We have been facing a general economic recession for the past two years, as well as the stagnation of Europe and America and the entry of new players in the world markets. How has Keko Equipment Company coped with the new conditions?

TK: We have not felt the recession, we’ve increased the scope of our operations each year; and this year has been a record breaking year for us. We are present on all key world markets; therefore, it is easier for us to balance the issues from individual markets. However, one of the main difficulties has been facing the “weakness” of the US dollar; and that has been going on for quite some time now. Besides producing devices for the production of passive electronic components, we have expanded our operations into other emerging markets. We have also developed solutions in the green energy area; however, the subsidies in this area have dried up in the European market, which consequently led to the reduction of investments in this area. Green energy is obviously more of a political issue rather than an economic one, and without national financial support, the development has stagnated in this area. We are looking for market opportunities in new technologies and we also carefully monitor all trends.

JŠ: To be honest, this is more a recession of the western world. Russia and China are facing great growth, and we have also made many steps forward in those regions. These are markets that are not considered as technological followers, but have become the top providers of services in the fields of technology. We support producers in developing new products. We also apply our know-how in various fields of industry.

You have mentioned growth of Chinese and Russian markets. This means that your distribution network has also changed or expanded?

TK: We have been present in the Chinese market for a very long time; and now we are successfully entering the Russian market with a local partner. The reduced activity on the western markets makes these two markets of key importance for us. The distribution network is also expanding in other markets, and even though the EU and USA markets have seen a slowdown, they have shown positive growth compared to last year.

JŠ: One of the problems of the European market is that certain industrial branches very much depend on national subsidies, and since that has decreased drastically, the investments also decreased. On the other hand, Russia is strategically setting up and developing the industry of electronic components, where we have a lot to offer.

TK: Both markets, Russian and Chinese, are equally demanding as all other markets. Any underestimation of those markets would get back at us, since both markets have developed substantially in the past years, people are open and focused in foreign markets, and a dynamic and progressive atmosphere is present.

JŠ: Each market has its own cultural identity and specifics. They are quite demanding and specific about what they need so we try to remain flexible. Our advantage on the Russian market is that, as Slavs, we have a better understanding of each other: Unfortunately, the Russian market still faces many bureaucratic obstacles despite its progress. Chinese people are very pragmatic, however, they are quite demanding negotiators, Europeans and Americans are traditionally known as demanding buyers as well, we are doing the best we can to satisfy each market and every customer.
Development has been mentioned many times. What are the key developmental goals of Keko Equipment?

JŠ: The drive of the development is production and not theory. The Chinese are very strong in this area; they are in constant contact with production.

TK: The ideas originate from customers who develop new products and require the technology for their production. Occasionally, we apply our solutions to other areas like pharmaceuticals, food industry etc. We are currently [slowly] investing in additional production facilities at our location in Žužemberk, and we are looking at the possibility of opening an additional production plant in China. The aim is to compete on various development-related tenders.

JŠ: We are seriously considering establishing an institute or R&D centre for the development of new applications based on our technologies, in this way we can offer greater support to our customers and their development, which is currently very popular in the Russian market. Russians are becoming technologically independent, they want their own solutions, and they are becoming more demanding. We also wish to cooperate more with the Jožef Štefan Institute in Ljubljana. We are one of the world leaders for this type of equipment and technologies, but this is a highly specialised sector and the market is very limited, we are always looking for new applications for our machines in other industries.

How do you assess progress in the past two years?

JŠ: Progress happens on a daily basis and remains constant, it is difficult to speak about large steps; however, development is constantly evolving. This year, our production department has been extremely occupied due to a large number of orders received, so there are many ideas that have been placed on stand-by, and are awaiting realisation. We cannot consider development as isolated from other areas of work, since it is very much connected with other functions, our designers are not separate from production; they also put a lot of effort into what they do and are rewarded by seeing how their solutions are functioning in practice. Our activity is very specific and involves special knowledge; that means that each new development engineer needs to be trained separately. In the future we plan to also employ technical experts from abroad.

