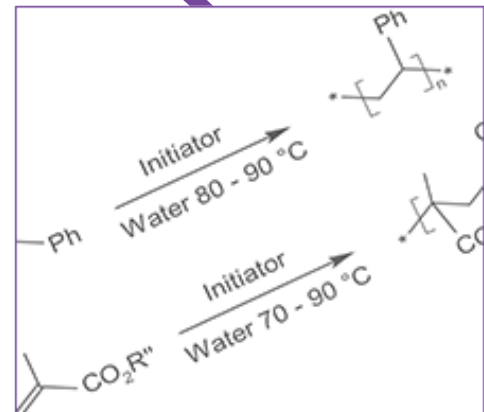# MULTIPLANT / AUTOPLANT POLY

Emulsion, Suspension, Dispersion, Solution, Mass and Pressure Polymerization Development and Scale-Up

Customer testimonial

"The Chemspeed *AUTOPLANT* is well suited for the process development of complex polymers. Excellent correlation was found for MW, clarity and viscosity. It is possible to calculate polymerization conditions for desired clarity, MW and viscosity, leading to exact copies in large scale polymerizations."

Robustness and Ease-of-Use by Design

The leading technology in overhead gravimetric dispensing / dosing (patented) combined with our reactor and process excellence, and our user-friendly software, allow you to standardize and accelerate your polymerization workflows (emulsion, suspension, dispersion, solution, mass, pressure).

Precision – Speed – Accuracy
Performance – Versatility – R&D Cost Savings
High-Output

Key Advantages:

- Decrease in cost per experiment up to 90+ %.
- Increase in productivity by a factor of 10+.
- Up to 36 experiments per run on an *AUTOPLANT*, up to 6 experiments per run on a *MULTIPLANT*.
- Independent control of all process parameters in each reactor with PAT like NIR, PSD, calorimetry, pH.
- Independent and precise temperature and stirring control in each reactor.
- Up to 8 independent gas, liquefied gas and liquid feeds per reactor.
- Gravimetric solid and viscous liquid dispensing.
- 4-Needle Head for volumetric liquid handling and sampling.
- Feeding and sampling under reaction conditions.
- Cleaning in place (e.g. automated cleaning, inserts).
- Dispensed amount, stirrer speed, temperature, pressure, time..., and other data are stored in a read only log file.
- Easy access to data with a convenient interface to pull results into Excel or virtually any other software.
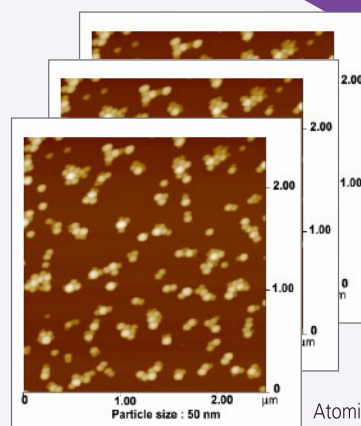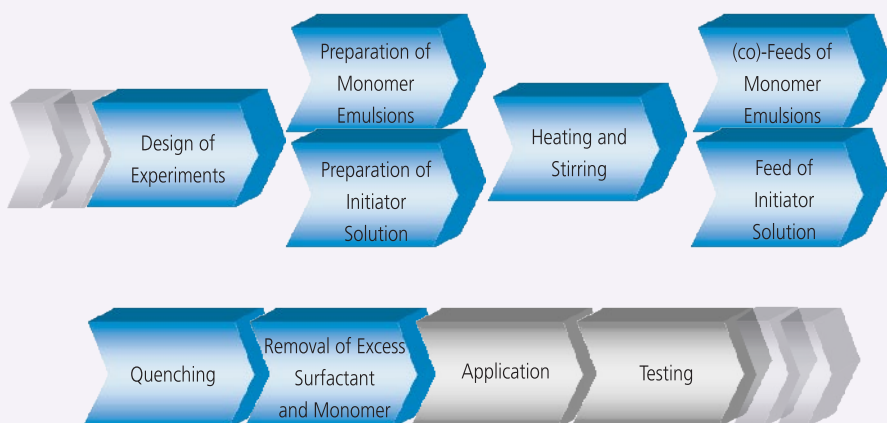- Interface to DOE.

Process research reactor

Process development workstation

MULTIPLANT POLY workstation

AUTOPLANT POLY workstation

1

Enhance your Efficiency and Productivity with our Workflow Solutions!

