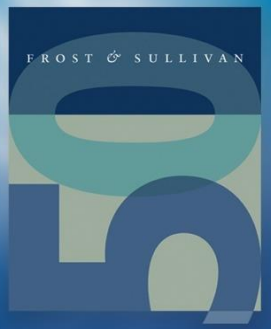
Advanced Manufacturing Technology (TechVision)

Metal-cutting Tool Innovations

Metal-cutting tools and related tool systems are key to the success of many metalworking firms. Technology advances can lower costs and expedite manufacturing time, boosting productivity



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Metal-cutting Tool Innovations

Vibration Damping Tool Holders
Sandvik Coromant, Sandviken, Sweden

Unmet Needs/Trends

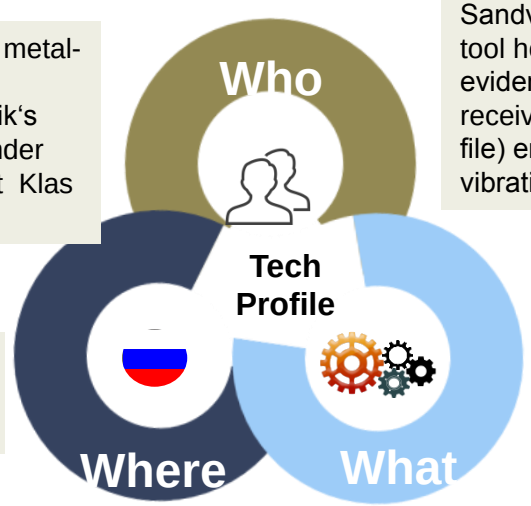
- Vibration-induced tool chatter is unwelcome because it can ruin the machined metal surface finish.
- In severe cases, tool chatter can leave an unsightly deeply scalloped surface morphology, which has to be machined off, or replaced if there is not enough metal to be machined off, at considerable expense.

Potential Applications

- Internal turning operations with large overhang ratios (application in long boring bars)
- External turning operations

The advanced research on metal-cutting tool holder vibration damping was led by Sandvik's Coromant business unit, under the leadership of President Klas Forsstrom..

Sandvik is located near Stockholm, Sweden, the capital city of the country.



Sandvik Coromant's insights on tool holder vibration damping is evident in the company's well-received handbook (a 60 page pdf file) entitled: "How to reduce vibration in metal cutting".

Innovation Attributes

The key innovation is the use of heavy weights, rubber springs and oil within tool holders to dampen vibration at the source. Vibrations can be induced by resonance at a natural frequency or forced by surface discontinuities, such as an interrupted cut across a gap.

Future Plans

The Sandvik engineers want to introduce beneficial vibration damping over a wider range of vibration frequencies.

This tool holder innovation is in the market now.

Funding

The vibration damping research was funded internally by Sandvik Coromant.

Advances in Automotive Aluminum (Al) Body Panel Forming and Cutting

Tesla Motors, Fremont, California, USA

Unmet Needs/Trends

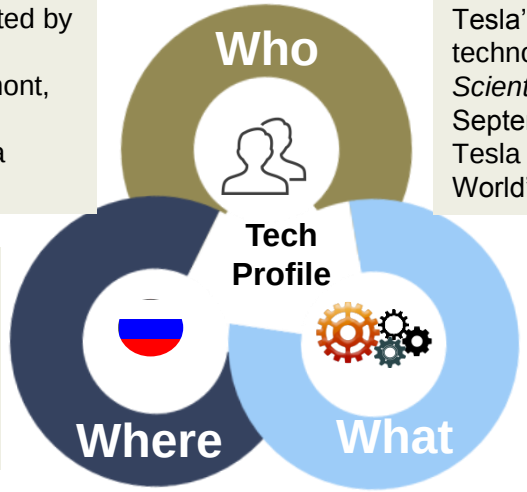
- The mass-market car builders have rather limited experience producing Al body panels in volume.
- Stamping is a challenge as well as secondary operations required before attachment to the vehicle
- Smaller specialty car producers can show how it can be done properly.

Potential Applications

- Electric vehicles for street use
- Weight-reduced conventional vehicles
- Racing vehicles: electric, hybrid electric, or engine-driven

The technology was illustrated by Tesla Motors via a private TechVision tour of the Fremont, California stamping and assembly plant, hosted by a Tesla tooling engineer.

Tesla's Fremont plant, formerly a GM and then a NUMMI (GM/Toyota JV) plant, is located near the southeastern sector of San Francisco Bay.