TK: Despite progress we stick to the basic concept, which is to provide complete solutions. Since we offer machines for the entire production processes, from the production of the ceramic tapes to the sintering of the ceramic packages, we are very good providers of services for production lines that develop new products. We take full advantage of any downturn in our industry by coming up with new ideas and products.

We have been present in the market for many years, the average lifetime of our machines is 10 to 15 years; so we feel honoured when customers keep coming back to us throughout the years when they need to expand or upgrade their production capabilities. Our basic activity remains the manufacturing of machines for the production of electronic passive components. Our staff includes many young experts, we are also experiencing an internal technological development and introducing a larger scope of CNC technology. Our plans are challenging, but there is no reason why we could not realise them just as we have realised our plans so far.
Multilayer ceramic components are manufactured from single green ceramic sheets. The single layers are very accurately stacked to form a multilayer package; the machines that perform this operation are called stackers or collators. Keko Equipment produces a wide range of stackers, adapted to different component types and production requirements. In this article I would like to explain the main stacking principles used by our machines and I would like to also offer some advice regarding how to select the proper stacking process and machine. Proper process and machine selection depends on several criteria like:

- **Tape type:**
  - Tape on carrier film (PET)
  - Tape without carrier (freestanding tape)
  - Tape on roll
  - Individual sheets

- **Tape properties:**
  - Tape thickness
  - Tape taking properties
  - Punched / no punched
  - Other properties which may influence the stacking performance, e.g. formation of bubbles, brittleness, etc.

- **Component type:**
  - Number of layers
  - Number of patterns
  - LTCC, MLCC, MLV, MIL, piezo, etc.

- **Production volume:**
  - small, medium, large

Processing possibilities to build a ceramic stack

There are two possible methods:
- Print on stack process
- Separate printing, drying and stacking

Processes descriptions and machines selection guide

**PRINT ON STACK PROCESS**

- **Layer is pressed on to a carrier**
- **Electrodes are printed**
- **Print drying**
- **Cycle repeats as many times as necessary**

Keko equipment is a leading worldwide supplier of print on stack technology and machines, owning several patented solutions.

**Advantages:**
- Lowest production cost (tape stacking, electrode printing and drying is done in one machine)
- Small footprint
- Suitable for medium to large scale production
- Possible to fill vias on thin layers
- Possible to use freestanding tape, or tape on carrier film

**Disadvantages:**
- Limited layer count depending on tape / print thickness ratio. (Larger ratio means more layers, smaller ratio means less layers. [The stack thickness is uneven at high layer counts and the printing quality deteriorates])
- Limited number of printed pattern (max. 4)
- Not a flexible process. It would take about the same time to build one stack than to build several ones. Main issue is the drying step.

Generally, print on stack process is recommendable where products design does not change very often, for components with less 100 layers, and with less than 4 different prints in the stack.

**Products:** MLCC [up to 100 layers, depending on tape thickness], MLCV, MILC, Piezo ceramics, etc.

**Machines:** Manual machines suitable for pilot or medium production. The production line can consist of several manual machines. For smooth operation two operators are needed, one on the printer and one on the stacker.

Individual layers are stacked and printed one by one until the full stack is built. In case different patterns are needed, multiple printers may be used.
SEPARATE PRINTING, SEPARATE STACKING

This is the most common approach to produce multilayer electronic ceramic components.

Advantages:
- Universal process suitable to produce most types of components
- Stable conditions during printing and stacking
- Highest layer count possible
- Very flexible, suitable for small or large production volumes

Disadvantages:
- Difficult to handle tapes without carrier film
- Difficult to fill vias on thin ceramic sheets
- Higher investments cost
- Larger production space required

Products:
- all types of multilayer electronic ceramic components

Machines:
Here will be described the stacker based on the type of printed tape used.

Tape on PET carrier, pre-printed, wound on roll

Applications: MLCC, MLCV, large scale production
Keko equipment is currently not offering a suitable stacker to build stacks from a roll of pre-printed ceramic tape.