Design of Experiments → Preparation of Monomer Emulsions / Preparation of Initiator Solution → Heating and Stirring → (co)-Feeds of Monomer Emulsions / Feed of Initiator Solution

Quenching → Removal of Excess Surfactant and Monomer → Application → Testing

Atomic force microscopy (AFM) images of poly-styrene particles formed by emulsion polymeriz-ation on the *AUTO-PLANT* workstation.

Particle Size ~ 60 nm

Particle Size ~ 32 nm

Stable nanolatex suspensions at different stirring speeds.
Faster and better generation of polymer libraries for profound process understanding in terms of e.g. particle size distribution.

Assembly of a process research reactor with our unique screwless and self-sealing design up to 100 bar

1 Choose and insert stirrer

2 Mount cylindric magnetic stirrer drive

3 Plug in reactor

4 Screwless closing and self-sealing of reactor

5 Add safety lock

6 Screwless mounting and self-sealing of multiport drawer valve

No screws
No gear wheel
No transmission belt
Self-sealing

→ Robustness and Ease-of-Use by Design

Technical Details

Chemspeed's *MULTIPLANT / AUTOPLANT POLY* 's deck modularity allows the user to execute and perform a variety of workflows in a fully or semi-automated fashion.

The heart of Chemspeed's solutions for emulsion, suspension, dispersion, solution, mass and pressure polymerization is to automate: reagents preparation, polymerization, work-up and analysis.

Example of **emulsion polymerization**:
• Step 1: water insoluble monomer is mixed in an aqueous solution containing a surfactant.
• Step 2: an initiator is added and the primary free radicals react with the monomer in aqueous phase to produce oligomeric radical species diffusing into monomer-swollen micelles.
• Step 3: the monomer diffuses from the aqueous phase into the micelles, this propagation phase induces the growth of the micelles.
• Step 4: the termination occurs when the monomer is no longer present or when the reaction is quenched.

Process development workstation for 6 X 100 mL, 3 X 250 mL, 3 X 1'000 mL

The cutting edge **Process Development Workstation Technology** allows scientists to truly mimic the final industrial production process and provides all the flexibility to optimize integrated reaction sequences, even if a complex configuration of reactors and feed vessels required.

Materials of choice: glass, stainless steel (PEEK, PTFE or glass inserts available), Hastelloy, others on request

