

Thin Film Photovoltaic Technology



Expert Technology for a Material of the Future



Grenzebach Maschinenbau GmbH was founded in Hamlar/Germany in 1960. Since then it has become the market leader in conveying and handling technology for the flat glass and gypsum plasterboard industries.

Today, Grenzebach is a corporation with six plants in three continents, over 1500 employees and a global customer base. Further service branches and local representatives guarantee optimum contact with Grenze-

bach's customers wherever they are located throughout the world.

Grenzebach places great emphasis on cooperative partnership with its customers and business partners.

Energy savings and climate protection play a major role in Grenzebach's philosophy. The development of thin-film technology on glass for production of photo-voltaic modules created a new market segment for Grenzebach, whereby the company is benefiting from many years of experience in flat glass handling.

The combination of processes such as feeding, washing, CVD, PVD, cutting, inspection, lami-

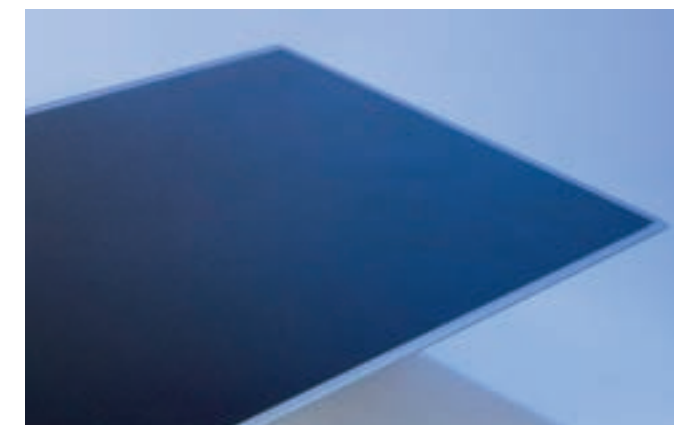
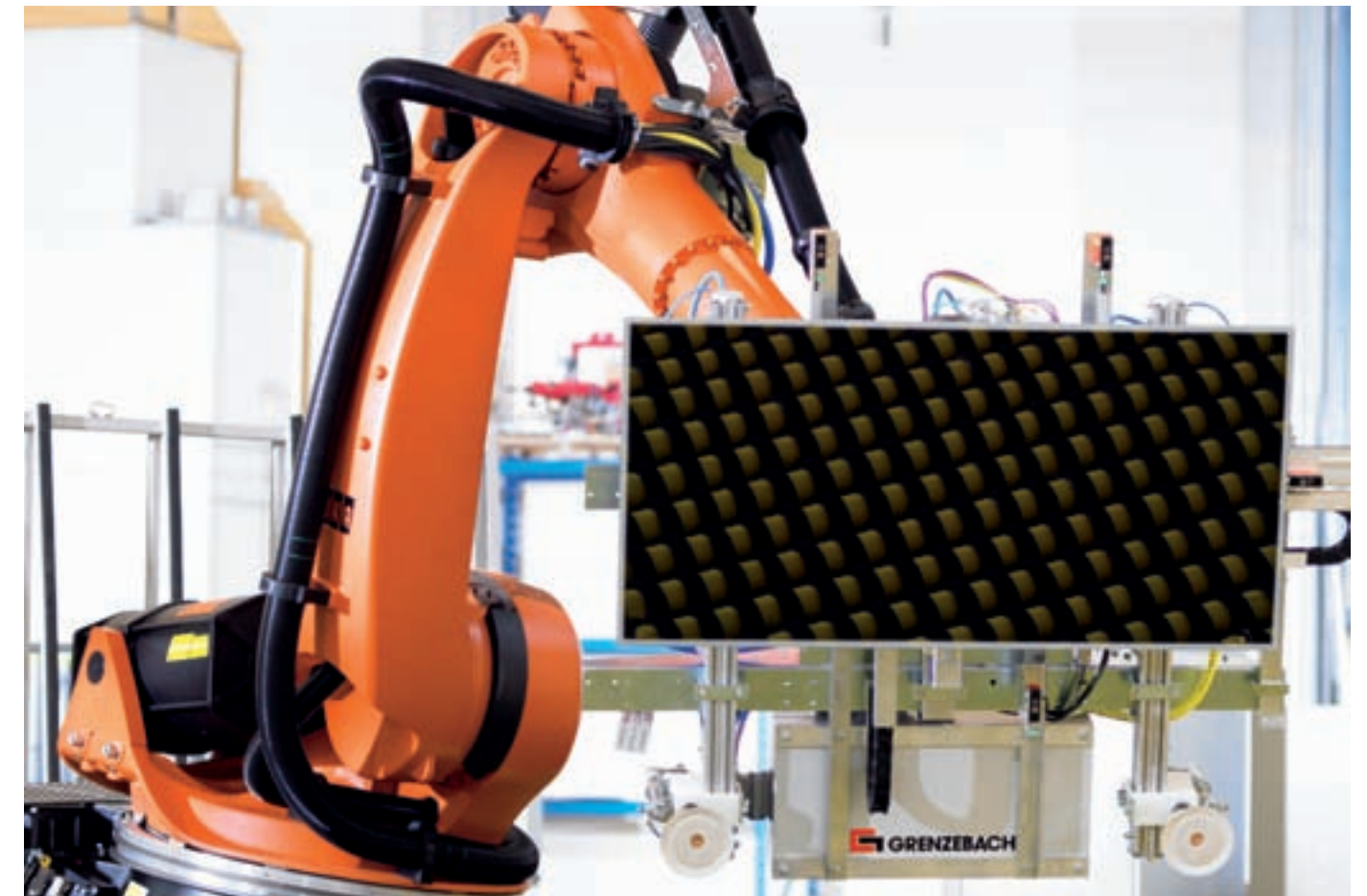
nation, testing and stacking can all be carried out by Grenzebach.