Tesla's Al body panel production technology was highlighted in a *Scientific American* article of 23 September, 2013 entitled: "How Tesla Motors Builds One of the World's Safest Cars"

The Tesla Model S has been on the market since 2012, and the new Model X SUV was first shipped in fall 2015.

Innovation Attributes

The key innovation is mastering the art of slow-stamping of Al sheet (to avoid heat warping) followed by laser-based metal-cutting for final shaping. Tesla Fremont operates the largest hydraulic presses (7 stories high) in North America, with 5 lined-up in a row.

Future Plans

The engineers want to expand the Al body panel technology perfected for the Model S to various new models (X, 3, E, et al)

Funding

The metalworking research was funded internally by Tesla Motors.

Metal-cutting Tools Replaced by Electrochemical Machining (ECM)

Everite Machine Products Company, Pennsauken, New Jersey, USA

Unmet Needs/Trends

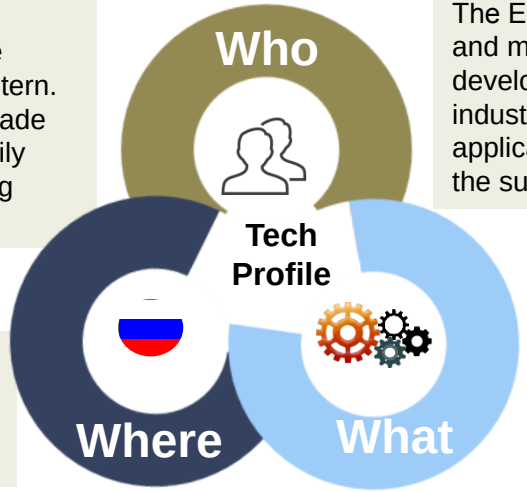
- Sometimes, metal-cutting can seriously damage workpieces
- Traditional metal-cutting can impart unwelcome heat, which can compromise the temper of the metal workpiece.
- Mechanical stress imparted by metal-cutting can also be serious, requiring application of a post-machining stress relief anneal heat treatment.

Potential Applications

- ECM is generally best applied to lower-volume workpieces made of challenging metals.
- Titanium alloy jet engine cases
- Nickel-based superalloy jet engine internal components.

Much of the ECM systems development was under the leadership of CEO Daniel Stern. Everite produces custom-made ECM machines and is heavily into electrochemical grinding (ECG) machines.

Everite is located in the area of New Jersey close to Philadelphia, Pennsylvania.



The Everite team's engineering and manufacturing expertise was developed over decades of industrial experience. R&D and application engineering is part of the suite of services offered.

ECM technology is on the market and well-proven, especially in the gas turbine industry.

Innovation Attributes

The key innovation is use of chemical etching (also known as reverse electroplating, or electrolysis) to remove metal in three-dimensions, instead of metal-cutting. ECM is used for milling, grinding and drilling of metals. No heat or stress is applied to metals.

Future Plans

The Everite engineers want to develop a means to accelerate the metal removal rate, so that higher-volume metal pieces can receive successful ECM or ECG processing.

Funding

The engineering development of ECM systems was funded internally.

Tooling for Automated Metal Turning Operations

Okuma Corporation, Oguchi, Aichi Prefecture, Japan

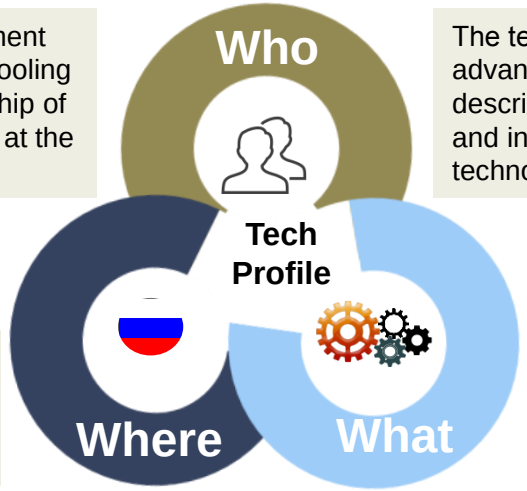
Unmet Needs/Trends

- Even given high-speed CNC (computer numerical control) metal-cutting (including turning) machines, production can be slowed down by inefficient cutting tool changing and handling.
- There is a need for quick-change tool holders and multiple tool turrets that can be quickly engaged for metal-cutting duties.

Potential Applications

- CNC turning centers
- CNC machining centers (external turning, internal turning (boring), milling, drilling, tapping, cut-off, et al)
- CNC machining cells

The research and development for global turning machine tooling activity is under the leadership of a Senior VP of Engineering at the Japan HQ (Oguchi Plant).



The team's development of advanced tool holders is described in the company website and in the metalworking technology literature.