Process reactor assembly, individually controlled tank reactors (reactor volumes 100, 250, 1'000 mL) with precise, continuous feeds.
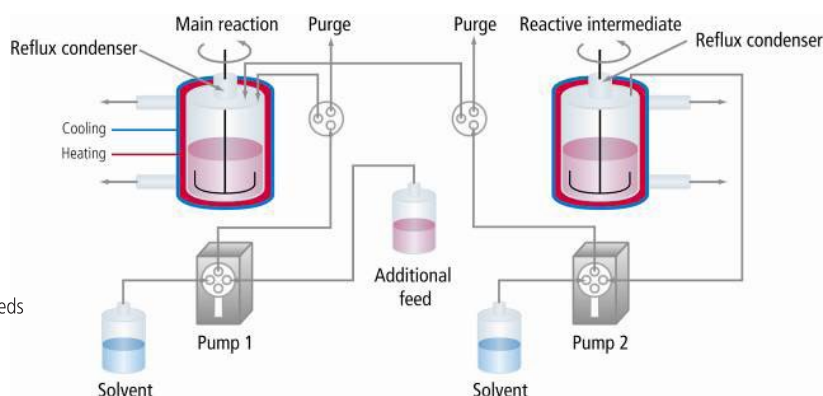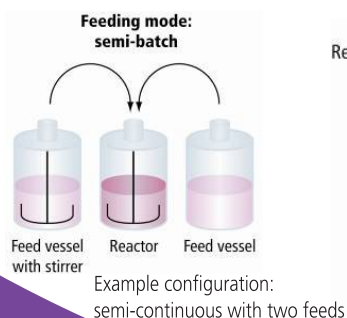• Flexible and precise continuous feeds, down to 10 µL / min.
• Up to 8 continuous liquid, liquefied gas and / or gas feeds per reactor and additional unlimited overhead access.
• Accurate and reproducible temperature control, 0.1 °C.
• Pressure up to 100 bar over the entire temperature range up to 250 °C with corresponding safety installations.
• Parallel high-performance calorimetry data.
• Viscosity data.
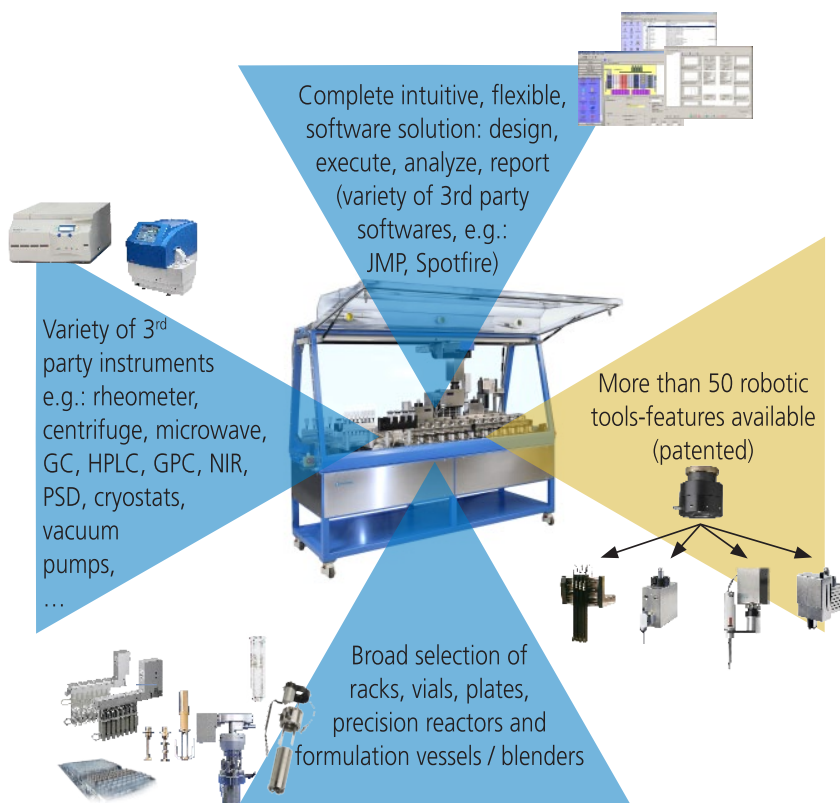• Dean Stark water trap.
• Distillation bridge between 2 reactors.

Easily exchangeable stirrer designs (anchor, twisted blade, gas entrainment stirrers…). Powerful mixing for viscosities up to 80 Pa·s at 300 rpm and 30 Pa·s at 900 rpm with an anchor stirrer.

Flexible Configuration

For one single unit, various feeding modes are available: batch, semi-continuous, continuous, continuous cascade.

Feeding mode: semi-batch

Feed vessel with stirrer   Reactor   Feed vessel

Example configuration: semi-continuous with two feeds

Main reaction   Purge   Purge   Reactive intermediate
Reflux condenser   Reflux condenser
Cooling
Heating
Additional feed
Pump 1   Pump 2
Solvent   Solvent

4 Dimensions of Modularity and Flexibility

Complete intuitive, flexible, software solution: design, execute, analyze, report (variety of 3rd party softwares, e.g.: JMP, Spotfire)

Variety of 3rd party instruments e.g.: rheometer, centrifuge, microwave, GC, HPLC, GPC, NIR, PSD, cryostats, vacuum pumps, …

More than 50 robotic tools-features available (patented)

Broad selection of racks, vials, plates, precision reactors and formulation vessels / blenders

– Off-the-Shelf-Design –

- Individual platform configuration tailored to your workflow with market-proven off-the-shelf components.

- Robotic platforms which can easily be integrated with one another to enable multi-workflow processes (e.g. Formulation, Application and Testing procedures all integrated in a single platform).

Complete Software Solution: Design, Execute, Analyze, Report

Chemspeed's AutoSuite User Interface & Executor software packages execute and control all modules of the entire product development cycle. They control all Chemspeed robotic platforms and any other integrated 3rd party software and hardware.

AutoSuite *MULTIPLANT/ AUTOPLANT* is a software with a user friendly interface which allows easy workflow orienteted pro-gramming. Many features such as gravimetric dispensing are automat-ically calibrated, eliminating tedious optimization steps.