A simulation programme allows customers to verify in advance the optimum layout, material flow and production yield.

A newly developed MES System offers access and transparency of critical production data inside companies and plants and is customized to the needs of the user.

Technology offered by Grenzebach includes handling, conveying, buffering, cutting, snapping, inspection and laminating of the panels in different processes.

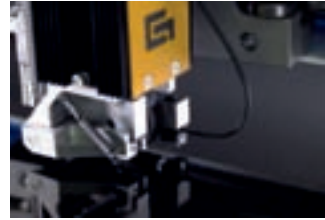
New ideas and innovative solutions are key to Grenzebach's development of other new technologies.



GRENZEBACH

- Market leader in flat glass and gypsum conveying and handling technology
- World-wide presence with over 1500 employees
- Wide product range for thin-film PV modules
- Innovative solutions with many years of experience
- Simulation for production yield, layout optimization and buffer calculation

Front End



xx Cutting and snapping technology
 – Accurate cutting of substrate glass in X/Y-direction



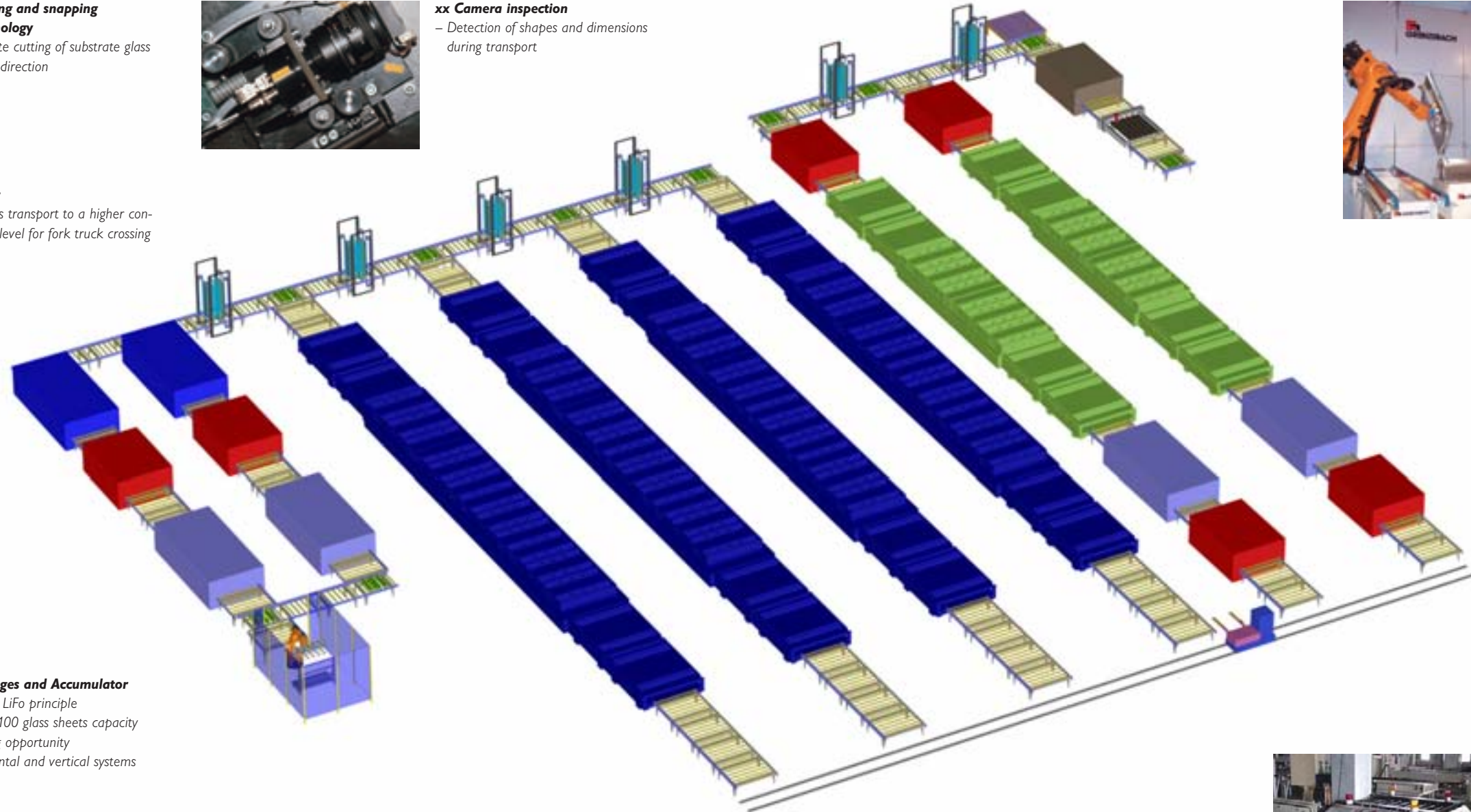
xx Camera inspection
 – Detection of shapes and dimensions during transport



xx Lifter
 – Enables transport to a higher conveying level for fork truck crossing



xx Seaming Robot
 – Edge seaming of raw glass material



xx Storages and Accumulator
 – FiFo or LiFo principle
 – Up to 100 glass sheets capacity
 – Cooling opportunity
 – Horizontal and vertical systems



xx Roller- / Roller angle transfer conveyor
 – Reduced maintenance conveying technology



xx Loading and unloading systems for cassettes and trolleys
 – FiFo or FiLo principle
 – Up to 30 substrates / trolley
 – Various cassette designs



xx Timing belt conveyor
 – Smooth conveying and accurate positioning with integrated systems like bar code writer/scanner, alignment bars



xx Fork loader
 – For process load locks
 – Single and double fork
 – Temperature resistant



xx Robot handling
 – De-stacking from substrate back side and loading on conveyor
 – Landscape or portrait
 – Spacer removal
 – Interleaver paper removal and elimination



xx AGV Shuttle
 – Enables access to processing equipment for service and maintenance
 – Transport of single / multiple substrates
 – Cassette transportation



xx Roller conveyor
 – Smooth conveying and accurate positioning
 – Transport technology for small and large glass sizes