Okuma HQ is located in the Aichi Prefecture of central Japan's Honshu Island.

Innovation Attributes

The key innovation is development of truly quick change tool holders plus multiple tool turrets (up to 3) that complement the CNC turning of metal workpieces, all tool turrets working in parallel.

Future Plans

The researchers want to constantly develop more clever and useful tool holders and quick-change tooling to boost customer productivity.

Many advanced Okuma tooling products are already on the market, with more coming soon.

Funding

The tooling R&D was funded internally by Okuma.

STRATEGIC INSIGHTS

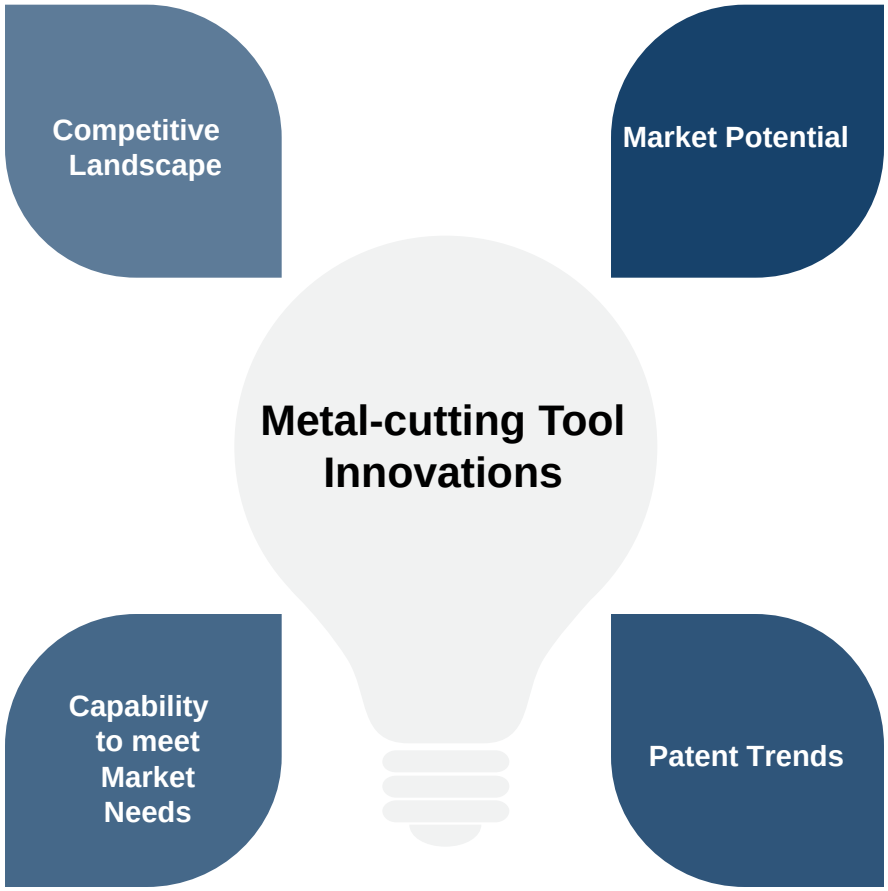
Strategic Insights

Various Research Rivals

A great many global research organizations and metal-cutting machinery/tooling participants are involved in pushing the state-of-the-art.

Little Ability to Serve Market

R&D organizations and universities have no ability to manufacture production tooling holders, but industry participants do that every day.



Market Potential is There

Analysts are optimistic about the market for metal-cutting tools and related tool systems, which is already a rather large global business. The market growth rate outlook, however, for such a mature business is not especially high.

Patent Activity Growing

Global patents related to metal-cutting tools and tooling systems applied for and granted, are growing annually. That reflects a robust level of research activity and a growing interest in securing IP in the field.

Strategic Insights

Drivers

- ✓ Boosting productivity
- ✓ Expediting machining throughput
- ✓ Lowering production costs

Challenges

- Ẋ Higher up-front costs of advanced tool solutions compared to standard tools
- Ẋ Limited availability from multiple competitive vendors
- Ẋ Heat and stress damage to machined workpieces can encourage rival technologies.

R&D Focus Areas

- Further development of less-mature technologies that can raise the confidence of potential investors
- Conducting proof-of-principle experiments
- Moving from laboratory to functional field applications in working machine shops
- Documenting results in peer-reviewed manufacturing technical papers

Funding & Market Potential

- Substantial amounts of annual funding have been directed toward development and production of metal-cutting tools as well as tooling systems
- The annual global market potential for metal-cutting tools and systems is quite large, perhaps tens of billions of dollars.