Foil on PET carrier, pre-printed, single sheet handling

Two methods of stacking are possible:
- Stacking a sheet (face down) on top of previous layer and then peeling off the PET film
- Removing the PET film first then stacking a new sheet on top of a previous one

Machines for stacking first then peeling off the PET-film

SM-series: Basic stacker with pin alignment and manual PET film removal, it uses a uniaxial press for stacking. It is suitable for R&D or small scale production level where high alignment accuracy is not required.

Heated upper and bottom pressing plates. Up to 2 mm stacking height. Up to 42 tons pressing force. Suitable for inline installation with a printer for print on stack technology (previously described).
**SW - series**
Universal stacker designed primary for LTCC, HTCC and similar applications.
Wide range of options like:
- Manual or fully automatic version.
- Pin or vision alignment
- Possibility of stacking sheets face up or face down.
- Possibility of pressing under a vacuum.
- Vacuum stack fixing.

**SB - series**
Fully automatic version only. High output, short cycle time.
Process takes place on several stages simultaneously. Vision or pin alignment.
For large scale application like MLCI, LTCC, etc.
Up to 32 patterns [sheets] manipulated from cassettes.
Process takes place on 24 carrier pellets, transported step by step from station to station.
Not suitable for tape thickness bellow 15 microns and high layer count.
Peeling of PET film first then stacking pressing sheet on top of previous layer

**ST - series**
The main advantage of using this approach is that it’s suitable to build stacks with a high number of layers using relatively thin sheets. It’s appropriate to produce MLCC, MLCV, piezo components, etc. This technology is not suitable to process punched sheets used in LTCC, HTCC and MLVI production.
- Manual or automatic tape handling from cassettes.
- Stacking on a carrier palette or (as an option) into a cavity.
- Stacks of up to 1000 layers can be built (using a cavity) for piezo ceramic components.
- Stacks up to 8 different patterns.

**Conclusion**
The stacking process has a great influence on the final quality of the product. Any issues from the previous steps are immediately evident during the stacking process. The results do not depend only on the machines; they also depend on the material and its condition. The most critical stacking properties are:
- uniform tape thickness
- low tacking forces
- low release force of the PET film
- minimum tape distortion during pressing
- small tape shrinkage due to temperature
- adequate tape air permeability
- tape should not be too brittle
- tape should accept some tension forces

The tape properties define the stacking ability of the stacker; unfortunately, there’s no tape system that has all the ideal properties for stacking. It’s not always possible to achieve high stacking quality without improving some of the ceramic tape properties, not even machine modifications can compensate for inferior tape properties.

In most cases, testing of the stacking properties for a particular tape is necessary. Keko Equipment’s engineers will offer advice or adapt the machine as much as possible to be able to process your particular material. On the next page there is a graphic showing the stacking machine selection guide, you can also use it to find the limits of a particular stacking method.

Please also read my article regarding the influences to the stacking accuracy in our newsletter No.5

Jože Štupar
Technical manager
Stacking process and stacking machine selection guide

Legend
- Print on stack process
- Carrier film removing after pressing
- Carrier film removing before pressing
- Customer material needs to be verified in order to confirm process limits for particular material

PAL machine type with carrier film supported tape feeder
PAL machine type with freestanding tape feeder
Punching up to five hundred 80 micron holes per second using multiple pin punching tool

New developed multiple pin servo motor driven punching tool dramatically increases punching efficiency, punching simultaneously up to 50 via holes at once. Maximal punching speed of tool is 15Hz. Multiple tool punching is particular suitable for mass LTCC and MLCI production. Minimal punching diameter is around 80 micron.

Next to multiple punching too, we developed also servo motor driven single pin punching too. Advantage of this tool is in quiet operation, less tool vibration at high speed what reflects in longer tool life time.

Thin layer via filling invention

Limitations of conventional via filling methods are known. Not only thick layers and small via diameter are difficult to fill by conductive paste, also thin layers bellow 30 microns are extremely difficult to via fill, as via filling paste is pushed easy out of it. Avoiding this problem Keko equipment engineers developed reliable via filling process and machines for via filling thin tapes. Process is especially suitable for 100 to 5 microns tape thicknesses.

