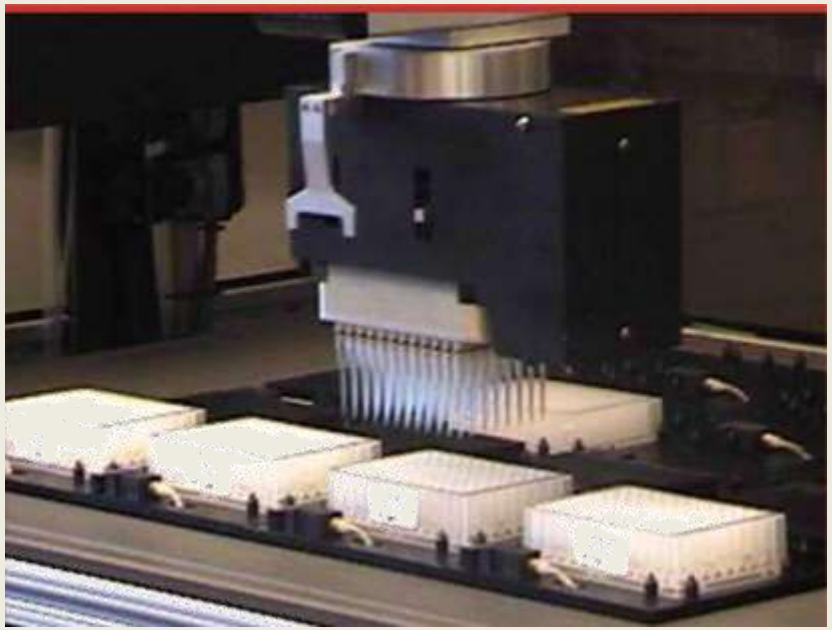
- Robotics has applications with Combinatorial Chemistry which has great impact on the pharmaceutical industry. The use of robotics has allowed for the use of much smaller reagent quantities and mass expansion of chemical libraries. The "parallel synthesis" method can be improved upon with automation. The main disadvantage to "parallel-synthesis" is the amount of time it takes to develop a library; automation is typically applied to make this process more efficient.
- The main types of automation are classified by the type of solid-phase substrates, the methods for adding and removing reagents, and design of reaction chambers. Polymer resins may be used as a substrate for solid-phase.