Back End



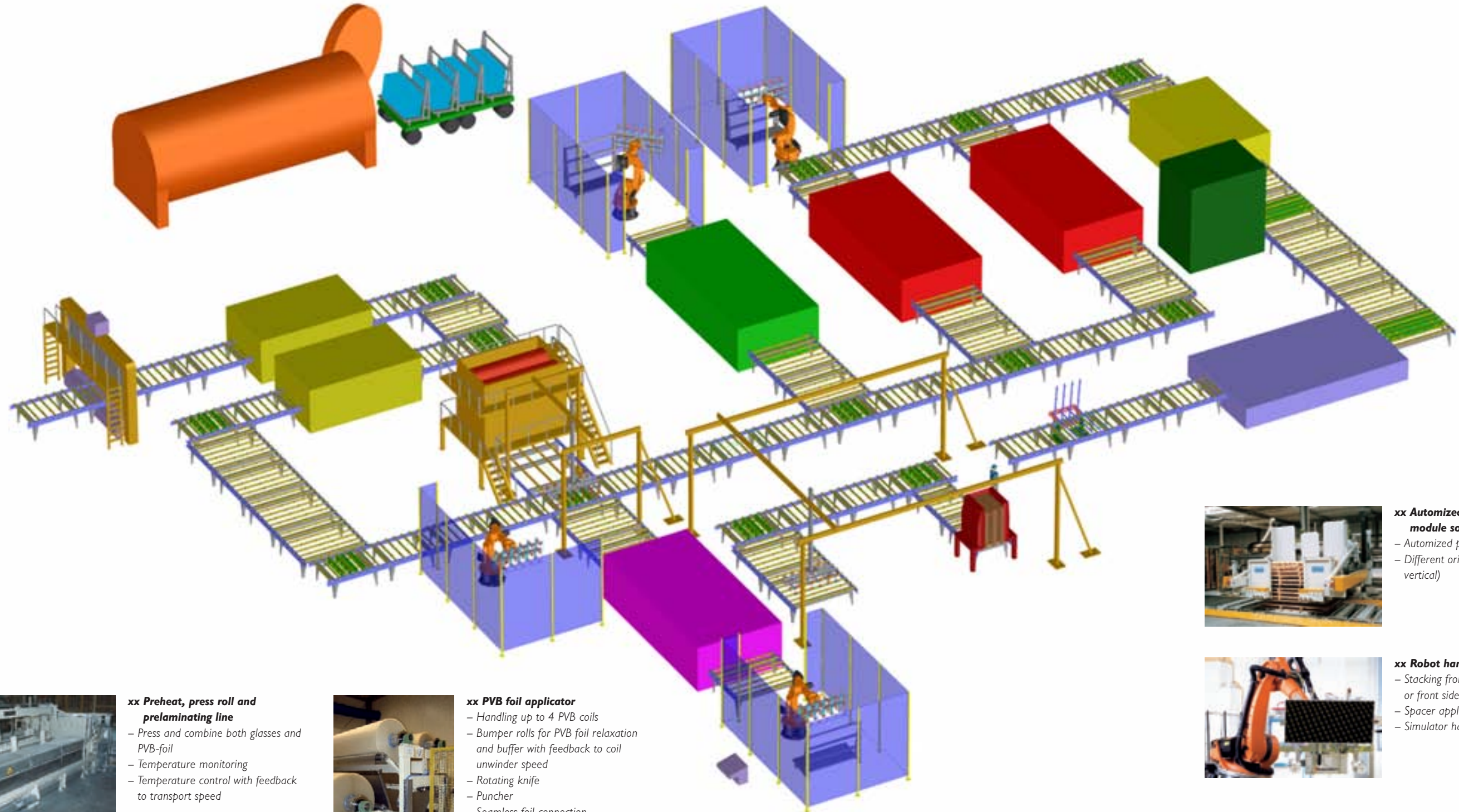
xx Autoclave loading system
 – Safe loading and unloading of autoclave racks



xx Rack stillages
 – Substrate glass, front glass and photovoltaik panel storage
 – Heat- and pressure resistance for autoclave with spacers



xx PVB foil trimming
 – Trimming of foil rests
 – Rejection of trims
 – Trimming on 4 sides
 – Combination with conveying technology



xx Preheat, press roll and prelaminating line
 – Press and combine both glasses and PVB-foil
 – Temperature monitoring
 – Temperature control with feedback to transport speed



xx PVB foil applicator
 – Handling up to 4 PVB coils
 – Bumper rolls for PVB foil relaxation and buffer with feedback to coil unwinder speed
 – Rotating knife
 – Puncher
 – Seamless foil connection



xx Automated palett feeder/ module sorting
 – Automated packing
 – Different orientation (horizontal and vertical)



xx Robot handling
 – Stacking from substrate back side or front side, landscape or portrait
 – Spacer application
 – Simulator handling