Process is suitable for low or high volume production and can be completely automatic. Contact Keko Equipment for more information.
Trade Fairs & Exhibitions

In 2010 and 2011 we were attending CARTS Jacksonville, Conference Kunshan China, EXPO Moscow, EXPO Solar South Korea, IMAPS Munich, Printed Electronics Dusseldorf, Productronica...
Standard Products Overview
### Slurry preparing

**Roller benches**
- BL - series
  - adjustable rotation speed and time
  - adjustable to different jar sizes

**Laboratory tape casters**
- L-series
  - for laboratory or small production volume
  - casting on PET film
  - casting speed control
  - gravity slurry feeding
  - tape winding

**Compact tape casters**
- C-series
  - compact size requiring minimum floor size
  - suitable for solvent and water based systems
  - high accuracy in thickness control
  - automatic tracking of carrier film
  - automatic slurry feeding
  - applicable for up to 100 micron tape thickness

**Horizontal tape casters**
- H-series
  - thickness 5-500 micron (0.2-2 mils)
  - advanced drying regimes possible
  - high accuracy in thickness control
  - automatic tracking of carrier film
  - automatic slurry feeding

**Steel belt tape casters**
- S-series
  - suitable for price sensitive applications
  - different drying regimes
  - high accuracy doctor blade
  - automatic tracking of steel belt
  - automatic slurry feeding
  - tape winding

### Tape casting

**Automatic green tape blanker**
- SC-series
  - blanks single sheets from a roll of green tape
  - suitable for freestanding or Mylar based tapes
  - trims sheet edges
  - punch registration holes
  - transfers blanked sheets to a magazine
  - sorting blanked sheets according to their thickness

### Tape blanking

**Punching machine**
- PAM-series
  - punch holes for vias and registration in green tape
  - punch cavity rectangle or square holes
  - Manual, CAD, NCDrill and DXF file input
  - tool breakage detection
  - automatic sheets re-alignment

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**Special features:**
- Especially suitable for LTCC production
- Suitable for price sensitive applications
- Advanced drying regimes possible
- High accuracy in thickness control
- Automatic tracking of carrier film
- Automatic slurry feeding
- Suitable for freestanding or Mylar based tapes
- Trims sheet edges
- Punch registration holes
- Transfers blanked sheets to a magazine
- Sorting blanked sheets according to their thickness

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**Tools have to be specified separately**
### Screen printing

**P - series**
- Three models available to meet all requirements
- Fully programmable printing parameters
- Print, print, print/flood, flood, print on contact print, stencil printing via filling
- Extensive options for demanding advanced technology applications

**Models:**
- P-xxx
- P-20G AM

### Roll to roll printing

**RTP - series**
- Automatic sheet handling, printing, drying process
- Two models available to meet all requirements
- Fully programmable printing parameters
- Print, print, print/flood, flood, print on contact print, stencil printing via filling, screen cleaning
- Extensive options for demanding advanced technology applications

### Drying

**Drier SD - series**
- Dry single sheets, substrates or wafers after printing
- Air flow ensures high drying efficiency
- Adjustable internal and fresh airflow circulation
- Sheets are transported by teflonized mesh belt
- IR fast drying version available
- Height adapted to Keko manual screen printers

### Cover sheets making

**CSM - series**
- Makes cover sheets directly onto carrying palette from roll of tape
- Glues the cover sheet to custom carrying palette
- Sheet blanker and press in one unit

### Stacking

**SM - series**
- Simplified manual stacker
- Uniaxial lamination possibility
- Pre-registration can be done by registration pins

**Stacking machine SW - series**
- Universal manual or automatic stacking machine for low to medium LTCC or similar component production
- Suitable for tapes with or without carrier film
- Process on one carrier pallet
- Possible to start building stack from top or from bottom
Stacking

**Stacking machine**

**ST-series**
- Automatic sheet loading from cassettes
- Carrier palette automatic loading / unloading
- Pre-registration is done by registration pins
- Automatic vision alignment
- Suitable also for very high layer count
- Not suitable for tapes with punched holes