- The AutoTeaching tool simplifies dispensing applications without manual trials and is applicable to e.g. solids eliminating the need for manual optimization before the dispenses are done.
- **Easy programming: drag-and-drop workflow steps or just ex-ecute standard workflow protocols.**
- Barcode tracking.
- Easy integration with virtually any LIMS or ELN software.
- AutoSuite Application Programming Interface (API) for 3rd party software and hardware integration.
- Optional, Chemspeed VLab for DoE and Data Analysis / Reporting. It includes a full document management system (electronic lab-journal) and is 21 CFR Part 11 compliant. The software scales from a single PC to large network installations with multiple hardware and clients.
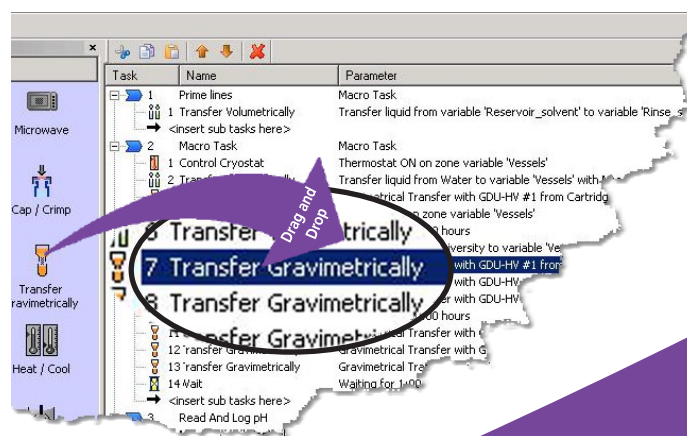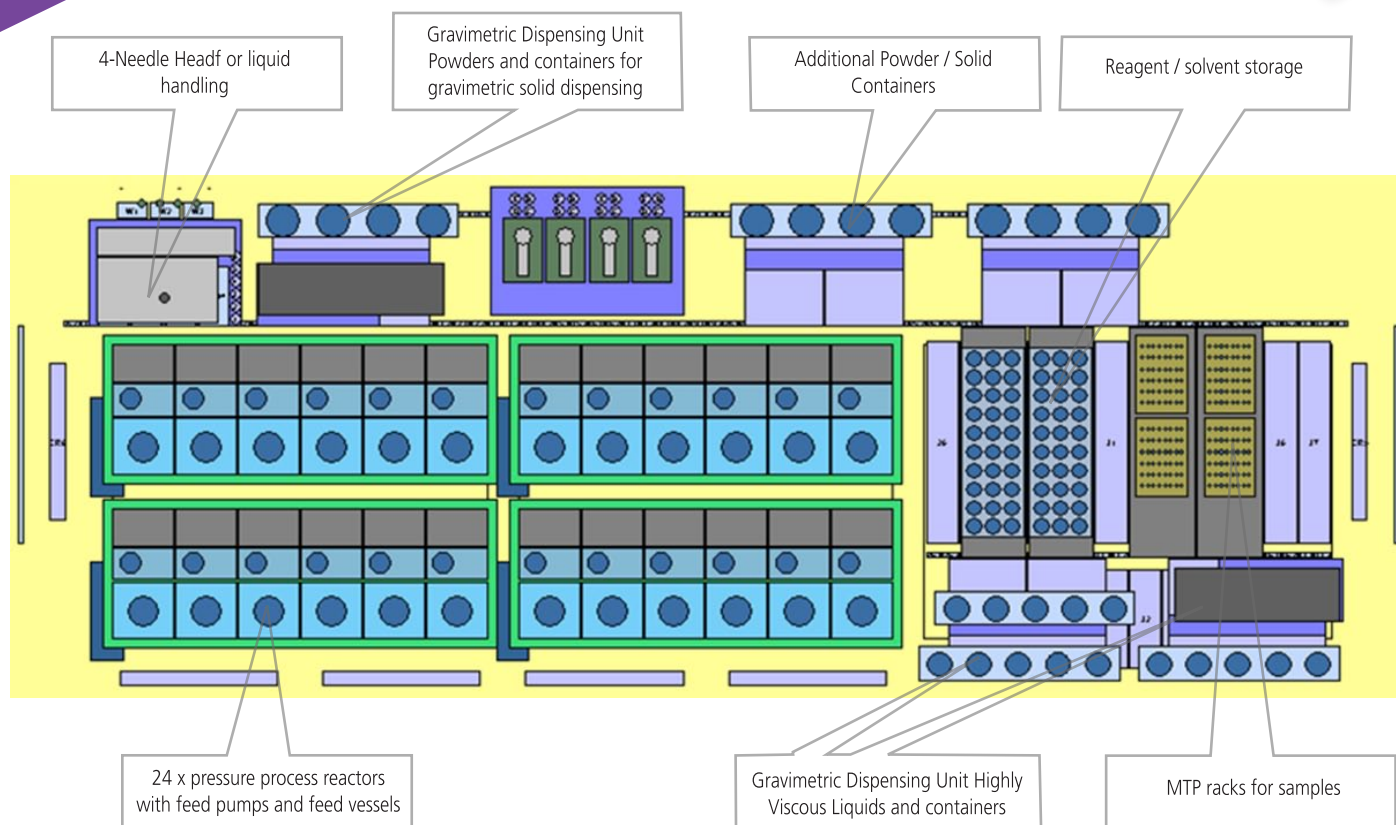
Easy Programming – Intuitive interface