Simulation – Controls – Network

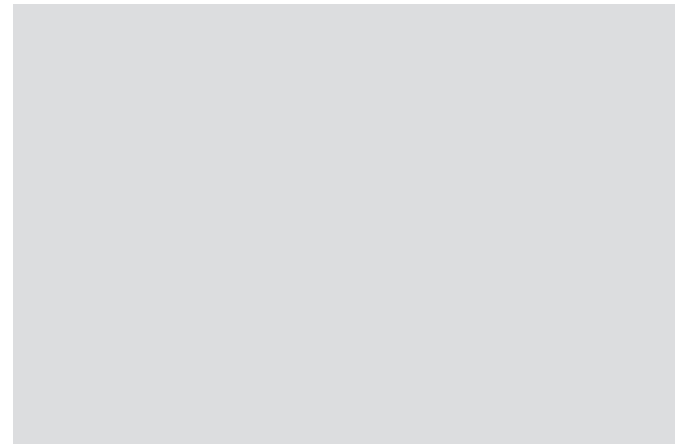
Simulation Line Layout Support and Buffer Evaluation

- Provides service from the beginning by producing line layouts and simulation from the customer's process equipment timing data.



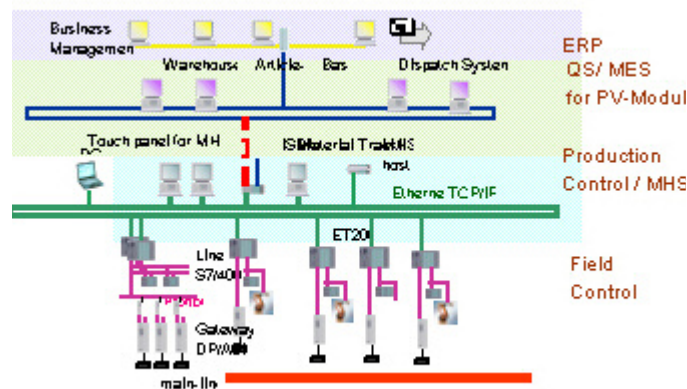
Controls and Visualization Tracking & Tracing

- Supplies the most recognized PLC systems and integrates a sophisticated visual module
- Tracking and Tracing is accomplished with a laser scribe or a data-matrix code identification marking system in combination with scanning cameras



Network

- Connects all interfaces from the PLC field bus to the customer supplied ERP system
- Grenzebach carries their extensive experience with host computers and production optimization into the Photovoltaic industry by developing a customized MES system