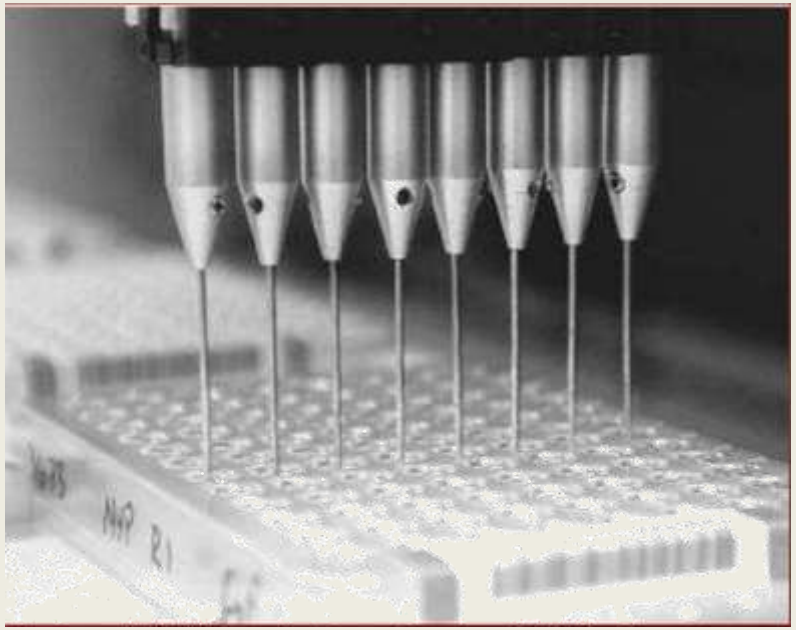
LABORATORY ROBOTS IN TECHNICAL MOOD

PURIFICATION

- Simulated distillation, a type of gas chromatography testing method used in the petroleum, can be automated via robotics. An older method used a system called ORCA (Optimized Robot for Chemical Analysis) was used for the analysis of petroleum samples by simulated distillation (SIMDIS). ORCA has allowed for shorter analysis times and has reduced maximum temperature needed to elute compounds. One major advantage of automating purification is the scale at which separations can be done. Using microprocessors, ionexchange separation can be conducted on a Nano liter scale in a short period of time.
- Robotics has been implemented in liquid-liquid extraction (LLE) to streamline the process of preparing biological samples using 96-well plates.15 This is an alternative method to solidphase extraction methods and protein precipitation, which has the advantage of being more reproducible and robotic assistance has made LLE comparable in speed to solid phase extraction. The robotics used for LLE can perform an entire extraction with quantities in the microliter scale and performing the extraction in as little as ten minutes

LABORATORY ROBOTS IN ANALYTICAL RESEARCH LAB





ADVANTAGES AND DISADVANTAGES

ADVANTAGES

- One of the advantages to automation faster processing, but it is not necessarily faster than a human operator. Repeatability and reproducibility are improved as automated systems as less likely to have variances in reagent quantities and less likely to have variances in reaction conditions. Typically productivity is increased since human constraints, such as time constraints, are no longer a factor. Efficiency is generally improved as robots can work continuously and reduce the amount of reagents used to perform a reaction. Also there is a reduction in material waste. Automation can also establish safer working environments since hazardous compounds do not have to be handled. Additionally automation allows staff to focus on other tasks that are not repetitive.

DISADVANTAGES

- Typically the costs of a single synthesis or sample assessment are expensive to set up and startup cost for automation can be expensive. Many techniques have not been developed for automation yet. Additionally there is difficultly automating instances where visual analysis, recognition, or comparison is required such as color changes. This also leads to the analysis being limited by available sensory inputs. One potential disadvantage is an increases job shortage as automation may replace staff members who do tasks easily replicated by a robot. Some systems require the use of programming languages such as C++ or Visual Basic to run more complicated tasks.

CURRENT CHALLENGES/ FUTURE ASPECT

- In medical device manufacturing, robotics plays an active role in assembly. The manufacturing process is highly regulated and must be approved by the Food and Drug Administration (FDA). Manufactures use robotics to reduce cost. Robotics performs important tasks in surgical procedures.
- Robots are used for delivery of radiation and for proton therapy. The goal is to administer the smallest dose of radiation as possible to the precise location. Robots are very precise, positioning equipment and patients accurately in three-dimensional space.
- Robots are loading and unloading injection moulding machines, assembling medical devices and polishing implants. In pharmaceutical production, robots handle bottles in the cell culture process, loading and unloading autoclaves and packaging machines, as well as de-nesting syringe tubs.
- Robotics has a certain future in laboratory, life science and pharmaceutical applications. There is increased activity for bench-top robotics performing various protocols. These stations are reprogrammable and many are complex. Robotics is essential to modern scientific .

COMPUTATIONAL FLUID DYNAMIC

- Computational fluid dynamics can be a viable tool to analyse and troubleshoot various process equipment used in the pharmaceutical industry. Because typical unit operations process large amounts of fluid, even small improvements in efficiency and performance may increase revenue and decrease costs.
- The integration of CFD methods can lead to shortened product-process development cycles, optimization of existing processes, reduced energy requirements, efficient design of new products and processes, and reduced time to market. Unit operations in the pharmaceutical industry typically handle large amounts of fluid. As a result, small increments in efficiency may generate large increments in product cost savings. Thus, research and development staffs as well as plant and production managers should understand the benefits of CFD so that it can be integrated into the development process.

APPLICATION OF CFD IN PHARMACEUTICS

- The application of CFD to a few key unit operations and processes in the pharmaceutical industry was described as follows.
- **CFD for mixing.**
- **CFD for solids handling.**
- **CFD for separation.**
- **CFD for dryers.**
- **CFD for packaging.**
- **CFD for energy generation and energy-transfer devices.**

CFD FOR MIXING

(a) stirred tank, radially pumping impellers; (b) stirred tank, closely placed impellers; (c) stirred tank, impellers too far apart.