Platform Configuration Example

A typical **AUTOPLANT POLY** deck consists of up to 36 independently controlled tank reactors, along with reagent / sample and solid dispensing container racks. Tools include a 4-Needle Head for liquid additions, Solid Dispensing Unit for the addition of solid reagents.

4-Needle Headf or liquid handling

Gravimetric Dispensing Unit Powders and containers for gravimetric solid dispensing

Additional Powder / Solid Containers

Reagent / solvent storage

24 x pressure process reactors with feed pumps and feed vessels

Gravimetric Dispensing Unit Highly Viscous Liquids and containers

MTP racks for samples

All tools and accessories from Chemspeed's **SWING**, **ISYNTH**, **FORMAX**, **APPLICATOR** and **INVESTIGATOR** platforms are fully compatible with the **MULTIPLANT / AUTOPLANT POLY** platforms and vice versa.

Example upgrade options:

- Various reactor materials and coatings are available (glass, hastelloy, Teflon, PEEK,...).
- Multiple stirrer designs and materials.
- Large choice of sample, reagent, and customized racks.
- Integrated NIR, particle size distribution (PSD), and viscosity measurement.

- (Heated) sampling for online or offline analytics (GC, HPLC, GPC,…).
- (Heated) sampling for offline analytics (NMR, MALDI-TOF, AFM,…).
- (Heated) sampling for online and particle size distribution analysis.
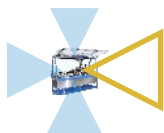
Variety of Plug-in (3rd Party) Solutions

Chemspeed integrates a large number of 3rd party components either on and / or off the deck.

Available upgrade options:
- Analysis module (GC, HPLC, GPC,...).
- Cleaning module.

Robotic Tool-Features

More than 50 robotic tool-features can be integrated with Chemspeed's unique robotic tool exchange technology, including unrivaled overhead gravimetric dispensing, which can operate while mixing, heating, refluxing and cooling. Virtually any combination of these robotic tools is possible.

*Highlighted are the most common and recommended robotic tool-features for the AUTOPLANT POLY robotic platform.*

Robotic tool exchange interface (proprietary)

Precision balance
Overhead gravimetric dispensing robotic tools (proprietary)

Volumetric dispensing
robotic tools

Action
robotic tools

Analytic
robotic tools

- Overhead gravimetric dispensing of solids & powders (0.1 mg to 20 g) Dispensing container volume: 15 mL or 30 mL resolution: 0.1 mg (or 0.01 mg with a second balance)

- Overhead gravimetric dispensing of solids & powders (1 mg to 100 g, larger volumes are available) Dispensing container volume: 100 mL resolution: 1 mg (or 0.01 mg with a second balance)

- Overhead gravimetric dispensing of highly viscous liquids, pastes and creams (1 mg to 100 g) with viscosities from 1 mPa·s to 500'000 mPa·s (based on Newtonian substances) resolution 1 mg (or 0.01 mg with a second balance)
- Optional aspiration feature
- Optional transfer of hot (up to 90 °C) substrates via heatable cartridges (e.g. for waxes)

- Overhead gravimetric aspiration and dispensing of viscous liquids (1 mg to 100 g) with viscosities from 1 mPa·s to 15'000 mPa·s via disposable positive displacement syringes, resolution: 1 mg (or 0.01 mg with a second balance)

- Liquid handling powered by 4 syringe pumps (syringe volumes: 1, 10, or 25 mL) for viscosities from 1mPa·s to 100 mPa·s
  Special options:
- Disposable tips (1'200 µL)
- Disposable syringes
- Heated needles (up to 100°C)
- Spray needles
- pH and temperature measurement and control
- Coated needles, PEEK needles...