The 2020 Scenario

- ❑ The 2020 scenario for commercialization is interesting
- ❑ There is a well-established metal-cutting tool market now, but acceptance of advanced (far-out) innovations in such a conservative industry takes time.

COMPANIES TO WATCH

Companies to Watch–Metal 3D Printing

Company	Description
ExOne Texas, USA	• ExOne's 3D printing technology– Binder jetting, is a technology initially developed by MIT. This technology varies largely from other 3D printing technologies and can be used extensively in manufacturing industrial grade metal components and objects. • The application potential of ExOne's 3D printing technology includes industries like aerospace, automobile, energy and semiconductor manufacturing. Being one of the few public companies in 3D printing industry, ExOne is a company to watch out for due to its metal 3D printing capabilities.
EOS GmbH Germany	• EOS is an additive manufacturing company that has worked extensively in additive manufacturing technology for nearly 25 years now. • Over the years, EOS has evolved to provide high-quality metal 3D printers and services. EOS uses Direct Metal Laser Sintering (DMLS) to provide high-grade industrial metal components and objects. • An eagle's eye for quality, several quality standard compliance, high quality metal finishing and diverse applications are some of the salient features of EOS that will put this company on top of metal 3D printing companies this year.
Arcam AB Sweden	• Arcam is a purely metal 3D printing company that produces metal 3D printers and 3D printing services based on a patented 3D printing technology named "Electron Beam Melting (EBM)". • Arcam delivers high-quality metal 3D printing for the aerospace industry. • However, Arcam's niche area is orthopedic implants, in which area Arcam has produced many new 3D printing innovations and implants for various types of bones and joints. • 3D printed orthopedic implants are gaining more importance in the healthcare industry. Arcam's 3D printing solution provides customized and high-quality metal implants, ensuring that the product has the edge over other 3D printers for orthopedic implants.