**Models:**

- **ST-xxx**
  - P - Carrier plates automatic loading
  - C - Cavity for high stacks, without pressing possibility
  - V - Vision alignment
  - M - Manual
  - A - Automatic
  - Sheet size: 4 6 8 inch

**Stacking machine**

**SB-series**
- Automatic sheet loading from cassettes
- Carrier palettes automatic loading / unloading
- Pre-registration is done by registration pins
- Automatic vision alignment
- Suitable for high volume production
- Suitable for various components

**Printing & stacking**

**Printing and stacking machine**

**PAL-series**
- Universal system for components up to 100 layers
- High productivity = low cost per component
- Suitable for smallest components size
- Uses carrier film tapes, freestanding tapes and individual sheets
- Special configurations like: several printers
  - several driers
  - sheet vision alignment
  - other special requirements

**Laminating**

**Uniaxial thermal press**

**TPR-series**
- Multiple stacks are laminated simultaneously
- High stack lamination possibility
- Simplified versions available
- Easy to operate, quick product turn-around time
- Rigid, compact design takes little floor space

**Isostatic lamination press**

**ILS-series**
- Up to 40 stacks/substrates laminated simultaneously
- Wide selection range of bar size
- Easy to operate, quick product turn-around time
- Rigid, compact design takes little floor space
- Stores up to 99 pressure programs
Cutting

Cutting machine
CM-series
- Cuts the most difficult high thickness green Ceramic Ware
- Automatically positions knife with high accuracy
- Automatically finds cutting markers
- Adjustable speed and cutting depth
- High productivity due to high cutting speed

Edge Trimmer
ET-series
- Simple, flexible and accurate
- Bar Edge trimming and Spitting possibility
- Laser pointers installed for precise block positioning
- Heated cutting table and cutting blade

CNC Drilling machine
DM-series
- Cuts round components out of green ceramic
- Drills holes
- Automatically positions bar by vision system
- Two working spindles with programmable cutting speed above using two different cutting tools
- DXF file conversion
- Vacuum bar fixing

Solar and SOFC cells printer

Automatic solar cells printing line
SOC-series
- Automatically prints electrodes on to solar silicon wafers or thin ceramic SOFC substrates
- Loads wafers from cassettes or inline integration
- Unique, high speed self cleaning wafer/substrate transport ensures minimal manipulation and low breakage
- Short exchange time for different dimensions
- Vision alignment and breakage check
- High precision screen printing with precise squeegee control prints the electrodes
- IR drier for efficient drying
- Modular design, for different configurations
- Automatic unloading in to cassettes or on to furnace belt

HOT MELT

Custom designed

Our machines are developed, designed and produced in our house.

One of Keke Equipment strongest part is custom designed equipment basted on custom requirements and our long term designing and machines production experiences.

Many customers are satisfied with our innovative solutions adapted to their needs.

Experienced production team is guaranty for quality and success.

Contact us, if you are looking for custom solution, which you can not find on the market.
Installed Keko Equipment machines worldwide
KEKO Equipment Ltd. is a leader in the manufacture of machines for the production of multilayer passive ceramic components but also many other products, based on a tape casting process.

Twenty-five years of experience have given us the vast knowledge that is now marketed under our own brand in the European, Asian, American and Australian markets.

Our roots stretch a long way back to when we were a unit of the Iskra consortium. Since 1995 the company is in private hands and its philosophy today is formulated by a team of highly motivated engineers and designers.

In addition to the extensive range of proven products, we focus our specialized know-how into custom manufacturing.

In the development of specialized technological solutions we take into account our customers requirements and the needs of each individual buyer; thus providing the basis for a successful long-term relationship.

This is aided by our widespread sales network that spans all continents, where we always cooperate closely with knowledgeable local agents. They have helped us to provide very successful post-sales services and ensure customer satisfaction.

Knowledge, flexibility and innovation are our company’s key competitive advantages and our brand name’s good reputation now reaches all over the world.