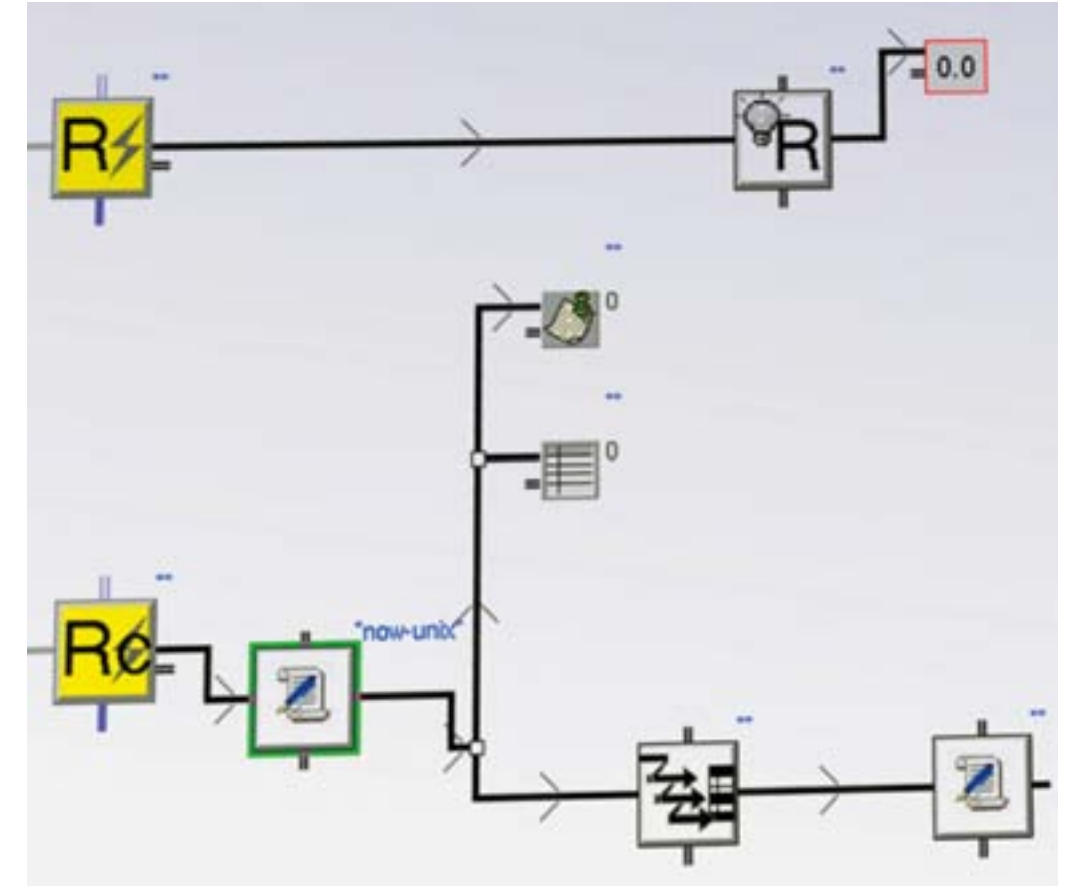


MES – Manufacturing Execution System

Maximize and simplify your PV-production by means of synchronization and the transparency of your processes

Principal benefits

- Increased efficiency of the entire supply chain
- Increased production visibility (Tracking & Tracing, Material Genealogy)
- Filling the information gap between business processes and PLC systems
- Maximized production quality
- Standardization of processes for multiple fabs



Possible Interfaces

- Line PLC, Tracking & Tracing, washers
- Laser scribes, furnace, sputter, PECVD, CVD and PVD

Meeting these goals means creating an integrated IT infrastructure that helps to coordinate production on a global scale and in real time. This requires not only integration between business and control levels inside companies and plants, but also specific manufacturing execution capabilities with access and transparency of critical production data for different levels in the company and the plant.

General functions

- ERP downloads
- ID generation
- Job generation
- QM and SPC
- Process data administration
- Reporting
- Module, processes, productivity KPI
- Re-Routing and re-working
- Buffer, fault trip
- Maintenance and resource management

SIMATIC IT as a Manufacturing Execution System provides exactly these capabilities: The synchronization of activities.



State-of-the-art manufacturing equipment and 24/7 production requires regular preventative maintenance.

Why invest in unnecessary spare capacity? Secure a lead over your competitors by utilising Grenzbach maintenance service to keep your machinery and equipment reliable and in the best possible condition.

Our After-Sales-Service team will relieve you from the burden of maintaining your valuable production machinery.

Give yourself peace of mind and ensure your productivity by targeting a strategic combination of Grenzbach service facilities.



24h Help-Line Support

Fast support by our operating and servicing personnel can be provided using our 24h help-line – worldwide.

An experienced task force leader can be contacted by phone at any time, day or night, to reduce your production downtime to a minimum.

In special circumstances, we can locate one of our specialists, wherever they are in the world, for immediate consultation and to find a fast solution to your problem.



Teleservice

Knowledgeable assistance, via telephone net or Internet, tailored to your specific equipment guarantees advantages which have positive effects on your running costs:

- Fast availability of our 24-hour service
- Support by an appropriate expert to solve your specific problem
- Reduction of costs for start-up, problem solving for operating personnel and breakdowns
- Teletraining, Telecoaching
- Full data security during tele access

Updates

Regular technical updates maintain and increase both availability and productivity of your machinery.