- CFD methods can be applied to examine the performance of static mixers and to predict the degree of mixing achieved, thus indicating whether more mixing elements are required shows surface mesh and blade orientation for a Kinecs mixer depicts the mass fraction concentration of the two species being mixed. The degree of mixing is shown as the color proceeds from distinct inlet streams (red and blue) to the fully mixed outlet stream (green). A CFD solution can be used to derive the pressure drop, hence the power required.

CFD FOR SOLIDS HANDLING

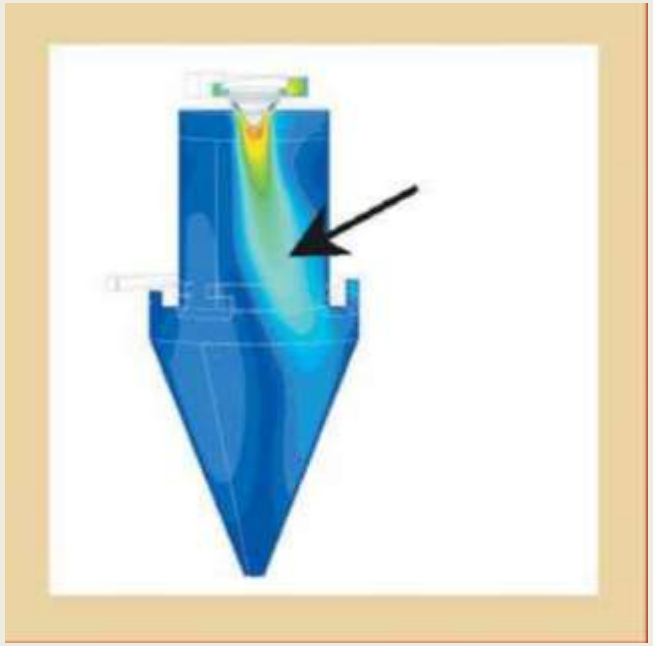
- CFD techniques can be applied to analyze such flows and minimize or eliminate the risk of erosion. CFD also can be applied to analyze the unsteady and chaotic flow behavior in fluidized beds. Simulation of such a flow field requires unsteady flow calculations and small time increments. As a result, performing calculations can take an extensive amount of time. Simulations of gas–solid flows in complex three-dimensional reactors can take months of computational time and are not practically feasible

CFD FOR SEPARATION

(a) cyclone, pathline of 1-m particle; (b) cyclone, pathline of 10-m particle.

- CFD techniques are used for analysing separation devices such as cyclones and scrubbers. The following example incorporates CFD methods to optimize and predict performance of an existing cyclone design. CFD solutions depict particle paths for various particle sizes. In this example, CFD techniques were used to perform what-if analysis for optimization of the design. The performance computed with CFD closely matched that observed in physical testing wherein 90% of 10-m particles were removed, but only 10% of 1-m particles were separated from the air stream.