KEY PATENTS

Key Patents- World

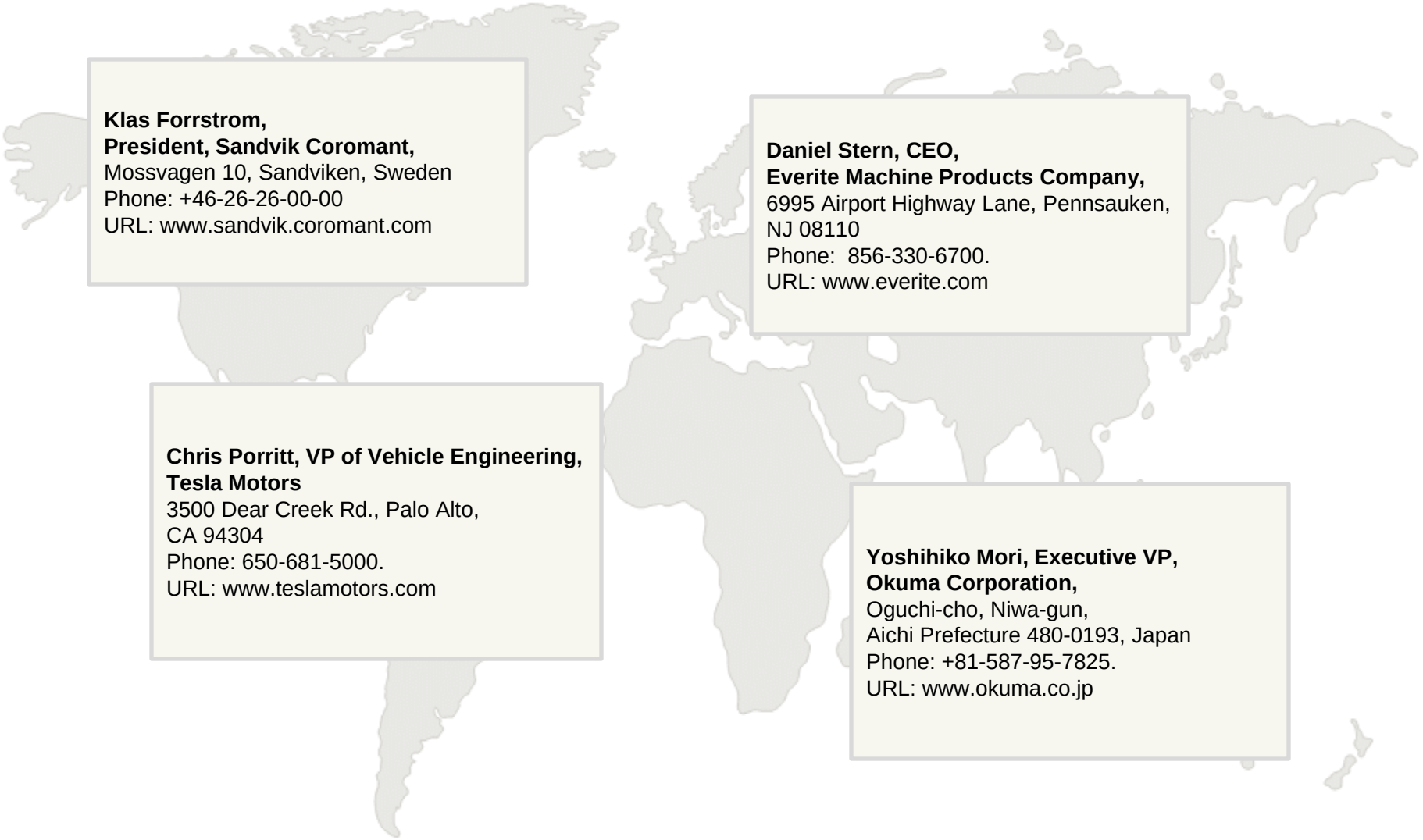
No.	Patent No.	Publication Date	Title	Assignee
1	**WO/2016/020134**	11.02.2016	Adjusting a targeted temperature profile at the strip head and strip base prior to cross-cutting a metal strip	Primetals Technologies Austria GmbH
	The invention relates to the area of metallurgical systems, specifically a rolling mill with a cooling zone for cooling and scissors for cross-cutting metal strips, which are preferably made of steel. The aim of the invention is to provide a method and a device with which even metal strips with thicknesses > 4 mm and/or metal strips made of high-strength materials can be cross-cut by means of scissors arranged after a production line and a cooling zone. This is achieved by a method in which the metal strip (6) is cooled in the cooling zone (10) to a specified temperature profile in the longitudinal direction of the metal strip (6) such that the metal strip (6) has a higher temperature in the region of the strip head of the trailing metal strip portion (31) and the strip base of the leading metal strip portion (32) than in the upstream and downstream regions.			
2	**WO/2015/168276**	05.11.2015	High speed laser cutting of amorphous metals	IPG Photonics Corporation
	Laser cutting systems and methods are used to cut amorphous metal materials, such as thin amorphous metal ribbons or foils, with a relatively high speed. Embodiments of laser cutting systems and methods described herein also allow cutting with reduced crystallization, and thus reduced increases in thickness, at the cut edges and with reduced cracks or other cutting defects at the cut edges. A fiber laser, such as an Ytterbium fiber laser, is used to generate a laser beam with a power level greater than about 50 W. The laser beam is focused and directed at the amorphous metal material with a beam spot size of about 30 microns or less. The focused laser beam and the amorphous metal material are moved relative to each other at a speed greater than about 18 inches per second such that the focused laser beam cuts the amorphous metal material.			

Key Patents- USA

No.	Patent No.	Publication Date	Title	Assignee
3	**US 20150360324**	17.12.2015	Method for cutting a sheet metal blank having a predetermined contour	Schuler Automation GmbH & Co. KG
	The invention relates to a method for cutting a sheet metal blank having a predetermined contour from a metal strip that is continuously conveyed in a transport direction (x). The method includes the following steps of providing at least one laser cutting apparatus having at least one laser cutting head that can be moved both in the transport direction and in a y-direction extending perpendicularly thereto, and a control device for controlling a movement of the laser cutting head in accordance with a control program generating the predetermined contour; continuously measuring a path (ΔXstrip) of the metal strip in relation to the transport direction by means of a path measurement device provided upstream of the laser cutting apparatus; and dynamically calculating the movements of the at least one laser cutting head by means of the control program with use of the measured path values provided by the path measuring device.			
4	**US 20150224600**	13.08.2015	Method and processing machine for piercing, drilling, or cutting metal workpieces	TRUMPF Werkzeugmaschinen GmbH + Co. KG
	The disclosure relates to methods and systems for piercing, drilling, or cutting metal workpieces in a laser processing operation. The methods include focusing a pulsed laser beam onto a processing location on a workpiece; detecting process radiation emitted from the processing location; determining an intensity of the process radiation at a plurality of temporally sequential times during pulse pauses; determining an intensity gradient of the process radiation; comparing the intensity gradient with a gradient threshold value; and detecting a spontaneous material removal on the workpiece when the number of times the gradient threshold value has been exceeded is above a predetermined limit value. When a spontaneous material removal is detected, the system changes one or both of a laser parameter and a processing parameter of the laser processing operation. The disclosure also relates to processing machines for carrying out the methods.			

INDUSTRY CONTACTS

Industry Contacts



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