These Grenzbach updates ensure your equipment is maintained up to the latest standards. Fault-free production using modern technology significantly improves your competitive position.



Spare Part Service

We are familiar with every part required for your specific machinery and order them for you from our suppliers. Due to our pre-arranged contracts, these suppliers give priority to our orders, so that we can provide fast delivery reaction and a quicker solution to your problem.

This service will reduce your spare parts stock, releasing tied up capital and valuable storage space.

Training

We provide regular and systematic training for your operating and service personnel, keeping them updated with the latest technologies.

Your staff are thus guaranteed a continuous and progressive training programme. This will result in less operating error, reduced down times and consequent improvement in your production quality.

Emergency operations

By prior agreement with you and initiated by our 24-hour hotline, Grenzbach will react promptly and reliably in case of emergency, by sending a specially trained service technician or specialist.

When requested, Grenzbach will train and retain a local co-operation partner to further shorten our reaction time and offset possible time differences around the world.

In such cases, our specialists are on hand to support the local service technician via teleservice or they will accompany him to the site.

Maintenance plan

We produce a detailed list describing the scope of our maintenance programme. It indicates servicing times, duration of work, length of process interruption, details of service personnel qualifications.



We offer a progressive series of solutions:

- The starting solution – a simple PC version of the maintenance plan.
- The maintenance software – a complete PC version of the maintenance organisation: timer functions, description of maintenance, arrangements for spare parts, report back of work completed and material used, history/log, cost controlling.
- Alternatively the maintenance data can be read using the site's existing maintenance software, e.g. SAP.

Maintenance Contract

Regular maintenance and servicing of your machinery ensures fault-free operation reducing downtime and expensive breakdowns. Grenzbach specialists will visit your production line at regular intervals and check each machine according to a maintenance plan. They will adjust all settings, check the stock of spare parts, write a detailed report, train your personnel, and inform you regarding available updates.



In case of emergency, a short reaction time is guaranteed by co-operation with local supply partners.

Further advantages:

- The required number of trained service personnel is always available to you.
- Machinery delivered by third parties can also be included in the Grenzbach maintenance programme in co-operation with the manufacturer concerned.

Other Grenzebach Technologies



Float Glass



Display – Thin Glass



Gypsum and building board



Veneers



Automation



Process Technology



GRENZEBACH BSH GmbH

Rudolf-Grenzebach-Straße 1
36251 Bad Hersfeld, Germany
Phone: +49 (0)66 21/81-0
Fax: +49 (0)66 21/81-3613
e-mail: info.bsh@grenzebach.com

GRENZEBACH Automation GmbH

Wikingerstr. 11
76189 Karlsruhe, Germany
Phone: +49 (0)7 21/9 52 40-0
Fax: +49 (0)7 21/9 52 40-50
e-mail: info.ga@grenzebach.com

GRENZEBACH Corporation

10 Herring Road
Newnan, Georgia 30265, USA
Phone: +1 (770) 253-4980
Fax: +1 (770) 253-5189
e-mail: info.gn@grenzebach.com

GRENZEBACH Machinery (Shanghai) Ltd.

388 Minshen Road, Songjiang Industry Zone
201612 Shanghai, P.R. China
Phone: +86 (21) 5768-4982
Fax: +86 (21) 5768-5220
e-mail: info.gs@grenzebach.com

GRENZEBACH Maschinenbau GmbH

Albanusstraße 1–3, Hammlar
86663 Asbach-Bäumenheim, Germany
Phone: +49 (0)9 06/9 82-0
Fax: +49 (0)9 06/9 82-2108
e-mail: info@grenzebach.com

GRENZEBACH Machinery (India) Pvt. Ltd.

Cluster 3, Unit 12, Kumar City,
Vagadon Sheri, Pune - 411014, India
Phone: +91 (20)2703-1631
Fax: +91 (20) 2703-0635
e-mail: info.gi@grenzebach.com

GRENZEBACH Machinery Taiwan Ltd.

11F, No. 51, Sec 2, Gonyi Road
Taichung City, 408 Taiwan, ROC
Phone: +886 (4)23289158-100
Fax: +886 (4)23289159
e-mail: albert.chen@grenzebach.com