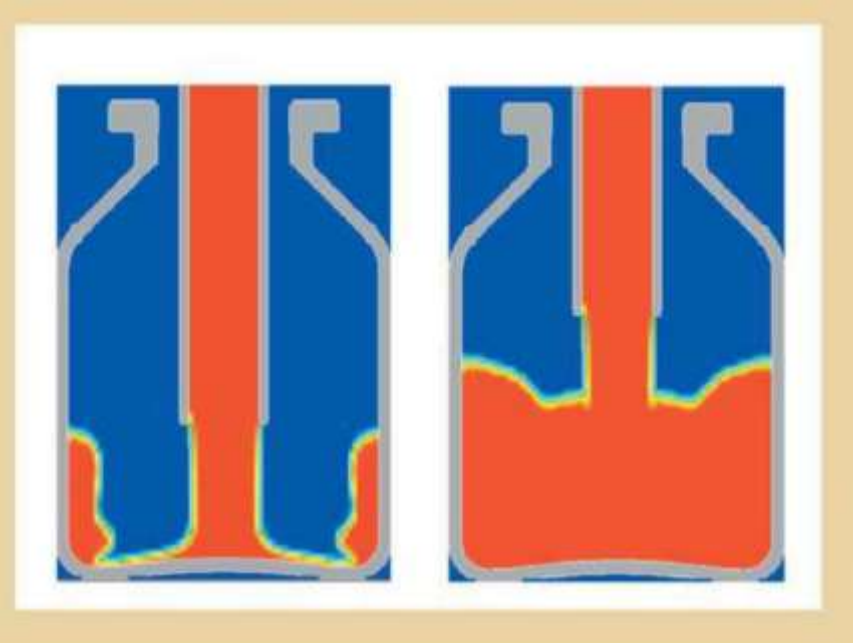
CFD FOR DRYERS



Spray dryer, velocity field

- We used CFD to analyze the performance of an industrial spray dryer before making major structural changes to the dryer. This strategy minimizes the risk of lost profit during changeover, especially if the improvement does not materialize. CFD was applied to examine configuration changes, thus minimizing risk and avoiding unnecessary downtime during testing shows the velocity distribution (skewed flow). This flow is a result of uneven pressure distribution in the airdispersing head.
- CFD models were applied to determine optimum equipment configuration and process settings. CFD results provided the necessary confidence that the proposed modifications would work so capital equipment would be ordered and field-testing could be scheduled.

CFD FOR PACKAGING



(a) filling process, liquid surface location, strong splash; (b) filling process, liquid surface location, no splash.

- CFD can be applied to conduct virtual experiments before changes are made to the filling lines or to the package geometry. This method allows a wide range of conditions to be tested and leads to an optimized filling process. depicts the filling of a container. The figures shown are typical of solution results that are used to optimize filling processes to increase throughput and reduce foaming.

CFD FOR ENERGY GENERATION AND ENERGY- TRANSFER DEVICES

- CFD techniques can be applied to analyze thermal and flow fields within such devices.
- CFD modeling methods also can be applied to gain insight into flame characteristics. Maintaining flame stability and burner efficiency is very critical to the proper functioning of a process heater, power plant, or furnace. Flame length,shape, and size can influence the process. If the flame is too long, then it can impinge on critical regions of the apparatus and cause thermal damage. If the flame is too short, then it may wear out the burner tip. Replacing the burner or associated apparatus results in downtime and loss of product revenue.

ADVANTAGES AND DISADVANTAGE

ADVANTAGES OF CFD

- A great time reduction and cost reduction in new designs
- There is a possibility to analyze different problem whose experiments are very difficult and dangerous
- The CFD techniques offer the capacity of studying system under conditions over its limits.
- The level of detail is practically unlimited.
- The product gets added value. The possibility to generate different graph permits to understand the features of the result. This encourages buying a new product.
- Accuracy in the result is doubted i.e. in certain situations we will not obtain successful result.
- It is necessary to simplify mathematically the phenomenon to facilitate calculus. If the simplification has been good the result will be more accurate.
- There are several incomplete models to describe the turbulence,
- multiphase phenomenon, and other difficult problems.

Untrained user of CFD has the tendency to believe that the output of the pc is always true

DISADVANTAGES OF CFD

- Hi-Tech CFD is a computer aided engineering company which provides total solutions to engineering problems in the field of Computational Fluid Dynamics (CFD),Computational Electromagnetic, Computational Structural Mechanics, Dynamics and Controls.

CURRENT CHALLENGES/ FUTURE ASPECT

- The integration of CFD methods can shorten product-process development cycles, optimize existing processes, reduce energy requirements, and lead to the efficient design of new products and processes. Unit operations in the pharmaceutical industry handle large amounts of fluid. As a result, small increments in efficiency, such as those created by implementing CFD solutions, can lead to significant product cost savings. Key processes in the pharmaceutical industry can be improved with CFD techniques. The aerospace and automobile industries already have integrated CFD methods into their design process. The chemical process and the pharmaceutical industries now are beginning to integrate this technology. The full potential for process improvements using CFD solutions is yet to be realized.

Thank you