- Liquid gas dispensing with gravimetric control resolution: down to 0.1 mg

- Overhead gravimetric / volumetric aspiration and dispensing of viscous liquids (0.1 µL to 12.5 mL) with viscosities from 1 mPa·s to 15'000 mPa·s via disposable positive displacement syringes, resolution: down to 1 µL

- Multigripper for vial and MTP transport and much more
- Automated barcode scanner

- Screw capper Vial diameter range: from 10 mm to 50 mm Larger ranges available Torque range: from 0.1 Nm to 1 Nm

- Capping, crimping (N8 / N11 / N13 / N20)
- Decapping (N8 / N11/ N13 / N20)

- High shear homogenization (11'000 to 30'000 rpm)

- Overhead stirrer (20 to 200 rpm) Different stirrer types available

- Ultrasonic dispersion (100 W)

- Vacuum / Degassing
- Reflux condenser
- Evaporation
- Filtration

- High speed injection molding
- Foam formation

- Draw-down with disposable or reusable precision spiral and / or gap bars
- Free film generation
- Dip coating
- Spray coating
- Wet-on-wet coating

- Robotic transfer arm to serve 3rd party instruments e.g. centrifuge

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- Online density measurement (aspiration technology), on the fly resolution: 1 mg (or 0.01 mg with second balance)

- Brookfield Viscosimeter (RVDV-II+ Pro BK)

- Tri gloss measurement
- Thickness measurement
- Color measurement
- Precision tack-cure

- Camera
- Observation of dissolution
- Particle size distribution and dynamic light scattering

15+ Years of Experience in Automated Chemistry.
Customized Workflow Solutions.
Swiss Quality Products.
An International Team of Highly Experienced Chemists.

Chemspeed Technologies AG is the leading provider of high-throughput and high-output research & development workflow-solutions from single bench-top / standalone automated workstations (powder dispensing - sample preparation- synthesis - process development - formulation - application - testing) up to complete and integrated product development workflows for the entire product development processes in the chemical, material science, renewables & energy, pharmaceutical, agrochemical, specialty chemical, home care, cosmetics and nutrition industries, as well as academia.
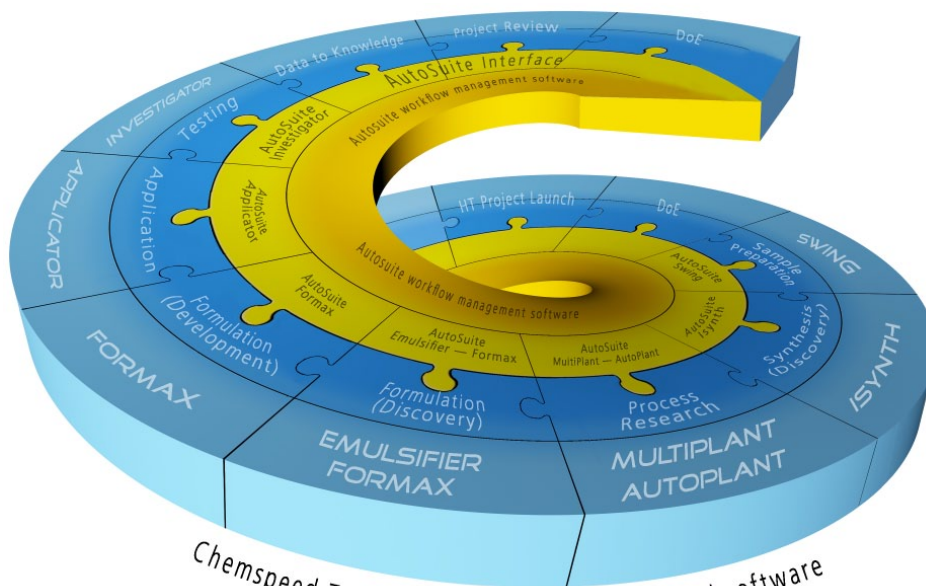
Chemspeed Technologies offers hardware and software for every step in the product development cycle

Discover our enabling portfolio for the entire product development cycle!

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